Final Report

Combined Sewer Overflow Abatement Study

Master Plan

City of Portland, Maine

December 1993

CH2M HILL
Boston, Massachusetts

Dufresne - Henry
Portland, Maine

CH2M HILL

Engineers
Planners
Economists
Scientists

December 21, 1993

BOS31506.B5.MP

Mr. Bill Goodwin
City of Portland
Department of Parks and Public Works
55 Portland Street
Portland, ME 04101

Subject: Combined Sewer Overflow Abatement Study Final Master Plan

Dear Mr. Goodwin:

CH2M HILL is pleased to transmit to the City, and simultaneously, to the Portland Water District, the Maine Department of Environmental Protection (DEP), and Region I of EPA, the Final Master Plan for control of combined sewer overflows in the City of Portland. Twelve (12) copies are enclosed for distribution to City staff. We believe that the Recommended Plan presents a balanced, reasonable approach to control of CSOs in Portland that is consistent with the overall objectives of the City to provide recreational and other benefits to the community.

This Final Master Plan addresses the comments collected on the Draft Master Plan presented at various forums with regulatory, environmental, and public groups in addition to formal comments received from Maine DEP and EPA Region I. The principal modifications to the Final Master Plan are highlighted below:

- Chlorination/dechlorination of the storage conduit relief overflow to Back Cove

- Additional flow slippage to the Portland Harbor to reduce annual average CSOs by approximately 90 percent by volume and 50 percent by events

Overall, the Final Master Plan provides the City with a cost-effective level of CSO control for protection of the critical uses and sensitive areas of environmental habitat and areas highly regarded by the public. We are prepared to make a presentation of the Final Master Plan to the City Council, whenever it can be scheduled.

We at CH2M HILL and Dufresne-Henry have sincerely enjoyed working with the City and District staff on this project and are very appreciative of the full support provided by your staff and those at the PWD. As the CSO Master Plan is implemented, components of the Plan will be refined and revised. This document, therefore, should periodically be updated as details evolve. We look forward to opportunities to work with you further in the implementation and refinement of the plan to the benefit of the Portland area.

Very truly yours,

CH2M HILL

Bruce A. Johnson, P.E.
Project Manager

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cc: Mark Jordan, Portland Water District (4 copies)
Dennis Merrill, Maine DEP (3 copies)
Susan Beede, USEPA–Region I (3 copies)

FINAL REPORT

COMBINED SEWER OVERFLOW ABATEMENT STUDY
MASTER PLAN

Prepared for
The City of Portland, Maine
Department of Parks and Public Works
55 Portland Street
Portland, Maine 04101

Prepared by
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December 23, 1993
BOS31506.B5.MP

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List of Abbreviations

ASPS	Arcadia Street Pump Station
BAT	best available technology
BBPS	Baxter Boulevard Pump Station
BCT	best conventional technology
BG/yr	billion gallons per year
BMP	best management practice
BOD_5	5-day biochemical oxygen demand
BPJ	best professional judgment
BPT	best practicable technology
BSF	base sanitary flow
CCI	construction cost index
cfs	cubic feet per second
CIP	Capital Improvements Plan
City	City of Portland, Maine
CSO	combined sewer overflow
CWA	Clean Water Act
DEP	Maine Department of Environmental Protection
DO	dissolved oxygen
EMC	event mean concentration
ENR	Engineering News Record
EPA	U.S. Environmental Protection Agency
FAVs	final acute values
FRPS	Fore River Pump Station
FSPS	Franklin Street Pump Station
GO	General Obligation
GWI	groundwater infiltration
I/I	infiltration and inflow
ISPS	India Street Pump Station

MG/yr	million gallons per year
mgd	million gallons per day
MHPC	Maine Historical Preservation Commission
NEPS	Northeast Pump Station
O&M	operation and maintenance
PAH	polynuclear aromatic hydrocarbon
PWD	Portland Water District
QAPP	Quality Assurance Project Plan
RDII	rainfall-derived infiltration and inflow
SS	settleable solids
Study	Portland Combined Sewer Overflow Abatement Study
SWMM	Stormwater Management Model
TKN	total kjeldahl nitrogen
TM	Technical Memorandum
TP	total phosphorus
TPPS	Thompson Point Pump Station
TSS	total suspended solids
USGS	U.S. Geological Survey
WWTF	Wastewater Treatment Facility

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Executive Summary

Combined Sewer Overflow Abatement Study
Draft Master Plan

Executive Summary

Over the last two decades the improvements in water quality of our nation's and Maine's waters due to the implementation of Public Law 92-500, known as the Clean Water Act, have been dramatic. Development of water quality standards, construction of secondary, and in some cases, advanced wastewater treatment facilities, management of wastewater sludge, and investment in wastewater conveyance systems have gone a long way toward restoring the beneficial uses of our water resources. Over the last few years, control of combined sewer overflows, as one of the remaining deterrents to achieving water quality standards, has become a national focus.

The Combined Sewer Overflow Abatement Study Master Plan for Portland, Maine, outlines a plan that will address not only the combined sewer overflow (CSO) problem in Portland, but also the directly related wet weather problems of flooding and sewer system surcharging, all in the context of the City's long-term goals for open space, recreational benefits, and community enhancement. During the course of the CSO Abatement Study, three of the 42 CSOs were eliminated.

Background

During dry weather, the Portland combined sewer system transports a combination of sanitary flow and groundwater infiltration to the Portland Wastewater Treatment Facility (WWTF). During wet weather, stormwater runoff from approximately 4,200 acres also flows to the combined sewer system, resulting in overflows of combined sewage at one or more of the 39 CSO locations shown on Figure ES-1. The following is a summary of the CSO activity in each of Portland's water bodies for an average year:

Table ES-1
CSO Water Quality Impact Summary[1]

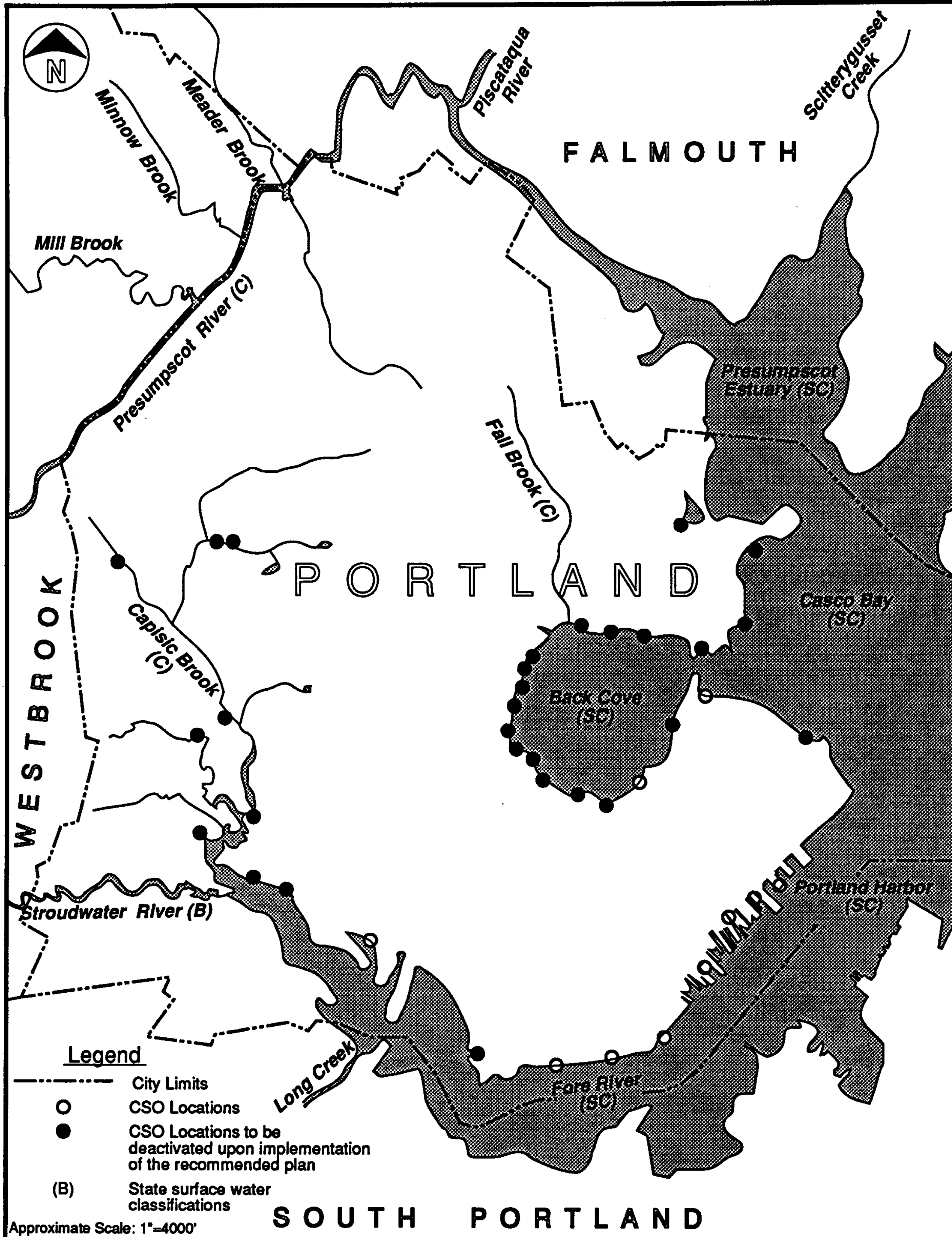
Receiving Water	No. of CSOs[3]	Annual		Summer[2]	
		No. of Events[4]	Vol. (MG)	No. of Events[4]	Vol. (MG)
Casco Bay	5	30	55	14	22
Presumpscot Estuary	1	13	2	6	1
Back Cove	15	44	416	19	157
Portland Harbor	7	43	145	19	62
Fore River	7	36	73	18	32
Capisic Brook	4	26	29	14	12
Areawide	39	44	720	19	286

[1]Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record.
[2]The summer season is defined by Maine's water quality regulations as May 15 to September 30.
[3]Two CSOs which discharged to the Capisic Brook and one CSO which discharged to the Fore River were recently closed bringing the total number of CSOs from 42 to 39.
[4]A receiving water CSO event is defined as one or more discharges to a receiving water resulting from a single precipitation event; it approximates the number of days a receiving water is impacted by CSOs.

CSOs degrade the quality of the riverine and coastal waters. The sanitary sewage component, combined with the stormwater runoff, contributes pathogens, bacteria, sanitary sewage "floatables," and elevated nutrient levels (phosphorous and nitrogen) that contaminate and limit use of the receiving waters.

The City of Portland operates and maintains the combined sewer collection system, while the Portland Water District (PWD) is responsible for the combined sewer interceptors and the WWTF. CSOs are permitted by the State of Maine under the National Pollutant Discharge Elimination System (NPDES). The PWD has permit responsibility for 25 CSOs, and the City maintains responsibility for the remaining 17 CSOs.

Bos31506 FigES-1



Portland CSO Abatement Study

CH2M HILL DH Dufresne-Henry

Figure ES-1
Portland's Water Resources and CSO Locations

BOS31506 Date: Dec. 1993

In January 1991, the City and the PWD entered into an Administrative Consent Agreement with the State of Maine Department of Environmental Protection (DEP). This agreement required the City and PWD to begin a prioritized, long-term program to abate CSOs in Portland. The components, cost, and schedule of the overall program were to be defined through development of a Master Plan. In March 1991, work on the Portland CSO Abatement Study began. A draft Master Plan was submitted to DEP on December 1, 1992. Comments were received from the DEP, the U.S. Environmental Protection Agency (EPA), and the public and incorporated into a final Master Plan. This report presents the recommended Master Plan to abate Portland's CSOs and summarizes work completed in development of the document. The overall purposes of the study were to:

- Assess CSO conditions and impacts under existing conditions
- Evaluate CSO control options
- Develop a cost-effective and affordable control plan
- Integrate the plan with the long-term goals of the City for recreational and community benefits

The Existing Conveyance and Treatment System

The Portland sewerage system consists of over 200 miles of sewer, 9 pump stations, and the Portland WWTF. The Portland combined sewer system consists of two regions: the region tributary to the Northeast Pump Station (NEPS), and the region tributary to the India Street Pump Station (ISPS). Both of these facilities pump to the Portland WWTF which has a peak primary treatment capacity of about 60 million gallons per day (mgd) and a peak secondary treatment capacity of about 37 mgd. Average dry weather flow, including base sanitary flow and groundwater infiltration, is approximately 11 mgd; therefore, the plant has approximately 49 mgd of available primary treatment capacity and 26 mgd of available secondary treatment capacity that could be used for treatment of wet weather flows.

Past and Present CSO Control Efforts

The magnitude of the CSO problem in Portland is considerably less than that of other New England cities with CSOs. The total amount of CSO volume as a percentage of combined sewer service area in Portland is about 60 percent that of Bangor, 50 percent that of Providence, and 40 percent that of Boston. This low volume of CSO per unit area is the result of several factors in Portland:

- A large sewer system capacity for transport of wet weather flow to the treatment plant
- Sufficient capacity at the treatment plant to provide primary treatment for a large percentage of the wet weather flow that is transported to the plant
- A continuous, aggressive, and successful program of controlling stormwater inflow to the system

Total flow conveyed to the plant from 1986 through 1990 averaged 16 mgd or 5.84 billion gallons per year (BG/yr). This means that the existing collection and treatment system currently processes an average of approximately 5 mgd (1.82 BG/yr) of wet weather flow. As a result, approximately 89 percent of all flow generated by the entire service area is currently receiving treatment. This includes all dry weather flow and approximately 72 percent of wet weather flow.

In addition, the City and PWD operate a progressive and extensive program of Best Management Practices (BMPs) and several programs to control pollutants at their source, including:

- Street Sweeping—Every street is swept twice per year, over 11,000 miles, resulting in removal of 17,000 cubic yards (CY) of material that would otherwise have to be removed by treatment or be discharged to receiving waters.

- Catch Basin Cleaning—Catch basins in Portland are designed to collect suspended solids in stormwater runoff. Every one of over 7,600 basins is cleaned annually, with problem areas addressed more frequently, resulting in removal of about 5,000 CY of solids per year.

- Combined Sewer Flushing—Approximately 65 miles of sewer per year are cleaned of sediment during dry weather by rodding or jet flushing.

- Vortex Valve Installation Program—The City of Portland has installed hundreds of vortex flow rate control valves on stormwater inlets throughout the City, significantly reducing the frequency and volume of CSOs.

- Construction Site Erosion and Litter Control—The construction site erosion and litter control program follows guidelines of the Soil Conservation Service to reduce pollutants entering the combined sewer system.

- Industrial Pretreatment—The City operates an aggressive program to eliminate discharge of toxic and non-conventional wastes to the sewer system from 25 permitted industrial dischargers in Portland.

- Sewer Separation—To eliminate flooding of streets and basements with combined sewage, the City has a program of sewer separation that is implemented jointly with other street and utility improvement programs.

- Stormwater Management—The City has an ongoing program for stormwater management in areas where the combined sewer system has become inadequate to convey the runoff.

- Roof Leader and Sump Disconnection Program—The City is currently pursuing a program of roof leader and sump disconnection to remove stormwater from the combined sewer system.

- Public Participation—The City has ongoing communication with the public and business community to provide information on programs and to report progress by the Department of Parks and Public Works.

Water Quality Standards

Water quality standards consist of designated beneficial uses for each water body, along with water quality criteria necessary to achieve each beneficial use. Portland's freshwater bodies are classified "C", requiring water quality suitable for fishing, recreational uses, and aquatic habitat. Portland's marine waters are classified "SC", requiring water quality suitable for fishing, restricted shellfishing, recreational uses, and habitat for marine and estuarine aquatic life.

Water quality criteria necessary to support Class "C" and "SC" receiving waters include limits for bacteria, dissolved oxygen, and settleable and floatable solids. Due to the nature of CSOs, bacteria and floatable material criteria are most applicable for measuring water quality improvements and evaluating control alternatives.

Receiving water quality data indicate that, for both marine and fresh waters, bacteria criteria are generally met during dry weather periods, but violate standards during wet weather. These violations are due to both CSOs and stormwater runoff. Areawide average bacteria (E. coli) concentrations in CSOs are about 430,000 CFU/100 ml, compared to about 20,000 CFU/100 ml for stormwater runoff. E. coli concentrations must not exceed 949 CFU/100 ml in Class "C" (fresh water) receiving waters in Maine.

It should be noted that shellfishing uses are prohibited in the Portland area for a number of reasons, including the proximity of WWTF discharge locations and other non-CSO activities. The elimination of all CSOs and stormwater would not mean that shellfishing would be allowed. Critical uses and sensitive areas have been identified throughout Portland. The majority of these uses and areas exist in and around Capisic Brook, Fore River, Back Cove, Presumpscot Estuary, and Casco Bay. Portland Harbor is predominantly utilized for boating and commerce.

The Recommended Plan

Numerous alternatives for control or elimination of Portland's CSOs were evaluated. They range from low-cost modifications to the existing system to large-scale storage and treatment options, including:

1. Optimization of the existing sewer system
2. Control of pollutants at their source
3. Control of stormwater inflow to the sewer system
4. Storage of CSO for treatment at the existing treatment plant
5. New facilities for treatment and discharge of combined sewage

As mentioned above, alternatives 1 through 4 are already being implemented to some extent by the City and the PWD with the result, as previously stated, that 72 percent of all wet weather flow is currently receiving treatment. Implementation of the Master Plan will raise treatment of wet weather flow to 93 percent.

Table ES-2 presents the recommended controls for each CSO, grouped by receiving water. The following summarizes the key features of the recommended plan:

1. The plan includes a wide variety of control measures from inexpensive modifications to the existing system to relatively expensive storage and treatment options for the high density areas of Portland.

2. In most cases, the recommendations are for the City and the PWD to continue to implement, at a greater level, the programs that are currently in practice, including:

   - Inflow reduction (separation and vortex valves)
   - Maximizing flow to the WWTP
   - Pollutant source control
   - Proper operation and maintenance
   - Increased use of the sewers for in-system storage

3. A major element of the plan includes increasing pumping capacity through the India Street pump station so that, along with the increased pumping from existing pumps at the Northeast pump station, the available capacity at the WWTF can be used to treat an additional 20 mgd of wet weather flow. Modifications to the pump stations and WWTF to implement this recommendation are included in the plan. The PWD is in discussions with the DEP for revision of the NPDES permit to allow this improvement. This measure itself considerably reduces the CSO frequency and volume at numerous locations and will allow deactivation of several overflows.

Table ES-2
Recommended CSO Control Plan

CSO	Facility/Action	Existing Conditions CSO Activity[1]		Remaining CSO Activity[1]		Percent Reduction		Level of CSO Control After Implementation
		No. of Events	Volume (MG)	No. of Events	Volume (MG)	Events	Volume	
Casco Bay								
1	Separate	10	0.2	0	0	100	100	High
3	Deactivate outfall	0	0	0	0	100	100	High
4	Deactivate outfall	0	0	0	0	100	100	High
20	Increase the pumping rate at the NEPS and provide a storage tank (1 MG)	30	54	0	0	100	100	High
21	Complete on-going Quebec Street flow slippage project	7	1.1	0	0	100	100	High
Results		30	55	0	0	100	100	High
Presumpscot Estuary								
2	Separate	13	1.8	0	0	100	100	High
Back Cove								
5	Increase pumping rate at NEPS by 12 mgd plus backflow prevention and partial separation	34	100	0	0	100	100	High
6	Increase pumping rate at NEPS by 12 mgd plus partial separation	23	1.6	0	0	100	100	High
7	Increase pumping rate at NEPS by 12 mgd, sewer separation, in-system storage and stormwater management	24	100	0	0	100	100	High
8	Separate	5	4.1	0	0	100	100	High
9	Deactivate outfall	0	0	0	0	100	100	High
10-18	Implement (1) Libbytown projects and (2) storage conduit along Baxter Boulevard and north of Marginal Way (4.4 MG) with chlorination and dechlorination	44	210	12	70	73	67	Intermediate-High[2]
19	Deactivate outfall	5	0.2	0	0	100	100	High
Results		44	416	12	70	73	83	Intermediate-High[2]

Table ES-2
Recommended CSO Control Plan

CSO	Facility/Action	Existing Conditions CSO Activity[1]		Remaining CSO Activity[1]		Percent Reduction		Level of CSO Control After Implementation
		No. of Events	Volume (MG)	No. of Events	Volume (MG)	Events	Volume	
Portland Harbor								
23-29	Increase pumping rate by 8 mgd at ISPS and implement flow slippage	43	145	22	17	49	88	Intermediate[3]
Fore River								
30	Implement backflow prevention plus separation (separation is part of Libbytown projects)	24	3.5	0	0	100	100	High
32	Storage tank (0.02 MG)	18	0.8	0	0	100	100	High
33	Deactivate outfall	2	0.1	0	0	100	100	High
34	Separate	23	0.2	0	0	100	100	High
35	Separate	13	0.2	0	0	100	100	High
36	Implement stormwater management and sewer separation	46	68	0	0	100	100	High
39	Deactivate outfall	0	0	0	0	100	100	High
Results		103	73	0	0	100	100	High
Capisic Brook								
38	Remove brook flow under Brighton Avenue bridge and separate	14	4.4	0	0	100	100	High
40	Sewer separation completed	0	0	0	0	100	100	High
41	Sewer separation (scheduled)	4	0.4	0	0	100	100	High
42-43	Remove brook flows and implement stormwater management and sewer separation	69	24.6	0	0	100	100	High
Results		87	29	0	0	100	100	High
Areawide		--	**720**	--	**87**	--	**88**	--

[1]Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record. Number of events approximates the number of days an overflow event is occurring.
[2]CSO control includes chlorination/dechlorination of remaining overflow.
[3]CSO control includes limited event control but high volume control. Additional BMPs will be implemented to further reduce pollutant loads.

4. The plan includes a recommendation to implement watershed management programs for the Fall Brook and Capisic Brook watersheds. These programs will be comprehensive efforts that include land use planning, stormwater management, selective sewer separation, expanded use of BMPs for source control, rehabilitation of natural waterways, and development of recreational and environmental resources in conjunction with CSO and stormwater control. The goal is to eliminate CSOs in these watersheds by managing the volume and quality of stormwater runoff, while maximizing use of existing conduits.

5. Completion of several Libbytown projects, including the Douglass Street and Edwards Street Interceptor separation projects, stormwater pumping of the Hood Dairy area, and flow slippage and sewer separation in the Maine Medical Center and Deering Oaks Park areas, are part of the Recommended Plan. These improvements, combined with the Fall Brook watershed projects and the storage conduit under Baxter Boulevard and the soccer field along Marginal Way, will considerably reduce overflow volume and frequency to Back Cove. The relief overflow of the storage conduit should be designed to trap solids and floatables in the conveyance system to the WWTF. Any overflow will be chlorinated and dechlorinated, further reducing the bacteria load to Back Cove.

Figure ES-2 illustrates the projected reduction in CSO frequency and volume by water body due to implementation of the recommended plan. The plan includes a Compliance Monitoring Program that is comprised of both short-term and long-term components which will track success in achieving objectives of the Master Plan.

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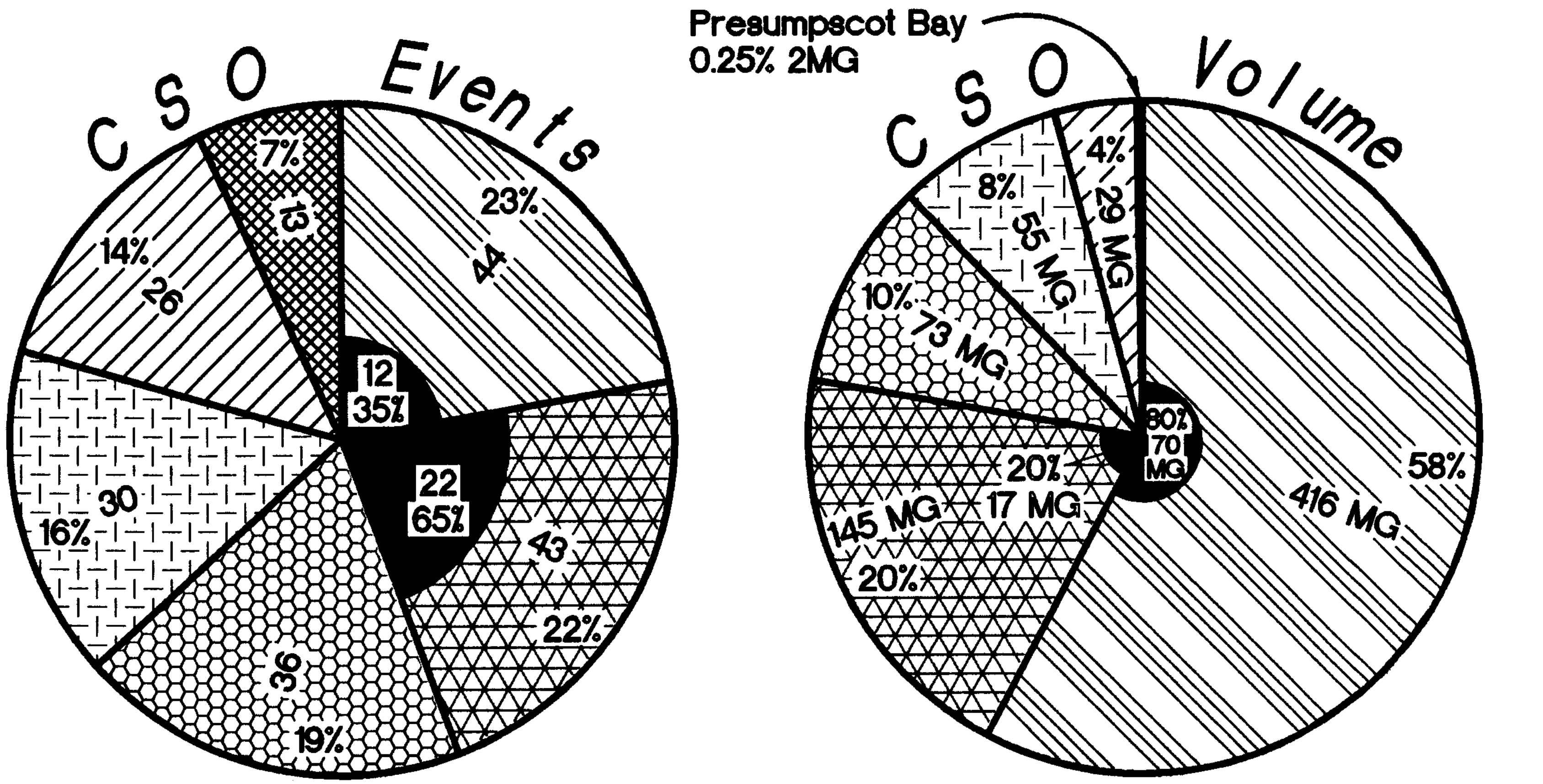


Before Plan Implementation

- Presumpscot Estuary
- Capisic Brook
- Casco Bay
- Fore River
- Portland Harbor
- Back Cove

Events
192 Total (to all receiving waters)
44 Maximum

Volume
720 MG

After Plan Implementation

- Results of Implementation

Events
34 Total (to all receiving waters)
22 Maximum

Volume
87 MG

Portland CSO Abatement Study
CH2M HILL DH Dufresne-Henry

Figure ES-2
CSO Impacts

B0S31506

Estimated Cost

The estimated capital cost for the recommended plan is about $52 million in 1992 dollars. Table ES-3 is a summary of the costs by water body. The majority of the cost, about $36 million, is for the protection of Back Cove which receives approximately 60 percent of Portland's CSO volume. Major components of the cost for Back Cove include the Libbytown projects, the Back Cove storage conduit, and the Fall Brook watershed management program.

Due to high variability, the estimates do not include any costs for land acquisition, nor do they include any potential reduction of cost due to grants or other outside funding assistance. Very rough estimates of potential costs for land acquisition are included in the text of the Master Plan for general consideration. Land acquisition cost estimates to be developed as part of the Capisic Brook Greenbelt/Stormwater Abatement Study currently underway will provide data for future projects.

Environmental Impacts of the Recommended Plan

The Recommended Plan recommends deactivation of 29 out of Portland's 39 CSOs and implementation of CSO abatement measures including maximization of flow to the WWTF, in-line flow adjustments, storage, treatment, stormwater management, and BMPs. The estimated annual CSO reductions are substantial: the number of individual CSO events will be reduced by 85 percent; CSO volume will be reduced by 88 percent; and CSO duration will be reduced by 88 percent. Similar decreases are predicted during the summer months.

Applying the approaches identified in the 1992 Draft CSO Policy, we have developed a Recommended Plan that will provide the following:

- Control of 99% of all wastewater flows generated during wet weather;

Table ES-3
Portland, Maine CSO Abatement Master Plan
Summary of Estimated Costs

Receiving Water and CSO Number	Project/Activity (Note 1)	Size/Length (Note 1)	Construction Cost	Capital Cost (Note 2)	Annual O&M Cost
Systemwide Projects					
	Portland WWTF Capacity Improvements		$284,000	$384,000	$6,700
	ISPS and NEPS Improvements		$185,000	$250,000	$7,200
	Benchmark and Compliance Monitoring		---	$16,000	$7,200
	Revision of Stormwater Management Regulations		$15,000	$20,000	$0
Subtotal			$484,000	$670,000	$21,100
Casco Bay					
CSO 1	Olympia Street Sewer Separation	350 LF	$44,000	$59,000	$700
CSO 3	Berwick Street Outfall Closure		$1,000	$1,000	$0
CSO 4	Tukey's Bridge Siphon Outfall Closure		$1,000	$1,000	$0
CSO 20	Northeast Pump Station Storage Facility	1 MG	$1,348,000	$1,819,000	$35,200
CSO 21	Quebec Street Flow Slippage		$269,000	$363,000	$4,000
Subtotal			$1,663,000	$2,243,000	$39,900
Presumpscot Estuary					
CSO 2	Arcadia Street Sewer Separation	2,100 LF	$210,000	$284,000	$3,200
Back Cove					
CSO 5	Randall St. Sewer Separation; Backflow Prevention	2,630 LF	$273,000	$369,000	$4,100
CSO 6	Johansen Street Sewer Separation	6,220 LF	$622,000	$840,000	$9,300
CSO 7	Fall Brook Projects		$8,450,000	$11,408,000	$237,400
CSO 8	Clifton/George Street Sewer Separation	950 LF	$95,000	$128,000	$1,400
CSO 9	George Street Outfall Closure		$1,000	$1,000	$0
CSO 10 - 18	Back Cove Storage Conduit	8,170 LF	$12,528,000	$16,912,000	$69,700
CSO 17	Libbytown Projects		$4,520,000	$6,100,000	$27,000
CSO 19	Diamond Street Outfall Closure		$1,000	$1,000	$0
Subtotal			$26,490,000	$35,759,000	$348,900
Portland Harbor					
CSO 23-29	Flow Slippage, Sewer Separation, and SWM		$1,920,000	$2,595,000	$30,100
Fore River					
CSO 30	St. John Street Sewer Separation (Note 3)		---	---	---
CSO 31	Eliminated		---	---	---
CSO 32	Thompson Point Storage Facility	0 MG	$183,000	$247,000	$4,800
CSO 33	Fore River Pump Station Outfall Closure		$1,000	$1,000	$0
CSO 34	Brewer Street Sewer Separation	240 LF	$12,000	$16,000	$200
CSO 35	Stroudwater Road Sewer Separation	1,350 LF	$135,000	$182,000	$2,000
CSO 36	West Side Sanitary Sewer	3,000 LF	$2,000,000	$2,700,000	$30,000
CSO 39	Rowe Street Outfall Closure		$1,000	$1,000	$0
Subtotal			$2,332,000	$3,147,000	$37,000
Capisic Brook					
CSO 36	Capisic Brook Sewer Separation and SWM		$2,609,000	$3,522,000	$46,800
CSO 37	Eliminated		$0	$0	$0
CSO 38	Brighton Avenue Sewer Separation	3,150 LF	$315,000	$425,000	$4,700
CSO 40	Sagamore Village Sewer Separation		$437,000	$590,000	$6,600
CSO 41	Holm Avenue Sewer Separation	2,300 LF	$230,000	$311,000	$3,500
CSO 42	Belfort/Commonwealth Dr. Sewer Separation and SWM	7,300 LF	$962,000	$1,299,000	$17,000
CSO 43	Bishop Street/Warren Ave. Sewer Separation and SWM		$864,000	$1,166,000	$16,000
Subtotal			$5,417,000	$7,313,000	$94,600
Total			$38,516,000	$52,011,000	$574,800

Notes:
(1) Abbreviations:
- ISPS India Street Pump Station — NEPS Northeast Pump Station
- LF linear feet — SWM stormwater management facility
- MG million gallons — WWTF Portland Wastewater Treatment Facility

(2) Land acquisition costs are not included.
(3) Costs included under Libbytown Projects.

BOSPM6/TABLES-3.WK1

- Improve the quality of Portland's surface waters;

- Provide, on average, 100% Portland CSO elimination in four out of six receiving waters;

- Reduce significantly the CSO events, volume, and duration in waters with remaining CSOs;

- Reduce significantly the number of violations of water quality standards for bacteria;

- Improve habitats for critical uses and sensitive areas;

- Expand the recreational potential of Portland's waters; and

- Move toward accomplishment of the state and federal water quality goals.

Several significant issues were identified in the environmental assessment and must be addressed during subsequent planning and implementation phases of the program. These issues relate to:

- Site constraints related to wildlife habitat, wetlands, and large trees for near-surface storage facilities,

- Traffic, noise and nesting impacts from construction of the Back Cove storage conduit, and

- Pollutant loads from the increased stormwater discharge resulting from combined sewer inflow reduction programs.

The environmental assessment recommends methods for mitigation of the impacts including seasonal construction scheduling, adjustment of route alignments, and other measures.

A major feature of the control plan is the reduction of peak inflow to the combined sewer system, especially in the Fall Brook and Capisic Brook watersheds. The means of reducing inflow include disconnection of stream inflow to the sewers, use of vortex valves to regulate inflow, stormwater detention facilities, selective sewer separation, and flow slippage. A significant concern regarding the quality of the increased volume of stormwater discharge exists. The following factors relate to mitigation of stormwater quality impacts:

1. The bacteria concentration in stormwater is about 40 to 90 percent less than that of CSO depending on the type of bacteria.

2. Stormwater management is included in the Recommended Plan to provide additional control of stormwater quality and quantity. Management controls will include source control measures similar to those currently being implemented throughout the City. In addition, controls will include "active" stormwater management structures such as wet detention ponds, wetland systems and infiltration basins, as well as "passive" management features such as vegetated filter strips, vegetated buffers, and maintenance/ rehabilitation of riparian areas.

The use of the above stormwater quality control measures in conjunction with stormwater quantity control and other BMPs for watershed management will be used to minimize adverse impacts of the overall plan.

Implementation Schedule

A 15-year schedule for implementation of the recommended plan is proposed. This schedule provides for early implementation of low cost, easily completed projects that will result in significant reduction of CSO frequency at some CSOs and resolution of chronic flooding in certain parts of the City. One of the earliest efforts planned are the improvements to the ISPS and the WWTF to allow the increased primary treatment rates at the plant. The Fall Brook and Capisic Brook recommendations involve numerous, smaller projects, a few of which can be completed each year, as is the City's current practice. Larger, capital-intensive projects are scheduled for later years, after the need and size of the projects are confirmed with data showing results of early improvements.

The implementation schedule has been planned to balance the annual expenditure of capital funds. Although a 10-year schedule is affordable, based on EPA guidelines, it is critically important that the need and benefit of each project be confirmed with additional monitoring data before design and construction of the larger projects begins. The City needs time to secure funding and manage the large number of projects and complex stormwater management initiatives included in the plan.

Each of the individual CSO abatement and stormwater management projects must be planned in more detail to include a schedule for permitting and regulatory review. It is anticipated that the proposed schedule will be modified each year, along with an update of the Recommended Plan, to reflect the most recent experience.

Financial Evaluation

According to the 1990 Census of Population and Housing, the population of the City of Portland is 64,358, residing in 28,230 households. This is about a 5 percent increase over the last decade. There are about 14,900 residential and commercial accounts. At present the typical household in Portland pays about $200 per year for sewer service.

It is assumed that funding for the capital costs required to implement the Recommended Plan will be secured through the issuance of general obligation bonds with a 20-year term and an 8.0 percent interest rate. Guidance from the U.S. EPA have suggested that when a community's total sewerage charges exceed 2.0 percent of annual income for the median income household, a sewerage program may be considered to impose financial hardship on the community. The projected sewerage rates for implementing the recommended CSO facilities fall within the recommended EPA guidelines.

For the 15-year implementation scenario, the annual cost to households would increase from approximately $200 today to approximately $250 during the average year and approximately $325 during the peak year of the planning period. The current user charges represent approximately 0.75 percent household income for the median income household in Portland. During the average year, implementation of the recommended plan is estimated to result in sewerage charges that would represent approximately 0.94 percent of median income; during the peak year of program costs, user charges are estimated to represent approximately 1.22 percent of household income for a household with median income.

Using a 10-year scenario for comparison, the estimated annual cost to households would increase from approximately $200 today to approximately $262 during the average year and approximately $335 during the peak year of the study period for the high cost estimate scenario. During the average year, implementation of the Recommended Plan is estimated to result in sewerage charges that would represent approximately 0.99 percent of median income; during the peak year of program costs, user charges are estimated to represent approximately 1.26 percent of household income for a household with median income. Although the 10-year scenario is feasible from a financial viewpoint, the 10-year scenario does not allow for adequate coordination, modeling, and monitoring time and is not recommended.

The City will make every effort to qualify for grants or low-interest loans to fund a portion of the projects and lower ratepayer costs. It is possible that the City's CSO program could qualify for a low-interest loan from the state revolving loan fund. This could reduce the annual charge to homeowners by approximately $9 per year during the average year. The City of Portland will also investigate the formation of a CSO/stormwater utility to provide an adequate level of CSO/stormwater control with charges assessed in a credible, defensible, and equitable manner.

Public Participation Program

During the development of the Recommended Plan, emphasis has been placed on alternatives that not only solve the CSO problem, but also address associated problems with aged sewer facilities, street flooding, basement flooding, stream channel degradation, and the need for open space and recreational facilities.

The CSO Abatement Master Plan presented here is the result of a planning process that began 3 years ago. Considerable guidance during this process has been provided by City staff, PWD staff, regulatory agencies, environmental groups, and others.

The City and the PWD will continue an active public participation program with the following two primary objectives:

- To further improve the Recommended Plan and make it more responsive to the desires and concerns of the affected communities

- To encourage and provide a basis for continuing public involvement that works in partnership with the City and mobilizes the resources and talents of the community in the implementation and on-going management of the watersheds

To accomplish these objectives, the public participation plan consisted of six components:

1. Monthly Progress Review Meetings

2. Public comment meetings (May 1993)

3. City Council, Planning Board, and PWD Trustees presentation (May 27, 1993)

4. Technical Workshop with regulatory groups (November 17, 1992)

5. Environmental Resources Workshop (December 3, 1992)

6. Continuing public participation

Comments and other input received during the review period are summarized in Appendix E and have been incorporated into this Final Master Plan.

Introduction

Section 1

Introduction

During dry weather, the Portland combined sewer system transports a combination of sanitary flow and groundwater infiltration to the Portland Wastewater Treatment Facility (WWTF). During wet weather, stormwater flow from approximately 4,200 acres is also collected by the combined sewer system. The sewer system is frequently overloaded during storms, and combined sewage that cannot be conveyed to the WWTF overflows to surface waters at various locations. There are 42 of these combined sewer overflow (CSO) locations in Portland. The locations of the CSOs and the drainage area tributary to each CSO are shown on Map No. 1.

CSOs degrade the quality of the riverine and coastal waters into which they overflow. The sanitary sewage component, combined with the stormwater runoff, contributes high concentrations of bacteria, sanitary sewage "floatables," elevated nutrient levels (phosphorous and nitrogen), and other pollutants that contaminate and often limit use of the receiving waters. The purpose of the Portland CSO Abatement Study (the Study) is to assess and reduce the impacts of CSOs on area receiving waters.

The City of Portland (the City) and the Portland Water District (PWD) operate and maintain Portland's combined sewer system. The City operates and maintains the combined sewer collection system, and the PWD operates and maintains the combined sewer interceptors and the WWTF. In January 1991, the City and the PWD entered into an Administrative Consent Agreement with the State of Maine Department of Environmental Protection (DEP) regarding Portland's CSOs. The City and PWD agreed to develop and implement a prioritized, long-term program to evaluate and cost-effectively abate CSOs in Portland. In March 1991, the Portland CSO Abatement Study began. This report summarizes the work performed for the Study and presents a recommended plan to abate Portland's CSOs.

1.1 Portland's Combined Sewer System

The Portland sewer system has 51 regulators which convey all dry and wet weather flows entering the sewer system to the WWTF until the system becomes overloaded; then the regulators divert excess wastewater to the 42 CSOs and associated receiving waters.

CSOs are licensed by the State of Maine and require National Pollutant Discharge Elimination System (NPDES) permits. The PWD maintains permit responsibility for 25 CSOs, and the City maintains responsibility for the remaining 17 CSOs. CSO identification numbers were developed for this study. The CSO identification numbers, locations, permit holders, and permit numbers are provided in Table 1-1. During the course of this 2-year study, the City eliminated 3 of the 42 CSOs (CSOs 31, 37, and 40); currently, there are 39 active CSO locations.

The Conveyance System

The Portland combined sewer system can hydraulically be described as two regions: Region 1 includes all flows tributary to the Northeast Pump Station (NEPS) and Region 2 includes all flows tributary to the India Street Pump Station (ISPS) and flows from the Quebec Street area which are conveyed directly to the WWTF via gravity. The two regions, the associated pump stations, and the Portland WWTF are highlighted on Figure 1-1.

The NEPS receives flows from several combined sewer drainage areas:

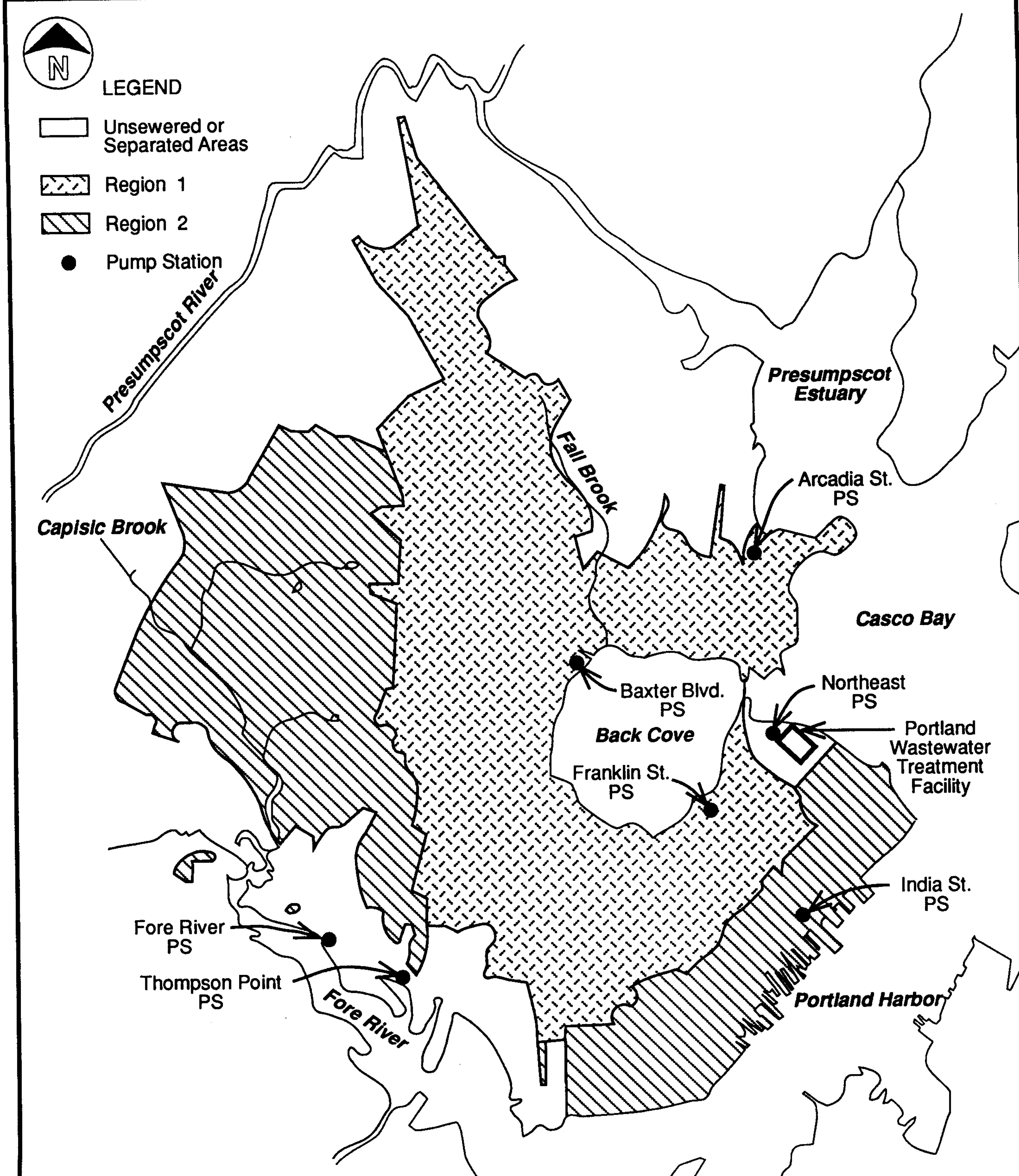
- Areas northeast of Back Cove via the Arcadia Street Pump Station (ASPS)
- Areas west of Back Cove via the Baxter Boulevard Pump Station (BBPS)
- Areas north and southeast of Back Cove via gravity
- Areas south of Back Cove via the Franklin Street Pump Station (FSPS)

Table 1-1
Identification of Portland's Combined Sewer Overflows

ID No.	Location	Permit Holder	Permit No.	ID No.	Location	Permit Holder	Permit No.
1	Olympia Street	PWD	027	23	India Street	PWD	003
2	Arcadia Street	PWD	022	24	Franklin @ Middle St. (Thomas St.)	City	*
3	Berwick Street	PWD	023	25	Long Wharf	PWD	004
4	Tukey's Bridge Siphon	PWD	026	26	Maple Street	City	006
5	Randall Street (Wash. Ave.)	PWD	010	27	Clark Street	PWD	005
6	Johansen Street #2	City	052	28	Emery Street	PWD	006
7	Ocean Avenue (East Side Int.)	PWD	011	29	West Commercial Street	PWD	007
8	Clifton Street	PWD	020	30	St. John Street	PWD	008
9	George Street	PWD	012	31'	Congress St. @ Sewall St.	City	018
10	Mackworth Street	PWD	014	32	Thompson Pt. P.S.	PWD	028
11	Codman Street	PWD	017	33	Fore River P.S. (West Side Int.)	PWD	009
12	Vannah Avenue	PWD	018	34	Brewer Street	PWD	025
13	Forest Ave @ Belmont	City	033	35	Stroudwater Road	PWD	029
14	Forest Ave @ Coyles Gully	City	056	36	Capisic Pond Dam Overflow	City	025
15	Dartmouth @ Baxter Blvd.	PWD	019	37'	Mayer Road	City	*
16	Bank Street (Bedford St.)	PWD	021	38	Brighton Ave. @ Capisic Creek	City	*
17	Preble @ Marginal	City	036	39	Rowe Street	City	026
18	Franklin @ Marginal	City	037	40'	Sagamore Village Overflow	City	050
19	Diamond @ Marginal	City	038	41	Holm Avenue	City	*
20	Northeast P.S.	PWD	024	42	Warren Avenue 60"	City	051
21	Quebec Street	PWD	002	43	Warren Avenue 24"	City	051

*Permit application submitted to DEP; City awaiting DEP response.
'CSO was recently eliminated.

Note: Names in parentheses represent alternate names used to describe the same location. ID No. 22 is associated with the WWTF discharge and is not a CSO location.



NOTE: Service area delineation includes some tributary area served by separate storm sewers.

Approximate Scale: 1"=4000'

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Figure 1-1
Portland's Combined Sewer Drainage Areas

BOS31506 Date: Oct. 1992

- Areas tributary to Casco Bay via gravity

The ISPS receives flows from the remaining combined sewer drainage areas:

- Areas tributary to Capisic Brook and upper Fore River via the Fore River Pump Station (FRPS)

- Areas tributary to the lower Fore River via the Thompson Point Pump Station (TPPS)

- Areas tributary to Portland Harbor via gravity

The Wastewater Treatment Facility

The Portland WWTF has a peak primary treatment capacity of about 60 million gallons per day (mgd) and a peak secondary treatment capacity of about 37 mgd. Average dry weather flow, including base sanitary flow and groundwater infiltration, is approximately 11 mgd; therefore, the plant has approximately 49 mgd of available primary treatment capacity and 26 mgd of available secondary treatment capacity that could be used for treatment of wet weather flows.

Total flow conveyed to the plant from 1986 through 1990 averaged 16 mgd. Subtracting the 11 mgd or 4.02 billion gallons per year (BG/yr) of dry weather flow leaves approximately 5 mgd (1.82 BG/yr) of wet weather flow currently being processed by the existing collection and treatment system. The wet weather flow includes surface runoff from the combined sewer basins and rainfall-derived infiltration and inflow (RDII) from separate sewer areas. Background infiltration was estimated at 1 percent of the total combined sewer volume. Aside from a few Capisic Brook inflow points which are addressed in this Master Plan, no other dry weather inflow sources have been discovered.

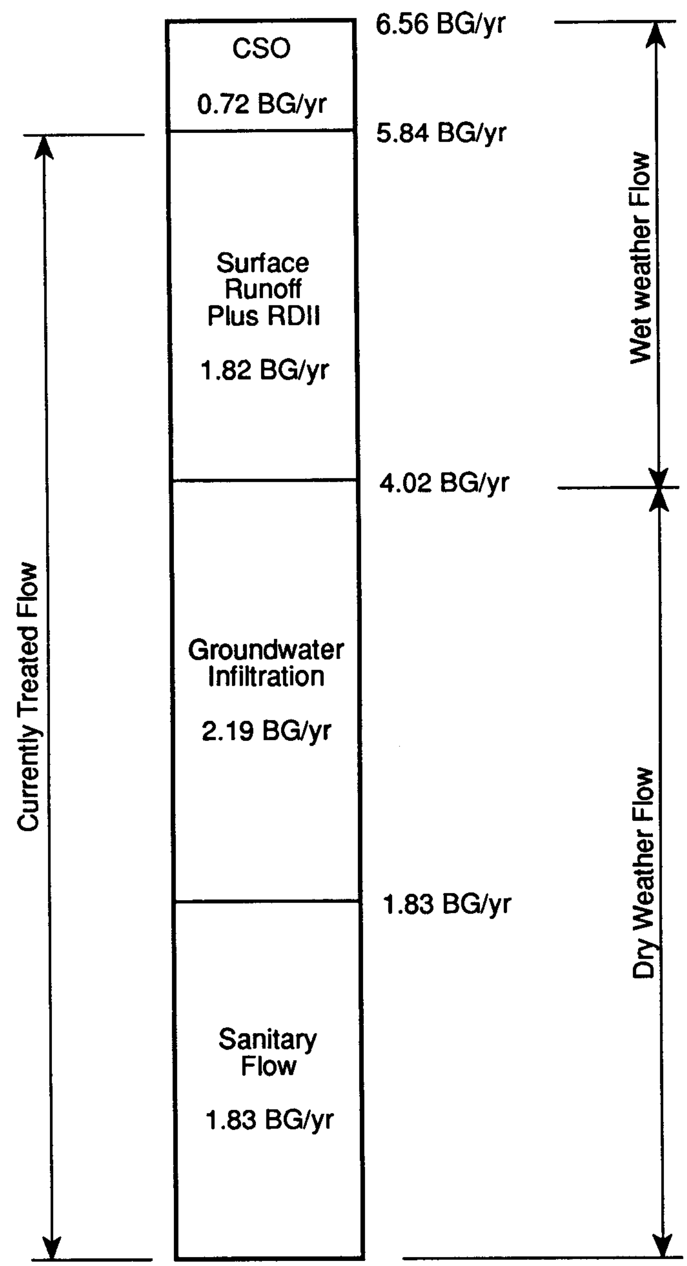
The computer model developed for the Study to simulate the hydrology of Portland and the hydraulics of the combined sewer system estimated average annual wet weather flow collected by the sewer system to be 2.54 BG/yr. Of the 2.54 BG/yr of wet weather flow, approximately 1.82 BG/yr receives treatment, and only 0.72 BG/yr of untreated wet weather flow is currently being spilled as CSO.

Overall Performance of the Portland System

Figure 1-2 shows a graphical summary of the average annual wastewater flow of 6.56 BG/yr generated by the entire City of Portland service area. Approximately 89 percent of all flow generated by the entire City of Portland service area is currently receiving treatment. This includes all dry weather flow and approximately 72 percent of all wet weather flow.

Some additional insight into the current level of CSO control being achieved by the City of Portland can be gained by comparing the unit CSO discharge estimated for Portland to unit CSO discharge estimates for Bangor, Maine; Boston, Massachusetts; and Pawtucket, Rhode Island. Service area and overflow data for these communities were available from recently completed CSO facilities plans.

Table 1-2 compares estimated annual CSO discharges for the selected communities to the estimated annual discharge for Portland. As shown in the table, the unit CSO yield for the City of Portland is much lower than the yield for other comparable New England communities. The unit CSO discharge for Boston is more than three times greater than Portland's, and Pawtucket's is about twice as large. Unit discharge for the Bangor system is about one and a half times greater than Portland's.



Note: Numbers represent estimated annual averages.

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Figure 1-2
Portland Wastewater Flow Summary

Table 1-2
Comparison of Estimated Annual CSO Discharges

Community	Combined Sewer Service Area Acres (sq. miles)	Estimated Average Annual CSO Volume* (MG)	Unit CSO Yield (MG/sq. mile)
Boston, Massachusetts	12,355 (19.30)	5,220	270
Pawtucket, Rhode Island	4,757 (7.43)	1,573	212
Bangor, Maine	2,321 (3.63)	635	175
Portland, Maine	4,182 (6.53)	720	109

Volumes based on study-defined typical years which differ from system to system.

Source: CH2M HILL facilities plans.

The relatively low CSO discharge estimated for the Portland combined sewer system is mainly due to the significant conveyance and treatment capacity of the Portland system and also to the implementation of several best management practices (BMPs) described in the following section. In summary, the Portland system provides:

- 11 mgd of dry weather conveyance, primary treatment, and secondary treatment capacity
- 49 mgd of wet weather conveyance and primary treatment capacity
- 26 mgd of wet weather secondary treatment capacity

Without the significant wet weather capacity and the implementation of BMPs, it is estimated that the unit CSO yield would be closer to the average of Bangor's and Pawtucket's or approximately 194 MG/sq. mile. This would result in an estimated average annual CSO volume for Portland of 1,267 MG, 43 percent higher than current volume.

1.2 On-Going Best Management Practices for CSO Control

In addition to Portland's large wet weather conveyance and treatment capacity, there are several on-going BMP programs to control CSO:

- Vortex valve installation
- Sewer separation and rehabilitation
- Stormwater management and flooding control
- Roof leader and sump disconnection
- Pollutant source control
- Public participation

These programs are discussed in the following paragraphs.

Vortex Valve Installation

The City of Portland has installed hundreds of vortex valves on stormwater inlets in drainage areas tributary to Back Cove, Capisic Brook, the Quebec Street CSO, and other areas, reducing the frequency and volume of downstream CSOs. Vortex valves develop in-system and surface storage by restricting stormwater flow into the combined sewer, thus decreasing CSO. Their quantitative impact on CSOs is unknown since definitive before and after studies of overflow characteristics are not available. However, maintenance crews have observed over the years a decrease in the frequency of CSO where vortex valves have been installed.

The Quebec Street Overflow Control Project utilizes vortex valves in the drainage area to "slip" stormwater down streets to a separate stormwater collection system. This project is currently under construction and will eliminate CSO 21 at Quebec Street. It will also serve as a demonstration of the program's effectiveness in reducing CSO (in this case, actually eliminating a CSO).

Sewer Separation and Rehabilitation

To reduce CSO and surcharging of combined sewers, the City has an on-going program of sewer separation and rehabilitation. Sewer rehabilitation includes sewer lining and/or replacement to reduce inflow/infiltration (I/I) sources to sanitary and combined sewers, thereby increasing the conveyance and treatment capacity of the system. Separation and rehabilitation often occur when streets are repaved or underground utilities are added or replaced. In some cases, streets are locally separated, with the stormwater flows controlled and then discharged into a downstream combined sewer until downstream separation is accomplished. This localized separation provides additional in-system storage by controlling and delaying the discharge of stormwater to the combined sewer, and thus, reducing CSO.

Stormwater Management and Flood Control

The City has an on-going program for stormwater management and flood control. Stormwater detention facilities are required by regulation for certain new development, and the City has constructed several off-line detention facilities to reduce combined sewer surcharging. The Baxter Woods stormwater detention facility off Forest Avenue is an example of the City's efforts. The Quebec Street flow slippage demonstration project and the several Libbytown area flood control projects are other large stormwater management projects in progress at this time. These two projects will be discussed in greater detail in Section 5.

Numerous areas with flooding and stormwater surcharging problems exist in the Fall Brook and Capisic Brook watersheds. As development has progressed in these watersheds, the combined sewer system has become inadequate to convey the increased runoff volume. Many small tributary streams and much of the flow in the two major brook systems have been diverted over the last 40 years to the combined sewer system. This not only reduced the recreational and aesthetic benefits of the brook systems, but also magnified the CSO problem. Today, there is considerable interest in recreating the natural drainages of the Fall Brook and Capisic Brook Watersheds by enhancing the brook corridors. This will also provide recreational and open space benefits to the community. Increased development in these watersheds and numerous regulations add to the complexity of stormwater management. This issue is discussed in more detail in Section 5.

Roof Leader and Sump Disconnection

The City is currently pursuing the development of a voluntary roof leader and sump disconnection program to remove stormwater from the combined sewer system. This is a new program that the City is promoting to the public to help manage stormwater runoff. Instruction kits have been assembled which explain a variety of homeowner inflow sources and how they can be mitigated. These kits will be sent out in early 1994 to homeowners living in the Quebec Street drainage area as a demonstration project. Results of homeowner participation and flow monitoring data are scheduled to be completed by fall of 1994. Future areas targeted for this program include Peaks Island and the Woodford area of Portland which includes several drainage areas tributary to Back Cove.

Pollutant Source Control

The City of Portland has implemented the following pollutant control programs:

- Street sweeping
- Catch basin cleaning
- Combined sewer flushing
- Construction site erosion control
- Litter control
- Industrial pretreatment

Street Sweeping and Catch Basin Cleaning. Street sweeping is performed using mechanical broom sweepers between mid-March and mid-November. Every street in the City is swept twice per year. Records from the 1991 fiscal year indicate that approximately 11,000 miles of streets are swept and 17,000 cubic yards of sweepings are collected annually. The City recently purchased a few flush and sweep trucks for initial use in 1994. Catch basin cleaning is performed year-round. Every catch basin in the City is cleaned at least once per year. Problem areas are targeted for multiple cleanings. This program collects 5,000 cubic yards of debris, from approximately 8,000 catch basins. The two programs capture approximately 22,000 cubic yards of debris (or 1 acre piled 14 feet high) per year that may otherwise have been conveyed to receiving waters. The frequency of street sweeping and catch basin cleaning will be improved in areas with separate storm sewers.

Combined Sewer Flushing. The combined sewer flushing program includes both rodding and jet flushing of combined sewers. Approximately 65 miles per year are either rodded or jet flushed. Sewer flushing is part of routine sewer maintenance in those areas which are particularly susceptible to deposits accumulating in the sewers and in areas where blockages may increase CSO activity.

Construction Site Erosion and Litter Control. Construction site erosion and litter control are implemented on an as-needed basis. Precautions to limit debris from entering catch basins or being conveyed directly to receiving waters is emphasized. The City follows guidelines provided by the Soil Conservation Service. Precautions outlined for public works projects are reviewed by the DEP.

Industrial Pretreatment. There are 25 permitted industrial dischargers to the Portland sewer system regulated by the City's Industrial Pretreatment Program. Federal pretreatment standards defined in Section 402 of the Clean Water Act (CWA) are enforced through local pretreatment plans as a condition of the Waste Discharge License granted to the WWTF. As defined by the federal standards, 5 of the dischargers are categorical, and 20 are significant. The five categorical dischargers include three metal fabricators and two pharmaceutical industries. The majority of the significant dischargers are food processing establishments. Currently, exceedance of the oil and grease limitation is the most significant issue in the industrial pretreatment program.

Public Participation

City staff have arranged many avenues for communication with the public and the business community to provide information on programs and to report progress by the Department of Parks and Public Works. Media include newspaper advertisements, brochures, mailers, public meetings, and, most recently, a calendar. Development of a CSO Abatement Study Public Participation Plan is outlined in Section 10.

1.3 Water Quality Issues and Goals

Description of Water Resources

The waters in the vicinity of the City of Portland include both fresh and marine waters. Major freshwaters in the City are Capisic Brook, Fall Brook, Presumpscot River, and Stroudwater River. The predominant marine waters are Casco Bay, Back Cove, Portland Harbor, and Fore River.

Overall, data on the quality of receiving waters are limited. Previous to this study, there had been no quantitative assessment of the receiving water impacts associated with Portland's CSO discharges and other pollutant loadings. There has been some investigation of bacterial concentrations at East End Beach by the DEP, the City, and the PWD, but these investigations did not address CSO impacts and are limited in scope.

Classifications and Standards

DEP has developed a system to classify all waters of the state (MRSA Title 38 Article 4A) with different classifications for freshwaters and marine waters. The general classifications for freshwaters are AA, A, B, and C, with AA being the highest quality water. Similarly, the classifications for marine waters are SA, SB, and SC, with SA being the highest quality water.

Surface waters in Portland are classified as B, C, or SC. The receiving waters and their state classifications are shown on Figure 1-3. The classification of a water body determines its designated uses and the quality of effluent that may be discharged. The water quality classifications applicable to Portland's receiving waters are defined in Table 1-3. The surface water quality criteria vary for each classification as described in Table 1-4.

In addition to surface water quality criteria, shellfish harvesting waters are classified based on criteria of the U.S. Food and Drug Administration's National Shellfish Sanitation Program Manual of Operations. These criteria include fecal coliform standards for approved and restricted harvesting areas. Portland's SC waters are closed to shellfish harvesting; therefore, no criteria are enforced.

Maine DEP maintains an inventory of critical uses and sensitive areas which support various types of flora and fauna. Numerous areas have been identified on Figure 1-4 which include the following categories of flora and fauna:

- U.S. Fish and Wildlife National Wetland Inventory
- Marsh environments
- Mud flats
- Mussel bars

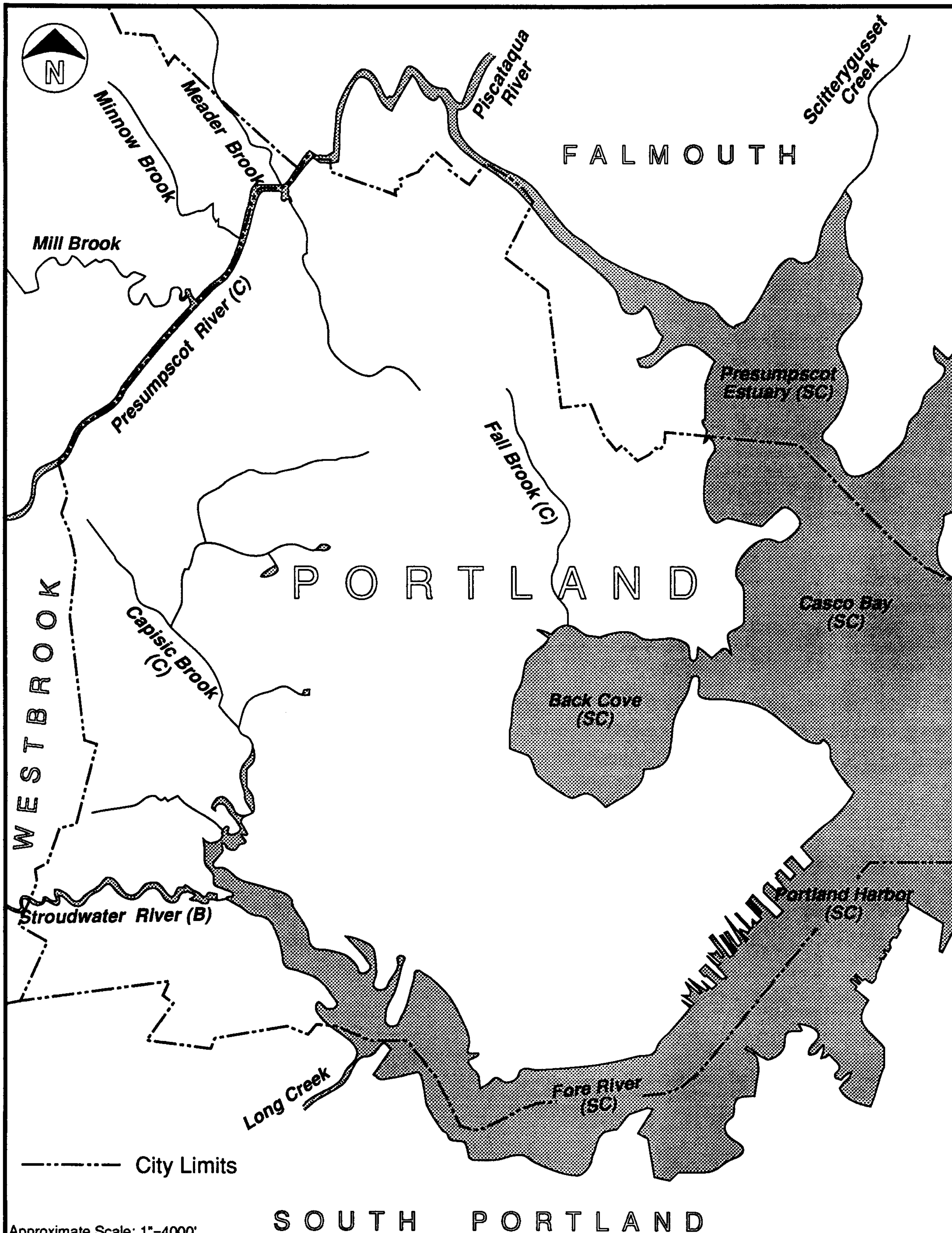

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Figure 1-3
Portland's Water Resources and Their State Classifications

BOS31506 Date: Oct. 1992

Table 1-3
Definitions of Surface Water Classifications Applicable to Portland, Maine

Uses/Discharge	Classification		
	Freshwater		Marine
	B	C	SC
Designated Uses			
Drinking Water Supply After Treatment	Yes	Yes	------
Fishing	Yes	Yes	Yes
Aquaculture	-------	-------	Yes
Shellfish Propagation/ Harvesting	-------	-------	Approved, restricted, or closed to use[1]
Recreation	Yes	Yes	Yes
Industrial Water Supply and Cooling Water	Yes	Yes	Yes
Hydroelectric Power	Yes	Yes	Yes
Navigation	Yes	Yes	Yes
Habitat	Yes	Yes	Yes
Pollutant Discharge			
Level of Impact	Effluent shall not cause adverse impact to aquatic life in receiving water	Effluent may cause some changes to aquatic life[2]	Effluent may cause some changes to aquatic life[2]

[1]Classification by the U.S. Food and Drug Administration's National Shellfish Sanitation Program Manual of Operations. Portland's SC waters are closed to shellfish propagation and harvesting.

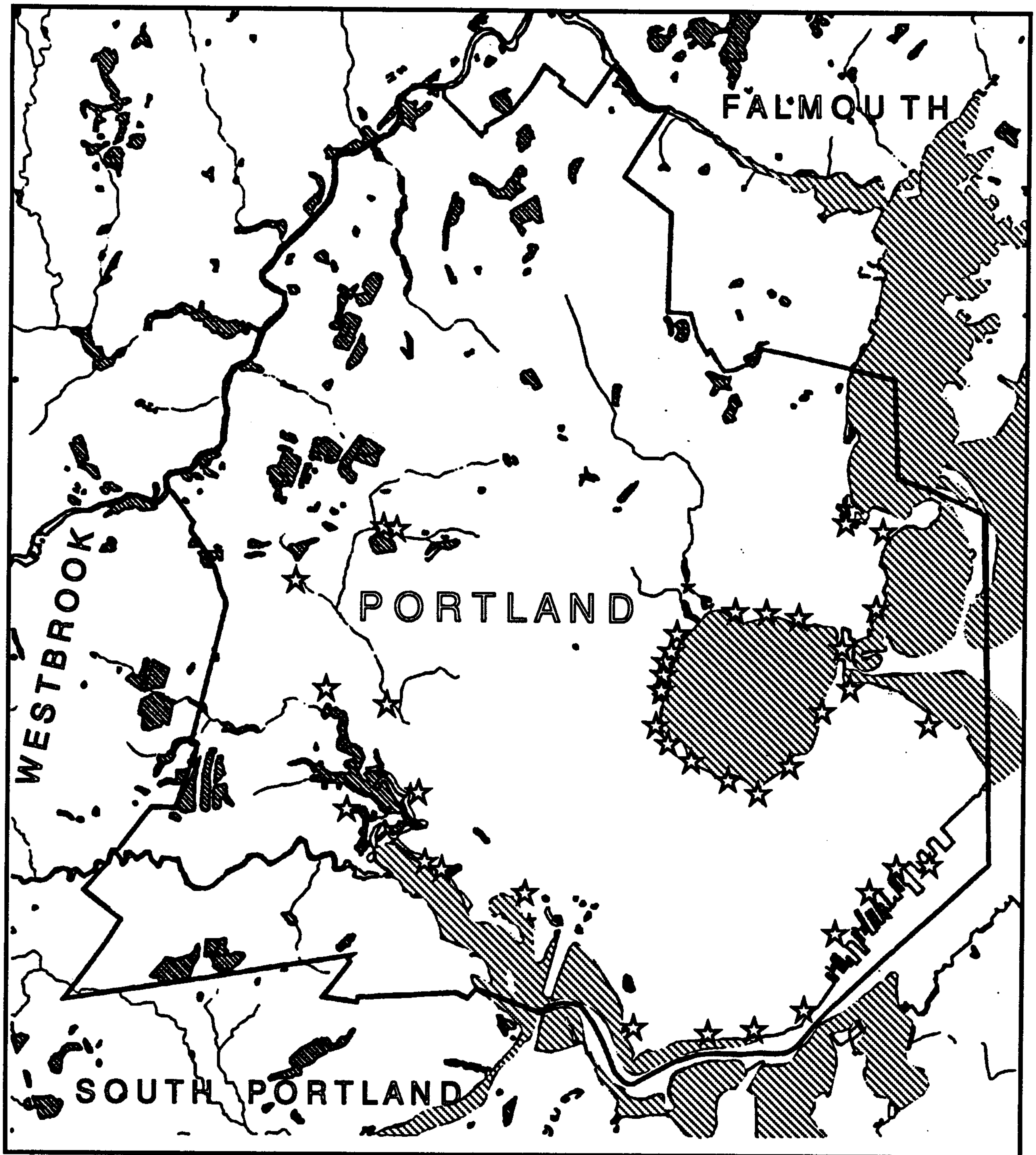
[2]Structure and function of biological community must be maintained.

Source: *Water Classification Program*, Maine Revised Statutes Annotated, Title 38, Article 4-A, October 1990.

Table 1-4 Summary of Surface Water Quality Criteria Applicable to Portland, Maine			
Parameter	Freshwater		Marine
	B	C	SC
Dissolved Oxygen (mg/l)	≥7 or 75% of saturation, whichever is higher. From Oct. 1-May 14, 7-day mean ≥9.5 and 1-day min. ≥8.0 in identified fish spawning areas.	≥5 or 60% of saturation, whichever is higher. In identified salmonid-spawning areas where water quality is sufficient to support spawning, egg incubation, and survival of early life stages, water quality sufficient for these purposes must be maintained.	≥70% of saturation.
Bacteria-General	-------	-------	No levels which would prevent shellfish propagation in "restricted" shellfish harvesting areas.[1]
E. Coli bacteria of human origin (#/100 ml)	From May 15-Sept. 30, geometric mean ≤64 or instantaneous level ≤427.	From May 15-Sept. 30, geometric mean ≤142 or instantaneous level ≤949.	-------
Enterococcus bacteria of human origin (#/100 ml)	-------	-------	From May 15-Sept. 30, geometric mean ≤14 or instantaneous level ≤94.
Toxics	Discharges shall not cause adverse impact to aquatic life. Receiving water shall be of sufficient quality to support all aquatic species indigenous to the receiving water without detrimental changes in the resident biological community.	Discharges may cause some changes to aquatic life, provided that receiving waters shall be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.	-------
Settleable and Floatable Substances	All surface waters shall be free of settled substances that alter the physical or chemical nature of bottom material and free of floating substances, except as naturally occur, that impair the characteristics and designated uses ascribed to their class.	All surface waters shall be free of settled substances that alter the physical or chemical nature of bottom material and free of floating substances, except as naturally occur, that impair the characteristics and designated uses ascribed to their class.	All surface waters shall be free of settled substances that alter the physical or chemical nature of bottom material and free of floating substances, except as naturally occur, that impair the characteristics and designated uses ascribed to their class.

[1]Portland's SC waters are closed to shellfish harvesting.

Source: *Water Classification Program*, Maine Revised Statutes Annotated, Title 38, Article 4-A, October 1990.



Legend

☆ CSO Location

Note: Critical uses and sensitive areas include the following flora and fauna:

- U.S. Fish and Wildlife National Wetland Inventory
- Marsh environments
- Mud flats
- Mussel bars
- Clam beds
- Seabirds

Approximate Scale: 1"=4,000'

Reference: Maine DEP Inventory

Portland CSO Abatement Study

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Figure 1-4
Critical Uses and Sensitive Areas

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- Clam beds
- Seabirds

Receiving Water Characteristics

Presumpscot River (C) and Estuary (SC). The Presumpscot River is the largest river in the Portland area. This freshwater river meets the ocean in the City of Falmouth and forms a large estuary, where the tidal variation is approximately 9 feet. A relatively small portion of the river and estuary are present within the city limits. A freshwater portion of the Presumpscot River forms the northwest boundary of Portland, and approximately one-third of the estuary is located within the City at its northeast border. Within Portland, the Presumpscot Estuary is primarily surrounded by residential and commercial land uses. A single CSO discharges to the estuary at a location where flushing is limited as a result of fill associated with I-295. Litter and debris such as tires are also observed along the Presumpscot.

The remainder of the permitted point sources of pollution discharging to the Presumpscot River are located outside of Portland. These include discharges from the Little Falls Treatment Plant, the Westbrook Treatment Plant, and the S.D. Warren Treatment Plant. The Presumpscot Estuary receives effluent from the Falmouth Wastewater Treatment Plant. In addition, there are seven CSO discharges to the river from the City of Westbrook.

In addition to wastewater effluent discharges and CSOs, the river has been reported to be contaminated with dioxin from a paper mill in Westbrook. As a result, there is an advisory against eating fish from the lower 7 miles of the river, and shellfish harvesting in the estuary is prohibited.

Stroudwater River (B). The Stroudwater River, which flows to the Fore River, is located in an area dominated by rural and suburban land uses. Several small, private, untreated wastewater discharges to the Stroudwater River were recently eliminated. There are no known remaining discharges to the river other than stormwater-related conduits from roads traversing the basin. The Stroudwater River is unaffected by CSO discharges and is only included in Section 1 as background information on Portland's major receiving waters.

Capisic Brook (C). Capisic Brook is a freshwater stream receiving drainage from commercial and undeveloped land near the Westbrook/Portland border and from moderately developed residential areas at the lower end of the drainage area adjacent to the Capisic Pond. Two CSOs which drained to the brook, CSOs 37 and 40, were recently eliminated. The brook currently receives discharges from 4 CSOs. The brook meanders through the drainage area and discharges to a highly visible impoundment at Capisic Street referred to as the Capisic Pond. Other portions of the brook are visible from adjacent residential areas which abut the brook. In some segments, litter and trash are present along the banks of the brook.

Fall Brook (C). Fall Brook is a small freshwater stream with low flow during summer months attributed, in part, to the diversion of its flow into the East Side Interceptor combined sewer. In several long reaches, dry weather flow is zero. The brook is contained in culverts in some areas, and in other areas the channel is overgrown with trees and bushes. Sediment has accumulated at various locations restricting capacity during large storms. Fall Brook does not have any known wastewater discharges or CSOs, although it does receive stormwater runoff from adjacent residential areas.

Casco Bay (SC). The bay is a large waterbody graced with hundreds of islands. The nearby bay areas are classified SC; however, there are some SB waters to the north outside of the Study area. The bay receives CSO, stormwater, and wastewater treatment plant effluent discharges from Portland and several neighboring cities and towns. Five CSOs from Portland discharge directly to Casco Bay. Depending on wind and tidal action the area could be affected by CSOs discharging to Back Cove. Health advisories for swimming at East End Beach have typically been associated with precipitation events and the nearby CSOs. Within Portland's city limits, Casco Bay is closed to shellfishing.

Back Cove (SC). Back Cove is a large tidal pool with extensive mudflats at low tide. The Cove receives drainage from Fall Brook, the Smith Creek area west of Baxter Boulevard, and from the Libbytown and Marginal Way areas to the south. During rainfall, as many as 15 CSOs from the City of Portland discharge to it. Back Cove is closed to shellfishing.

Portland Harbor (SC). Portland Harbor is a viable commercial water body. It receives CSO discharges and stormwater runoff from Portland and South Portland. It is a highly visible water body because it is a working marine waterfront with tourist and commercial activities. As a result, it is also subject to bilge water discharges and impacts from sources such as onshore oil and grease deposits. Portland Harbor is closed to shellfishing.

Fore River (SC). Fore River, which is predominantly estuarine, receives flow from the Stroudwater River and Capisic Brook in Portland and other drainage areas outside of Portland. It receives urban stormwater runoff from South Portland and Portland, and the South Portland Treatment Plant discharges to the river.

There is significant tidal flushing near the mouth of the Fore River that exposes large areas of mud flats upstream of the Veteran's Bridge. The mud flats, which are closed to shellfishing, receive CSO discharges from the Cities of Portland and South Portland. Downstream of the Veteran's Bridge, the Fore River channel widens and contains major oil and coal terminals.

CSO Impacts

Designated uses of fresh and marine surface waters in the Portland area are impaired by water quality degradation. In general, causes of water quality impairment include wastewater treatment plant effluent discharges; stormwater runoff; CSO discharges; and commercial waterfront activities.

In some cases, water quality is likely to be affected by pollutants from a single type of source. For example, the Stroudwater River is affected only by stormwater runoff. In other water bodies, water quality is most likely affected by pollutants from multiple sources. For example, Portland Harbor is believed to be affected by CSOs, stormwater runoff from Portland and South Portland, and commercial waterfront activities. Table 1-5 indicates which Portland CSOs discharge to each receiving water.

Table 1-5
Portland CSO Discharges to Receiving Waters

Receiving Water	Classification	Number of Portland CSOs	CSO ID Numbers	Area of CSO Drainage (acres)
Freshwaters				
Presumpscot River	C	0	-	-
Stroudwater River	B	0	-	-
Capisic Brook	C	4	38, 41-43	406
Fall Brook	C	0	-	-
Marine Waters				
Casco Bay	SC	5	1, 3, 4, 20, 21	89
Presumpscot Estuary	SC	1	2	25
Back Cove	SC	15	5-19	2,612
Fore River	SC	7	30, 32, 36, 39	599
Portland Harbor	SC	7	23-29	451
System Total	-	**39**	-	**4,182**

Note: CSOs 37 and 40 which discharged to the Capisic Brook and CSO 31 which discharged to the Fore River were recently closed.

Bacteria data from the East End Beach area of Casco Bay are summarized in Table 1-6. Elevated bacteria levels have typically been associated with precipitation events and nearby CSOs, such as the Quebec Street CSO.

Table 1-6
Bacteria Data for East End Beach[1]

Period	No. of Samples	No. of Samples ≥ 94/100 ml	% of Samples ≥ 94/100 ml	Geometric Mean for Period	Geometric Mean ≥ 14/100 ml
Enterococcus Data					
5/15/89-9/30/89	52	0	0	4	No
5/15/90-9/30/90	52	6[2]	12	9	No
5/15/91-9/30/91	53	8[3]	15	28	Yes
5/15/92-8/31/92	46	5[4]	11	16	Yes

[1]Data collected by Portland Water District
[2]Sample Dates: May 29; June 19, 25, 26; July 2, 24
[3]Sample Dates: May 15; June 12, 13, 15; July 11; August 12, 19, 21
[4]Sample Dates: June 25; July 6, 7, 9, 10

Note: Precipitation record from Portland Jetport provided in Appendix D.

Ambient water quality data for other surface waters are limited. However, a qualitative assessment of CSO impacts can be made based on the number, volume, and duration of CSO overflow events. An estimate of CSO impacts to surface waters in Portland is summarized in Table 1-7. Receiving water quality before and after implementation of the recommended CSO Abatement Plan is the focus of Section 7.1.

Table 1-7 CSO Water Quality Impact Summary[1]							
		Annual			Summer[2]		
Receiving Water	No. of CSOs	No. of Events	Vol. (MG)	Duration (hours)	No. of Events	Vol. (MG)	Duration (hours)
Casco Bay	5	30	55	185	14	22	69
Presumpscot Estuary	1	13	2	50	6	1	20
Back Cove	15	44	416	357	19	157	96
Portland Harbor	7	43	145	202	19	62	99
Fore River	7	36	73	181	18	32	94
Capisic Brook	4	26	29	107	14	12	44
Areawide	39	44	720	357	19	286	99

[1]Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record. A receiving water CSO event is defined as one or more discharges to a receiving water resulting from a single precipitation event; it approximates the number of days a receiving water is impacted by CSOs. The duration is the accumulative length of overflow time.
[2]The summer season is defined by Maine's water quality regulations as May 15 to September 30.

Receiving Water Quality Goals

Water quality goals for surface waters impacted by Portland CSOs can be derived from three sources: designated uses (Table 1-3), existing uses, and uses desired by local residents. For the most part, designated uses are long-term goals, because achieving water quality sufficient to support the designated uses will require controlling pollutant loads from a variety of sources within Portland and from upstream areas outside the city limits. Depending on the receiving water, existing uses may include boating, windsurfing, fishing, and passive waterside recreation such as walking, jogging, and enjoying scenic views. Uses are further defined as primary contact, such as swimming or windsurfing, and secondary contact, such as boating where there is not extended body contact with the water. It is likely that surface waters are being used for recreation because of their proximity to residential areas, although their use has not been documented. Over the short-term, existing uses should be maintained and enhanced. Existing uses and desired goals of the receiving waters with respect to CSO impacts are summarized below.

- Presumpscot Estuary—Although there are no documented uses of the Presumpscot Estuary within Portland's city limits, it is adjacent to residential areas, and the potential for primary contact recreation is high. The primary water quality impact by City of Portland in the southern portion of the Estuary is a single CSO which discharges to a poorly flushed area. This particular section of the Presumpscot Estuary was separated from the larger section by the construction of I-295 in the 1980s. Flushing is constricted by a culvert under the highway. Elimination of this CSO is a goal to improve water quality and aesthetics in the area.

- Capisic Brook—The brook corridor is scenic, and a walking trail exists along portions of the corridor. Because of the proximity of the brook and pond to residences, the potential for primary and secondary contact is high. The City of Portland and several community groups have plans to expand the passive recreational opportunities of Capisic Brook. Capisic Pond has potential for fishing, secondary contact recreation, aesthetics, and passive waterside recreation. Approximately half of the watershed is comprised of combined sewer drainage area. Uses of the receiving water are greatly impaired by CSOs. Elimination of these CSOs is a primary goal of the Study.

- Fall Brook—There are no documented uses of Fall Brook, primarily due to its low flow. There is significant potential for brookside recreation and secondary contact recreation. The goal is to return the natural flow of Fall Brook and achieve these uses. Although no CSOs discharge to Fall Brook, storm water management in the watershed would significantly control CSO 7 (Ocean Avenue) and reduce impacts to Back Cove.

- Casco Bay—There is public bathing at East End Beach and along the coast of several of the Bay's islands. Secondary contact recreation and fishing are also existing uses. Shellfish harvesting is restricted in portions of the

Bay and closed within Portland's city limits. The City's goal is to minimize the effect of Portland's CSOs in maintaining these uses.

- Back Cove—Approximately 70 percent of the area tributary to Back Cove is comprised of combined sewer drainage area. There is some limited lobstering in the deeper parts of the cove, bloodworm and clam worm harvesting from the mud flats, and significant windsurfing. The City has completed a 4-mile path around the entire cove that is heavily used by joggers, walkers, cyclists, and others. The City's goal is to minimize the effect of Portland's CSOs in maintaining these uses.

- Portland Harbor—The predominant existing uses of the Harbor are boating, commercial activities, and lobstering, although it is closed to shellfishing. The City's goal is to minimize the effects of Portland's CSOs in maintaining these uses.

- Fore River—The predominant existing uses of the River are boating and some lobstering. The City's goal is to minimize the effect of Portland's CSOs in maintaining these uses.

Selection of CSO control strategies discussed in Section 4, varies with the desired goals of each receiving water; however, receiving water quality is impacted by several pollution sources (especially in Casco Bay, Fore River, and Portland Harbor). Therefore, selection is also based on factors such as cost, CSO control performance, feasibility of implementation, and overall benefit.

1.4 DEP Consent Order

Pursuant to 38 MRSA Section 347-A(1) and DEP's Consent Agreement Policy, the Maine Board of Environmental Protection ordered the City and the PWD to develop and implement a prioritized, long-term program for evaluation and abatement of Portland's CSOs. According to the DEP Consent Order provided in Appendix A, the program is to incorporate the following:

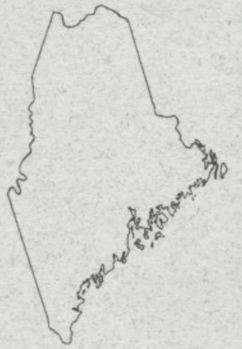
- CSO assessment
- CSO monitoring plan
- Sewer system evaluation
- Sewer system master plan
- Best management practices plan
- Sewer system rehabilitation and improvements

The Portland CSO Abatement Study scope of work incorporates the first five. As discussed in Section 1.2, the City performs sewer system rehabilitation and improvements on a continuous basis and provides required documentation directly to DEP.

The Study began in March of 1991 and has included monthly progress meetings with the City, PWD, DEP, and on occasion, local environmental groups. Technical Memorandums (TMs) were issued during the Study to provide detailed documentation of collected information, methodologies, progress, and comments received during meetings and in correspondence and telephone conversations. Summaries of the TMs are included in Appendix B. The Study approach is discussed in Section 2 and presented as three primary objectives which incorporate the five elements outlined in the DEP Consent Order:

- Assess Portland's CSOs
- Develop options for CSO control
- Recommend a cost-effective plan to abate CSOs

The CSO assessment provided in Section 3 incorporates the CSO monitoring plan and sewer system evaluation results. CSO control options and a cost-effective strategy for their application based on the CSO assessment are presented in Section 4. Elements of the sewer system master plan and best management practices plan are incorporated into the recommended plan presented in Section 5. Various aspects of the recommended plan are presented in Sections 6 through 10. This Master Plan incorporates the work performed to date and documented in the TMs and the conclusions of the Study for presentation to DEP on December 1, 1992, as required by the DEP Consent Order.



Study Approach

Section 2
Study Approach

The objectives of the CSO Abatement Study were to:

- Assess Portland's CSOs
- Develop options for CSO control
- Recommend a cost-effective plan to abate CSOs

The approach used to achieve these objectives is outlined in the following paragraphs.

2.1 CSO Assessment

To assess CSO activity in Portland, a computer model was developed to simulate stormwater runoff and wastewater collection and conveyance. The CSO Abatement Model was developed using the United States Environmental Protection Agency's Stormwater Management Model (SWMM) and incorporating SWMM's EXTRAN capabilities to model flow transport, internal flow diversions, and surcharged conditions.

The sewer system evaluation involved review of available information and provided data to develop estimates of base sanitary flow, I/I, and wet weather capture of the sewer system for incorporation into the sewer system computer model. Pump station and WWTF flow records were also reviewed. The simulated response of the sewer system to dry and wet weather conditions was compared to available monitoring data. The model was adjusted using the available data until as close a match as possible was achieved between the simulated sewer system response and the monitored response. See TMs 1-4 for additional information on collected I/I data and the initial modeling effort.

The initial CSO Abatement Model calibrated in 1991 provided a preliminary estimate of the frequency, volume, and duration of CSOs. Subsequently, a comprehensive monitoring program was developed to gather baseline CSO and receiving water quality data and to gather additional frequency and flow monitoring data to improve the computer model. The additional monitoring data was required because of the sparsity of existing data and the need to calibrate and verify the systemwide model. The results of the additional monitoring and the assessment of CSO activity and pollutant loadings using the recently recalibrated CSO Abatement Model are presented in Section 3. Details of the model recalibration effort and the results of the monitoring program are provided in TMs 7-9.

2.2 CSO Control Options

Numerous technologies exist to control CSO impacts. Technologies are categorized according to their method of control. The categories are:

- Sewer system optimization
- Pollutant source control (often referred to as BMPs)
- Stormwater inflow reduction
- CSO treatment
- CSO storage

Approximately 40 technologies were reviewed for their applicability and effectiveness to control CSOs in Portland. Relative advantages and disadvantages with respect to performance, implementation, and cost on a gross scale were evaluated until a short-list of technologies was developed.

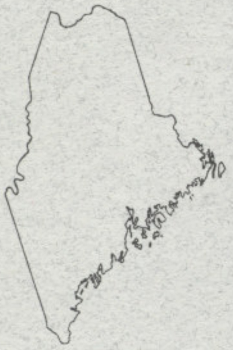
An economic optimization analysis was performed to determine a cost-effective level of CSO control for Portland. The optimization results indicated a cost-effective goal of 90 percent control of CSO events as an areawide goal for Portland, achievable in most of the receiving water drainage areas. Field surveys and model simulations were conducted to analyze the application of specific technologies to specific drainage areas and CSO locations to evaluate the feasibility of achieving this goal in the six receiving water drainages impacted by Portland's CSOs:

- Casco Bay
- Presumpscot Estuary
- Back Cove
- Portland Harbor
- Fore River
- Capisic Brook

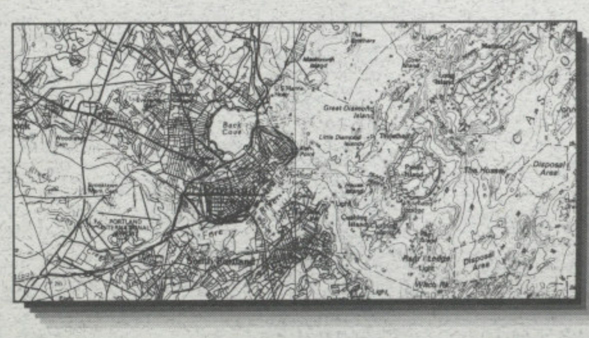
Since economic optimization model results indicated 90 percent CSO reduction as a cost-effective goal, three CSO control alternatives were developed for each receiving water:

- Limited—no specified level of control
- Intermediate—90 percent CSO event reduction
- High—90 percent CSO volume reduction

Although sewer separation was not considered as a systemwide alternative because of the relatively limited reduction in bacteria, total suspended solids, and floatables, costs were calculated for comparison purposes as a 100 percent CSO elimination alternative. CSO control technologies were applied in specific locations, and order-of-magnitude costs, preliminary performance estimates, and implementation issues were evaluated. As a result, a preliminary CSO control plan was developed. The various CSO control technologies, their evaluation, and the preliminary CSO plan are presented in Section 4. Details of the preliminary and final screening of CSO control technologies are provided in TMs 5 and 6.



CSO Assessment



Section 3
CSO Assessment

The overall purpose of this task was to define existing conditions: frequency of activation of CSOs, overflow volume and duration, and CSO pollutant concentration. To accomplish this, the following tasks were performed:

- Existing data was reviewed and base sanitary and I/I flows were estimated for use in developing a sewer system computer model.

- A sewer system computer model was developed based on limited existing data to simulate the system's response to rainfall and to provide a preliminary assessment of CSO activity. This preliminary modeling effort helped to define monitoring sites where additional data was needed.

- A monitoring plan was developed to supplement the existing data in quantifying and qualifying CSO impacts. The monitoring data was used in model recalibration and in developing CSO pollutant loads.

This section discusses the monitoring program and how the data was used in the CSO assessment.

The City of Portland monitoring program was conducted during the period November 1991 through July 1992. The monitoring plan was described in detail in a document entitled *City of Portland Combined Sewer Overflow Abatement Study Monitoring Plan* (Monitoring Plan), dated July 1, 1991. The goal of the program was to acquire flow and water quality data at representative locations in the combined sewer system and CSO frequency data at all CSO locations. Flow and frequency data were used to enhance, recalibrate, and verify the CSO Abatement Model and to assess CSO activity (i.e., volume, frequency, and duration). The water quality data were used to characterize the pollutant loading of Portland's CSOs (pollutant concentrations are applied to estimated CSO volumes). Together, estimates of CSO activity and pollutant loading can be used to perform a qualitative assessment of CSO impacts on receiving water quality.

3.1 CSO Volume, Frequency, and Duration

This section summarizes the combined sewer flow and block monitoring program and presents an assessment of CSO activity using the recalibrated CSO Abatement Model. The information, in addition to specifics of the CSO Abatement Model recalibration effort, is presented in detail in TM 7, CSO Frequency and Volume Data.

Flow and Block Monitoring Program

The Monitoring Plan identified the need to conduct a flow and block monitoring program to assess the volume, frequency, and duration of Portland's CSO contribution to area receiving waters. Data acquired during the flow monitoring period included the precipitation record, flow at specific in-system and overflow locations in the combined sewer system, and results of the CSO frequency block test program.

Precipitation Record

The National Oceanic and Atmospheric Administration (NOAA) maintains a weather station at the Portland International Jetport, 2 miles west of downtown Portland. An hourly rainfall report is published monthly. In order to more precisely correlate CSO occurrences with rainfall, 15-minute precipitation data were acquired directly from the rain gauge strip charts for rainfall events during the monitoring period. Storms occurring during the monitoring period varied in volume, duration, and intensity. The largest storm was estimated to have a recurrence interval of just under 3 years for a 6-hour duration. Other storms were well under a 1-year recurrence interval for all durations.

Flow Monitoring Locations

Flow monitoring stations were installed at the following nine locations:

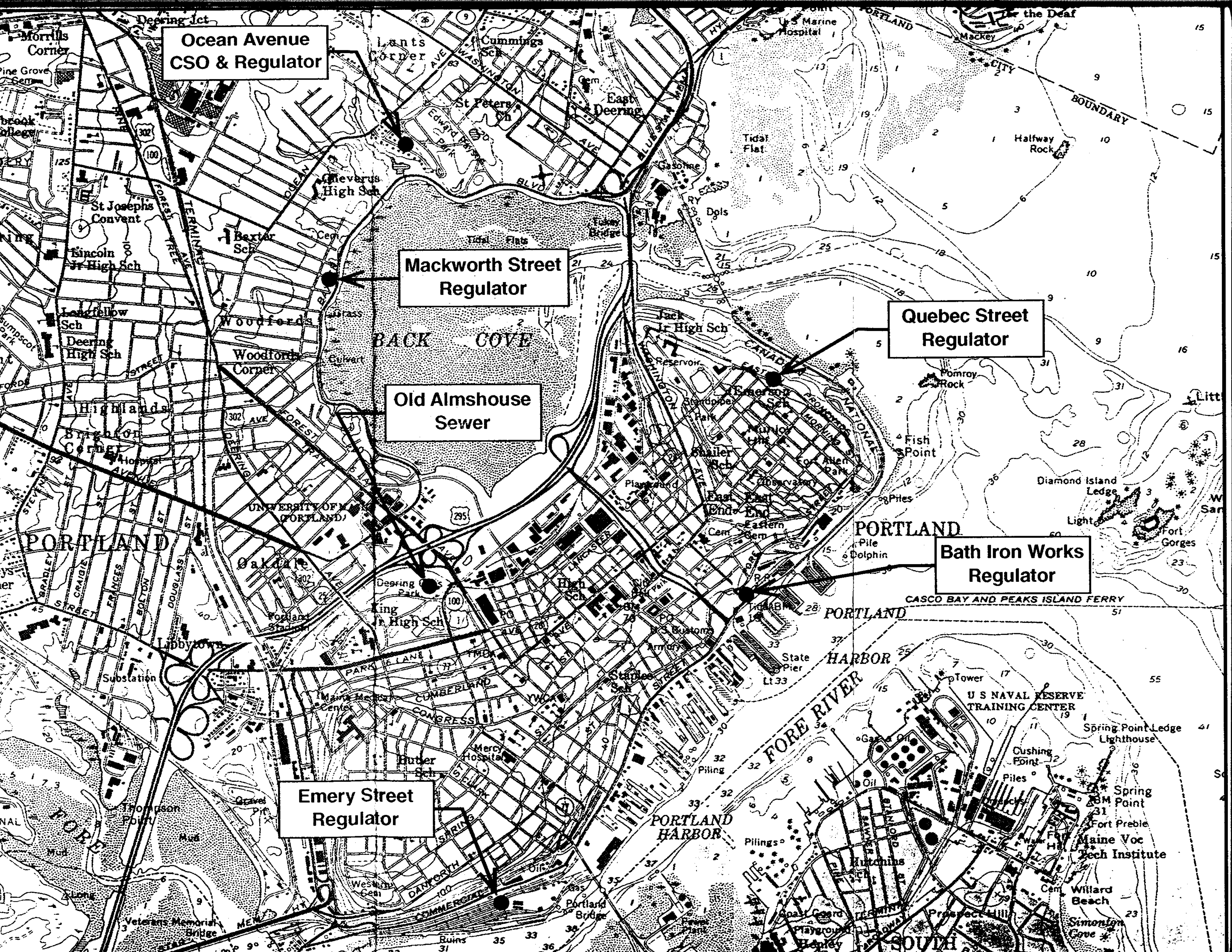
- Ocean Avenue CSO 84-inch Conduit (CSO 7)
- Ocean Avenue Regulator Outgoing 42-inch Interceptor
- Mackworth Street Regulator Incoming 36-inch Conduit
- Old Almshouse Sewer
- Quebec Street Regulator Incoming 18-inch Conduit
- Bath Iron Works Regulator Incoming 50-inch Conduit
- Bath Iron Works Regulator Outgoing 21-inch Interceptor
- Emery Street Regulator Incoming 36-inch Conduit
- Capisic Dam Overflow Weir

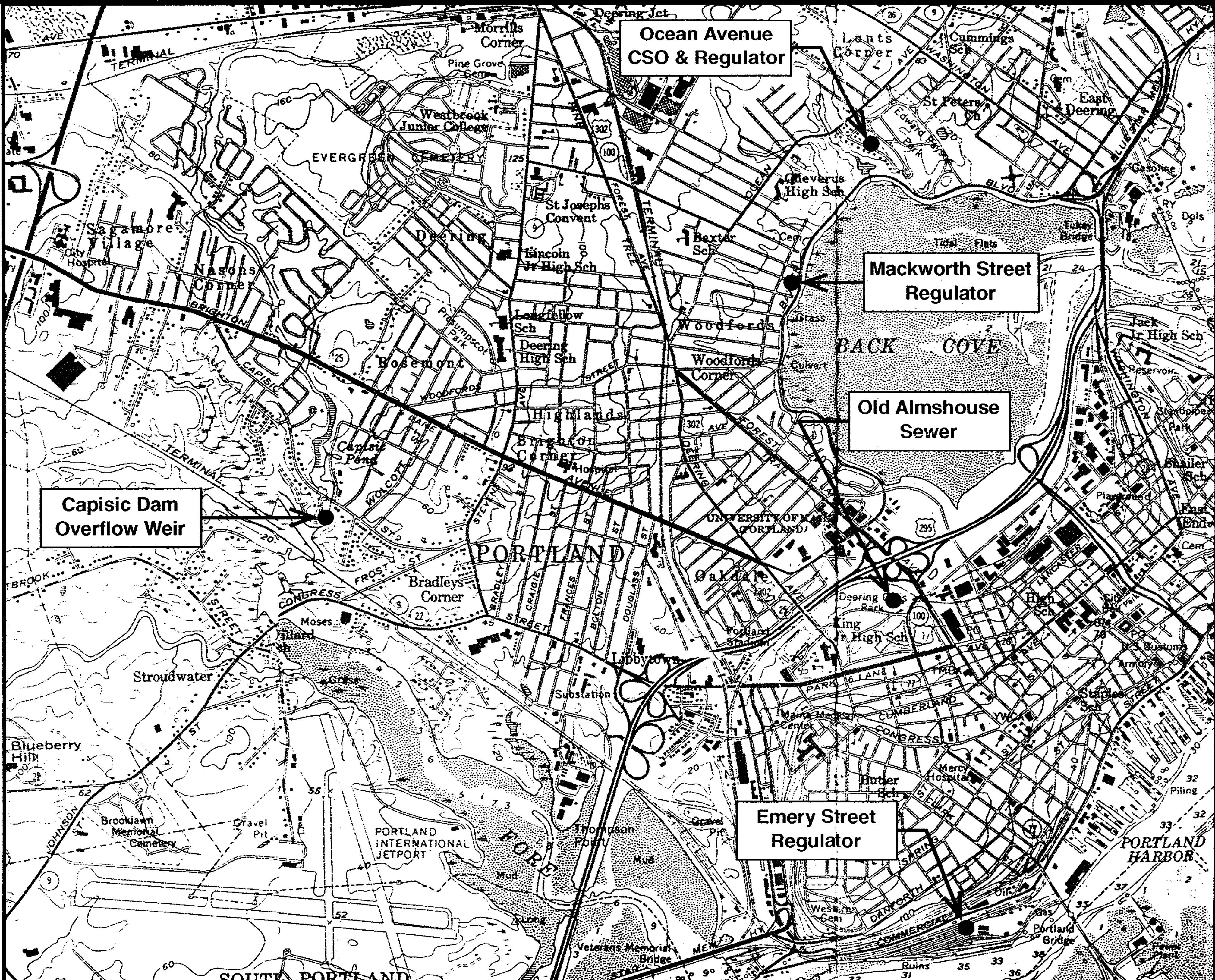
The stations were selected based on representative characteristics such as size of drainage area, land use in the drainage area, system hydraulics, and frequency of overflows. The ease of implementation and accessibility were also factors in site selection. Several of the sites listed above differ from the sites listed in the original monitoring plan. The changes were a result of subsequent discussions with DEP and implementation issues encountered during meter setup. The flow monitoring sites are shown on Figure 3-1. Flow monitoring data collected was used extensively for model recalibration.

Pump Station Flow Records

The flow monitoring stations were, with the exception of the Old Almshouse Sewer station, located at or near system regulators in order to characterize CSOs. Flow in the trunk sewers which convey sewage to the WWTF is equally important for model calibration and system characterization. Trunk sewer flow is represented by pump station flow records. Flow records were available for the following stations:

- Fore River


Ocean Avenue CSO & Regulator
Mackworth Street Regulator
Quebec Street Regulator
Old Almshouse Sewer
Bath Iron Works Regulator
Emery Street Regulator
BACK COVE
PORTLAND
PORTLAND HARBOR
FORE RIVER
CASCO BAY AND PEAKS ISLAND FERRY
U S NAVAL RESERVE TRAINING CENTER
UNIVERSITY OF MAINE (PORTLAND)
Deering Jct
Morrills Corner
Lunts Corner
East Deering
Woodfords
Woodfords Corner
Highlands
Brighton Corner
Oakdale
Libbytown
Diamond Island Ledge
Fort Gorges
Spring Point Ledge Lighthouse
Halfway Rock
Pomroy Rock
Fish Point
Tidal Flat
State Pier
Portland Bridge
Veterans Memorial Bridge


Ocean Avenue CSO & Regulator
Mackworth Street Regulator
Old Almshouse Sewer
Capisic Dam Overflow Weir
Emery Street Regulator

- Thompson Point
- India Street
- Baxter Boulevard
- Arcadia Street
- Northeast

The pump station flow records consist of flow values at 2-minute intervals. With a few exceptions, the flow record was complete at each of the locations listed for all significant rainfall events during the monitoring period. Franklin Street was the only pump station incorporated into the system model for which flow records were not available.

Block Testing Program

The frequency of combined sewer overflow was observed during the monitoring period through inspection of wooden blocks ("telltales") tied to strings and placed on the CSO regulator weirs. The regulators were checked after every significant rainfall event, or approximately weekly during dry weather and light precipitation events, by PWD or City staff. The weekly checks served to monitor CSO activity during small precipitation events, to ensure that the blocks remained in place during dry weather, and to detect dry weather CSOs.

Block tests were performed at 33 of 39 CSO locations. Six locations were not monitored because of awkward configurations not amenable to the procedure. These include CSOs 5, 12, 20, 23, and 25 which have tidegates and CSO 36 which has a 30-foot-long weir.

Flow and Frequency Monitoring Results

Flow

The monitoring period of November 1991 through July 1992 included 20 rainfall events that were considered to be of sufficient magnitude to initiate widespread CSOs and were therefore selected for wet weather model calibration and verification. The flow data are representative of contributing drainage area characteristics and hydraulic conditions. Hydrographs of precipitation and flow recorded at each monitoring location are provided in TM 7. Flow data was not recorded for all events at all monitoring locations and some data collected indicated anomalies as described in TM 7.

The 14 precipitation events which provided usable data for model calibration and verification are described in Table 3-1. Table 3-2 presents the number of events for which flow data were recorded at each monitoring location and differentiates between collected data and usable data.

Frequency

The majority of the regulator structures have been monitored for overflow frequency by the "telltale" method since November 1989 by the PWD. Overflow frequency data were collected specifically for the monitoring period extending from November 1991 through July 1992 for calibration and verification of the Portland CSO Abatement Model. Regulators maintained by the City Wastewater and Drainage Division were monitored simultaneously with those of the PWD except for the period from July 1990 to January 1992.

Results of the block test monitoring program are presented in Table 3-3. The periods represented by the block test results are shown in the first column. The second and third columns show the number of discrete rainfall events and the total precipitation which occurred over the period. The fourth and fifth columns show the peak rainfall intensity (inches/15-minutes) and rainfall (inches) associated with the largest event of the period. The rows in the table are sorted in descending order based on the maximum intensity and rainfall. The remainder of the table presents a summary of the block test program results. Details of the block test program at specific overflow locations are provided in TM 7.

Table 3-1 Calibration and Verification Precipitation Events				
Event Date	Depth (in.)	Maximum Intensity (in./15 min.)	Duration (hours)	Return Period* (months)
November 21, 1991	2.32	0.12	48	6.4
December 13, 1991	0.53	0.05	24	0.5
December 29, 1991	1.26	0.10	16	1.4
January 4, 1992	1.31	0.12	12	1.6
January 14, 1992	1.29	0.15	7	1.6
January 23, 1992	1.92	0.10	14	4.1
February 15, 1992	1.92	0.12	12	4.1
March 11, 1992	0.84	0.03	13	0.8
March 26, 1992	0.73	0.06	11	0.6
April 24, 1992	0.60	0.03	16	0.5
May 24, 1992	0.70	0.07	8	0.6
June 5, 1992	2.40	0.15	10	7.4
July 9, 1992	0.52	0.08	13	0.4
July 18, 1992	0.23	0.10	2	0.3

* Calculation of the return period is based on rainfall depth (in.) per "Evaluation of Wet Weather Design Standards for Controlling Pollution from Combined Sewer Overflows," Water Policy Branch, Office of Policy Analysis, USEPA, March 1992.

Table 3-2
Summary of Flow Data Records

Event Date	Ocean Ave. CSO	Ocean Ave. Downstream	Mackworth St. Upstream	Old Almshouse Sewer	Quebec St. Upstream	Bath Iron Works Upstream	Bath Iron Works Downstream	Emery St. Upstream	Capisic Dam CSO
November 21, 1991			(✓)						
December 13, 1991			(✓)						
December 29, 1991			(✓)						
January 4, 1992			(✓)						
January 14, 1992	✓		(✓)		(✓)			(✓)	
January 23, 1992	✓	✓	(✓)		(✓)			(✓)	
February 15, 1992	✓	✓	(✓)		(✓)			(✓)	
March 11, 1992		✓	(✓)	✓		(✓)			(✓)
March 26, 1992	(✓)	✓	(✓)	(✓)	(✓)	(✓)			
April 24, 1992		✓		✓		(✓)	✓		(✓)
May 24, 1992		✓	(✓)	✓		(✓)	✓		(✓)
June 5, 1992	(✓)	✓	(✓)	(✓)	(✓)	(✓)	✓	(✓)	(✓)
July 9, 1992		✓	(✓)	✓		(✓)	✓		✓
July 18, 1992	(✓)	✓	(✓)	(✓)	(✓)	(✓)	✓	(✓)	(✓)

✓ = Data collected but not used in calibration and verification; see TM 7 for discussion.

(✓) = Included in calibration and verification

Table 3-3
Summary of Block Test Results

Period	Period Characteristics						
	Number of Events	Total Rainfall (in)	Largest Event Maximum Intensity (in/15 min)	Largest Event Maximum Rainfall (in)	No. of CSOs Block Tested	No. of CSOs Over-flowing	% of CSOs Over-flowing
06/02-06/08	2	2.60	0.15	2.40	28	21	75
01/07-01/15	2	1.50	0.15	1.29	28	20	71
07/14-07/29	5	1.36	0.15	0.60	27	3	11
11/22-11/25	1	2.32	0.12	2.32	18	7	39
02/12-02/19	2	2.18	0.12	1.92	33	22	67
12/31-01/06	1	1.31	0.12	1.31	8	2	25
04/02-04/13	1	0.90	0.11	0.90	28	2	7
01/16-01/24	1	1.92	0.10	1.92	30	24	80
12/28-12/30	1	1.26	0.10	1.26	18	3	17
03/13-03/25	2	0.92	0.10	0.79	32	1	3
11/26-12/04	1	1.08	0.09	0.92	18	2	72
07/08-07/13	2	0.82	0.08	0.52	30	17	57
06/09-06/25	2	0.46	0.08	0.26	30	7	23
03/10-03/12	1	0.84	0.07	0.84	32	7	22
05/13-05/27	2	0.72	0.07	0.70	28	6	21
02/28-03/09	1	0.57	0.07	0.57	33	8	24
05/28-06/01	2	0.84	0.06	0.79	28	4	14
03/26-03/30	2	1.47	0.06	0.74	30	10	33
04/14-04/22	2	0.82	0.05	0.70	29	3	10
12/11-12/18	3	1.13	0.05	0.60	18	3	17
02/20-02/27	2	0.51	0.05	0.46	23	3	13
06/26-07/07	1	0.67	0.04	0.57	30	7	23
12/05-12/10	2	0.43	0.04	0.23	18	4	22
12/21-12/27	1	0.09	0.04	0.09	18	5	28
04/23-04/29	2	0.63	0.03	0.60	30	3	10
04/30-05/06	1	0.17	0.02	0.17	28	2	7
05/07-05/12	1	0.12	0.01	0.12	28	0	0
03/31-04/01	1	0.11	0.01	0.11	31	1	3

The block test data were used primarily as a check against model predictions of overflow events as discussed in the next section on sewer system modeling. The block test data were used for model verification, but not for model calibration.

Sewer System Modeling

Combined sewer modeling of the Portland system was initiated in the fall of 1991. The general objective of the modeling study was to develop an understanding of the sewer system hydraulics and to quantify CSO frequency, volume, and duration at each of the system's CSO outfall structures under various storm conditions. The model was used to direct the planning and implementation of the monitoring program and as a tool for testing the effectiveness of various CSO technologies.

Components of the Model

The SWMM RUNOFF block was used to estimate stormwater runoff from subareas of the system. The data necessary for building the runoff model were developed from collection system maps, field reconnaissance, previous studies, and interviews with City and PWD staff. The SWMM EXTRAN block was used to simulate the transport of water generated by runoff, infiltration/inflow, and base sanitary flow through the main interceptors and trunk sewers of the collection system. The use of EXTRAN enabled the modeling of surcharge conditions and internal flow diversions within the system.

Prior to the monitoring period, limited data existed to calibrate and verify the model. The monitoring program was designed to generate data which could subsequently be used to test the preliminary model. During the second phase of the modeling effort system updates and changes were incorporated along with any new information about the existing system. In addition, several enhancements were made to aid numerical stability of the solution procedure.

The precipitation events providing the most complete data at the monitoring locations were selected for the first few calibrations runs (July 18, 1992; June 5, 1992; and March 26, 1992). Additional calibrations runs were then performed with the remaining data acquired during the monitoring period. Due to the limited data available, different storms were used at each location for verification. A comparison of block test data and model-simulated results was also performed as part of the model verification effort. Tables 3-4 and 3-5 present a comparison of monitored flow and block test data and model-simulated results. In Table 3-5, the total number of events compared is listed along with the number and percent of matches. In general, the verification results indicated that the model provided close approximation of measured data, especially considering the precision of the block test data and that blocks were known to move by activity that was not CSO-related. Details of the recalibration and verification efforts are presented in TM 7. Details of the original calibration effort are presented in TM 3.

Description of the Modeled Regions

The system model is composed of two regions (see Figure 1-1). Region 1 includes the Back Cove, Marginal Way, and Northeast areas upstream of the Northeast Pump Station, and Region 2 includes the Portland Harbor, Fore River, and Capisic Brook areas upstream of the India Street Pump Station.

Region 1 encompasses 39 subcatchments (areas delineated and represented with surface runoff parameters in the RUNOFF block of the SWMM model) and 20 CSOs. CSOs 5 through 19 discharge to Back Cove while CSOs 1, 3, 4, and 20 discharge to Casco Bay. CSO 2 overflows to the Presumpscot River. Drainage areas along Marginal Way, in the vicinity of CSOs 17 through 20, encompass commercial and industrial land use with substantial impervious cover. Slopes are steep at the upper reaches along the northern face of the peninsula, and flatten out along Marginal Way. Along the northern rim of Back Cove, drainage areas are dominated by medium density residential and light commercial. In the Northeast/Fall Brook area, subcatchments are divided approximately

Table 3-4
Modeled Versus Measured Flow Monitoring Results

Page 1 of 2

Location	Storm Date*	Measured CSO Volume (MG)	Modeled CSO Volume (MG)	Difference (Modeled-Measured) (MG)	Difference (Modeled-Measured) (%)
North East Pump Station					
	1/23/92	26.3	29.2	2.9	11
	2/15/92	38.5	39.9	1.4	4
	3/26/92	51.2	49.9	-1.3	-3
	6/5/92	27.6	29.0	1.4	5
	7/18/92	2.3	7.2	4.9	213
Ocean Ave. CSO 7					
	1/14/92	12.5	14.1	1.6	13
	1/23/92	21.9	20.6	-1.3	-6
	2/15/92	23.4	23.7	0.3	1
	3/26/92	6.1	3.7	-2.4	-39
	6/5/92	13.1	25.4	12.3	94
	7/18/92	1.0	3.7	2.7	270
Mackworth St. Regulator Incoming Flow					
	11/21/91	3.1	3.0	-0.1	-3
	12/13/91	1.2	1.0	-0.2	-17
	12/29/91	1.0	1.2	0.2	20
	1/4/92	1.6	1.4	-0.2	-13
	1/14/92	1.7	1.4	-0.3	-18
	1/23/92	2.9	2.0	-0.9	-31
	2/15/92	3.2	3.0	-0.2	-6
	3/11/92	1.3	1.0	-0.3	-23
	3/26/92	3.2	2.1	-1.1	-34
	5/24/92	1.7	1.6	-0.1	-6
	6/5/92	3.6	4.2	0.6	17
	7/9/92	1.1	0.9	-0.2	-18
	7/18/92	2.0	1.9	-0.1	-5
Old Almshouse Sewer					
	3/26/92	22.9	10.3	-12.6	-55
	6/5/92	14.0	20.8	6.8	49
	7/18/92	22.7	28.2	5.5	24
Quebec St. Regulator Incoming Flow					
	1/14/92	0.4	1.0	0.6	150
	1/23/92	1.2	1.1	-0.1	-8
	2/15/92	1.4	1.2	-0.2	-14
	3/26/92	0.7	0.9	0.2	29
	6/5/92	1.2	1.7	0.5	42
	7/18/92	0.4	0.7	0.3	75

Table 3-4
Modeled Versus Measured Flow Monitoring Results

Location	Storm Date*	Measured CSO Volume (MG)	Modeled CSO Volume (MG)	Difference (Modeled-Measured) (MG)	(%)
Bath Iron Works Regulator Incoming Flow					
	3/11/92	0.7	1.0	0.3	46
	3/26/92	2.2	1.9	-0.3	-14
	4/24/92	1.0	1.1	0.1	10
	5/24/92	0.6	0.8	0.2	33
	6/5/92	1.5	4.2	2.7	180
	7/8/92	0.5	0.6	0.1	20
	7/18/92	27.4	2.3	-25.1	-92
Emery St. Regulator Incoming Flow					
	1/14/92	0.7	1.4	0.7	100
	1/23/92	1.6	1.5	-0.1	-6
	2/15/92	1.7	1.5	-0.2	-12
	6/5/92	1.2	2.2	1	83
	7/18/92	0.4	0.6	0.2	50
Fore River Pump Station					
	3/11/92	8.4	8	-0.4	-5
	4/24/92	5.6	5	-0.6	-11
	5/24/92	3.3	3.8	0.5	15
	6/5/92	10.0	12.3	2.3	23
	7/9/92	3.6	5.1	1.5	42
	7/18/92	1.1	0.9	-0.2	-18
Capisic Dam CSO 36					
	3/11/92	15.5	12.4	-3.1	-20
	4/24/92	1.1	0.7	-0.4	-36
	5/24/92	2.8	0.9	-1.9	-68
	6/5/92	5.4	4.5	-0.9	-17
	7/18/92	1.0	3.7	2.7	270

*Storms used for initial calibration effort include July 18, 1992; June 5, 1992; and March 26, 1992.

Table 3-5
Field and Modeled Frequency Test Results
Region 1 - Northeast Pump Station Drainage Areas (page 1 of 2)

Combined Sewer Overflows

Period	Period Number of Events	Period Total Rainfall Volume (in)	Period Largest Event Maximum Intensity (in/15min)	Period Largest Event Maximum Volume (in)	1		2		3		4		5		6		7		8		9		10	
					M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B
06/02 - 06/0	2	2.60	0.15	2.40	Y		Y	N	N		N	N	Y		Y	Y	Y	Y	Y	Y	N	N	Y	Y
01/07 - 01/1	2	1.50	0.15	1.29	Y	N	Y	Y	N	N	N	N	Y		Y	Y	Y	Y	N	Y	N	N	Y	Y
07/14 - 07/2	5	1.36	0.15	0.60	Y	N	Y	N	N	N	N	N	Y		Y	Y	Y	N	N	N	N	N	Y	Y
11/22 - 11/2	1	2.32	0.12	2.32		Y		Y		N		Y						Y		N		N		Y
02/12 - 02/1	2	2.18	0.12	1.92	Y	N	Y	Y	N	Y	N	N	Y		Y	Y	Y	Y	Y	Y	N	N	Y	Y
12/31 - 01/0	1	1.31	0.12	1.31																				
04/02 - 04/1	1	0.90	0.11	0.90	N	N	Y	N	N	N	N	N	Y		Y		Y	N	N	N	N	N	Y	N
01/16 - 01/2	1	1.92	0.10	1.92	N	N	Y	Y	N	Y	N	Y	Y		Y	Y	Y	Y	N	Y	N	N	Y	Y
12/28 - 12/3	1	1.26	0.10	1.26	Y	Y	N	N	N	N	N	N	Y		Y		Y	Y	N	N	N	N	Y	Y
03/13 - 03/2	2	0.92	0.10	0.79		N		N		N		N						N		N		N		Y
11/26 - 12/0	1	1.08	0.09	0.92	N	N	N	N	N	N	N	N	Y		Y		Y	N	N	N	N	N	Y	N
07/08 - 07/1	2	0.82	0.08	0.52	N	N	Y	Y	N	N	N	N	Y		Y	Y	Y	Y	N	Y	N	Y	Y	Y
06/09 - 06/2	2	0.46	0.08	0.26		N		N		N		N				Y		N		N		N		N
03/10 - 03/1	1	0.84	0.07	0.84		N		N		N		N				Y		Y		N		N		Y
05/13 - 05/2	2	0.72	0.07	0.70	N	N	N	N	N	N	N	N	Y		Y	Y	Y		N	N	N	N	Y	Y
02/28 - 03/0	1	0.57	0.07	0.57	N	N	N	N	N	N	N	N	Y		Y	Y	Y	Y	N	N	N	N	Y	Y
05/28 - 06/0	2	0.84	0.06	0.79		N		N		Y		N				N		Y		N		N		
03/26 - 03/3	2	1.47	0.06	0.74	N	N	N	N	N	N	N		N		Y	Y	Y	N	N	N	N	N	Y	Y
04/14 - 04/2	2	0.82	0.05	0.70		N		N		Y		N				N		N		N		N		N
12/11 - 12/1	3	1.13	0.05	0.60		N		N		Y		N						Y		N		N		Y
02/20 - 02/2	2	0.51	0.05	0.46		N		N				N				Y		N		N		N		N
06/26 - 07/0	1	0.67	0.04	0.67	N	N	N	Y	N	N	N	N	Y		N	Y	N	N	N	N	N	N	Y	N
12/05 - 12/1	2	0.43	0.04	0.23		N		N		Y		N						N		N		N		Y
12/21 - 12/2	1	0.09	0.04	0.09	N	N	N	Y	N	N	N	Y	N		N		N	N	N	N	N	N	N	N
04/23 - 04/2	2	0.63	0.03	0.60		N		N		Y		N				N		N		N		N		N
04/30 - 05/0	1	0.17	0.02	0.17						Y		N				N		N		N		N		Y
05/07 - 05/1	1	0.12	0.01	0.12		N		N		N		N				N		N		N		N		
03/31 - 04/0	1	0.11	0.01	0.11	N	N	N	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N
				No. of Results:	15	25	15	26	15	25	15	26	15	0	15	20	15	26	15	27	15	27	15	25
				No. of Y:	5	2	7	7	0	8	0	3	12	-	12	14	12	11	1	5	0	1	13	16
				No. of Events Compared:	14		15		14		14		0		11		14		15		15		14	
				No. of Results Matched:	11		12		12		12		-		10		10		12		14		11	
				% of Results Matched:	79		80		86		86		-		91		71		80		93		79	

Period	11		12		13		14		15		16		17		18		19		20	
	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B	M	B
06/02 - 06/0	Y	N	Y		Y	Y	N	Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	
01/07 - 01/1	N	N	Y		Y	Y	N	Y	Y	Y	Y	Y	Y		Y		Y	Y	Y	
07/14 - 07/2	N	N	Y		Y		N	N	N	N	Y		Y		Y		N	N	Y	
11/22 - 11/2		N										Y								
02/12 - 02/1	Y	N	Y		Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y	
12/31 - 01/0																				
04/02 - 04/1	N	N	Y		Y		N	N	N	N	Y	N	Y		Y		N	N	Y	
01/16 - 01/2	Y	Y	Y		Y	Y	N	N	Y	Y	Y		Y		Y		N	Y	Y	
12/28 - 12/3	N	N	Y		Y		N		N		Y		Y		Y		N		Y	
03/13 - 03/2		N				N		N		N		N		N		N		N		
11/26 - 12/0	N	Y	Y		Y		N		N		Y	Y	N		N		N		Y	
07/08 - 07/1	N	N	Y		Y	Y	N	N	N	Y	Y	Y	N		N		N	N	Y	
06/09 - 06/2		N				N		N		N		Y						N		
03/10 - 03/1		N				N		N		N		N		N		N		N		
05/13 - 05/2	N	N	Y		Y	Y	N	N	N	N	Y	N	Y		Y		N	N	Y	
02/28 - 03/0	N	N	Y		Y	Y	N	N	N	Y	Y	N	N	N	N	N	N	N	Y	
05/28 - 06/0		N				N		N		N		Y						N		
03/26 - 03/3	N	N	Y		Y	Y	N	N	N	Y	Y		Y	N	N	N	N	N	Y	
04/14 - 04/2		N				N		N		N		N						N		
12/11 - 12/1		N																		
02/20 - 02/2		N				N		N		N		N		N		N		N		
06/26 - 07/0	N	N	Y		Y	Y	N	N	N	N	Y	Y	N		N		N	N	Y	
12/05 - 12/1		N																		
12/21 - 12/2	N	N	Y		Y		N		N		Y	Y	N		N		N		N	
04/23 - 04/2		N				N		N		N		N						N		
04/30 - 05/0		N				N		N		N		N						N		
05/07 - 05/1		N				N		N		N		N						N		
03/31 - 04/0	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
No. of Results:	15	27	15	0	15	19	15	21	15	21	15	22	15	7	15	7	15	21	15	0
No. of Y:	3	2	14	-	14	9	0	3	4	7	14	10	9	0	8	0	3	3	13	-
No. of Events Compared:	15		0		10		12		12		11		4		4		12		0	
No. of Results Matched:	12		-		10		9		9		8		2		3		10		-	
% of Results Matched:	80		-		100		75		75		73		50		75		83		-	

M - Modeled Result
B - Block Test Field Check Result
"Y" Denotes Overflow Occurrence During Specified Period.

Table 3-5
Field and Modeled Frequency Test Results
Region 2 - India Street Pump Station Drainage Areas (page 2 of 2)

Period	Period Number of Events	Period Total Rainfall Volume (in)	Period Largest Event Maximum Intensity (in/15min)	Period Largest Event Maximum Volume (in)	21 M	21 B	23 M	23 B	24 M	24 B	25 M	25 B	26 M	26 B	27 M	27 B	28 M	28 B	29 M	29 B
06/02 - 06/08	2	2.60	0.15	2.40	Y	Y	Y		Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
01/07 - 01/15	2	1.50	0.15	1.29	Y	Y	Y		Y	Y	Y		Y		Y	Y	Y	Y	Y	Y
07/14 - 07/29	5	1.36	0.15	0.60	Y	N	Y		Y		Y		Y		Y	N	Y	N	Y	N
11/22 - 11/25	1	2.32	0.12	2.32		N												Y		N
02/12 - 02/19	2	2.18	0.12	1.92	Y	Y	Y		Y	Y	Y		Y	N	Y	Y	Y	Y	Y	Y
12/31 - 01/06	1	1.31	0.12	1.31		Y										N				N
04/02 - 04/13	1	0.90	0.11	0.90	N	N	Y		Y	Y	Y		Y		Y	N	Y	N	Y	N
01/16 - 01/24	1	1.92	0.10	1.92	N	Y	Y		Y	Y	Y		N	N	Y	Y	Y	Y	Y	Y
12/28 - 12/30	1	1.26	0.10	1.26	N	N	Y		Y		Y		N		Y	N	Y	N	Y	N
03/13 - 03/25	2	0.92	0.10	0.79		N				N				N		N		N		N
11/26 - 12/04	1	1.08	0.09	0.92	N	N	Y		Y		Y		N		Y		Y	N	Y	N
07/08 - 07/13	2	0.82	0.08	0.52	N	Y	Y		Y	Y	Y		N		Y	Y	Y	Y	Y	Y
06/09 - 06/25	2	0.46	0.08	0.26		N				N						Y		Y		N
03/10 - 03/12	1	0.84	0.07	0.84		N				Y				N		Y		N		N
05/13 - 05/27	2	0.72	0.07	0.70	N	Y	Y		Y	N	Y		N		Y	N	Y		Y	N
02/28 - 03/09	1	0.57	0.07	0.57	N	N	Y		Y	Y	Y		N	N	Y	N	Y	N	Y	N
05/28 - 06/01	2	0.84	0.06	0.79		N				N						N				N
03/26 - 03/30	2	1.47	0.06	0.74	N	N	Y		Y	Y	Y		N	N	Y	N	Y		Y	N
04/14 - 04/22	2	0.82	0.05	0.70		N				Y						N		N		N
12/11 - 12/18	3	1.13	0.05	0.60		N										N		N		N
02/20 - 02/27	2	0.51	0.05	0.46						Y				N						
06/26 - 07/07	1	0.67	0.04	0.67	N	N	Y		Y	Y	Y		N		Y	N	Y	N	N	N
12/05 - 12/10	2	0.43	0.04	0.23		N										Y		N		N
12/21 - 12/27	1	0.09	0.04	0.09	N	Y	N		N		Y		N		Y	N	N		N	N
04/23 - 04/29	2	0.63	0.03	0.60		N				Y						N		N		N
04/30 - 05/06	1	0.17	0.02	0.17						N				N		N		N		N
05/07 - 05/12	1	0.12	0.01	0.12		N				N						N				N
03/31 - 04/01	1	0.11	0.01	0.11	N	N	N		N	N	N		N	N	N	N	N	Y	N	N
No. of Results:					15	26	15	0	15	20	15	0	15	9	15	25	15	21	15	27
No. of Y:					4	8	13	-	13	13	14	-	5	0	14	8	13	8	12	5
No. of Events Compared:					15		0		11		0		5		14		12		15	
No. of Results Matched:					10		-		10		-		4		6		5		8	
% of Results Matched:					67		-		91		-		80		43		42		53	

Combined Sewer Overflows (continued)

Period	30 M	30 B	32 M	32 B	33 M	33 B	34 M	34 B	35 M	35 B	36 M	36 B	38 M	38 B	39 M	39 B	41 M	41 B	42 M	42 B	43 M	43 B
06/02 - 06/08	Y	N	N	Y	Y	Y	N	N	Y	N	Y		Y	Y	N	Y	Y	Y	Y	Y	Y	Y
01/07 - 01/15	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y		Y	Y	N	Y	N	N	Y		Y	
07/14 - 07/29	Y	N	N	N	N	N	N	N	N	N	Y		Y	Y	N	N	N	N	Y	N	Y	N
11/22 - 11/25		N		N		Y		N		N												
02/12 - 02/19	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y		Y	Y	N	N	Y	Y	Y	Y	Y	Y
12/31 - 01/06		N		Y		N		N		N												
04/02 - 04/13	Y	N	Y	N	N	N	N	N	N	N	Y		Y	N	N	N	N	N	Y	Y	Y	N
01/16 - 01/24	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y		Y	Y	N	Y	Y	N	Y	Y	Y	Y
12/28 - 12/30	N	N	N	N	N	N	N	N	N	N	Y		Y		N		N		Y		Y	
03/13 - 03/25		N		N		N		N		N				N		N		N		N		N
11/26 - 12/04	N	N	N	N	N	N	N	N	N	N	Y		N		N		N		Y		Y	
07/08 - 07/13	N	N	N	N	N	N	Y	Y	N	Y	Y		N	Y	N	Y	N	Y	Y	Y	Y	Y
06/09 - 06/25		N		N		N		N		N				N		Y		N		Y		Y
03/10 - 03/12		N		N		N		N		N						N		N		Y		Y
05/13 - 05/27	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	Y	N	N	N	N	Y	Y
02/28 - 03/09	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N	N	Y	Y	Y	Y
05/28 - 06/01		N		N		N		N		N				N		N		N		Y		N
03/26 - 03/30	N	N	N	N	N	N	N	N	N	N	Y		N	Y	N	Y	N	Y	Y	Y	Y	Y
04/14 - 04/22		N		N		N		N		N				Y		N		N				N
12/11 - 12/18		N		N		N		N		N												
02/20 - 02/27														N		N		N		Y		N
06/26 - 07/07	N	N	N	N	N	Y	N	N	N	N	Y		N	N	N	N	N	N	N	Y	N	N
12/05 - 12/10		N		N		N		N		Y												
12/21 - 12/27	N	N	N	N	N	Y	N	N	N	N	Y		N		N		N		N		N	
04/23 - 04/29		N		N		N		N		N				N		N		N		Y		N
04/30 - 05/06		N		N		N		N		N				N		N		N		N		N
05/07 - 05/12		N		N		N		N		N				N		N		N		N		N
03/31 - 04/01	N	N	N	N	N	N	N		N		Y		N	N	N	N	N	N	N	N	N	N
No. of Results:	15	27	15	27	15	27	15	26	15	26	15	0	15	20	15	21	15	21	15	19	15	20
No. of Y:	6	0	2	5	1	6	4	4	4	5	15	-	7	8	0	7	3	4	11	13	12	9
No. of Events Compared:	15		15		15		14		14		0		12		12		12		11		11	
No. of Results Matched:	9		11		11		14		12		-		9		6		9		9		9	
% of Results Matched:	60		73		73		100		86		-		75		50		75		82		82	

M - Modeled Result
B - Block Test Field Check Result
"Y" Denotes Overflow Occurrence During Specified Period.

equally between low density residential and open/undeveloped space, with some light industrial parks also present. Slopes are mild to gently sloping.

Region 2 includes 24 subcatchments and 19 CSO locations. CSOs 33 through 43 (excluding 37 and 40 which have been recently eliminated) are located upstream of the Fore River Pump Station and ultimately discharge to the Fore River. The drainage areas in this section are typical medium density residential with mild slopes and low impervious cover percentages. Several strip commercial areas are interspersed with the residential land use. The Fore River drainage areas are similar to those areas along the northern rim of Back Cove.

Region 2 also contains the Quebec Street combined sewer drainage area, CSO 21, and the combined sewer drainage area between the Fore River Pump Station and the India Street Pump Station where CSOs 23 through 30 are located. Drainage areas here are commercial and high-density residential characterized by high imperviousness and steep slopes descending the southeastern face of the peninsula.

Estimates of CSO Activity

Initial model estimates were generated using a 3-year precipitation record, 1966 through 1968, which was determined by a statistical analysis, presented in TM 4, to be the most representative of the 40-year precipitation record for Portland. During the course of the study, the CSO Abatement Model was updated from the 4.05 version to the 4.2 version, six regional submodels were combined into two, and the solution technique was refined from 3-minute computational intervals to 10-second computational intervals. These modeling changes greatly enhanced the accuracy of the model predictions, but also lengthened the recalibration effort and computer run time. Run time of the model is approximately 90 hours for Region 1 and 60 hours for Region 2 for one year of precipitation record using a 486/33MHz computer. To facilitate timely generation of results, one year instead of three years of precipitation record was used for the final analysis. The most typical year, 1966, was chosen for the analysis and will be used throughout the remainder of this study to assess average annual CSO activity. 1966 incorporates a variety of storms up to approximately a 2-year recurrence interval storm as shown in Appendix D.

Table 3-6 presents the frequency, volume, and duration of CSO activity under existing sewer system conditions using the 1966 precipitation record. The frequency of CSO activity for individual CSO locations is recorded as the number of times an overflow event occurs of 0.1 cubic feet per second (cfs) or greater and an interevent time of 24 hours. The duration listed in Table 3-6 reflects the total time of overflow for all events listed.

A 5-year recurrence interval storm was selected from the 40-year precipitation record to add to the modeling results. The characteristics of the selected 5-year storm, which occurred on November 1, 1988, are as follows:

Depth (inches)	Max. Intensity (inches/hour)	Duration (hours)	Return Period (years)
4.56	0.64	21	5.4

Modeling results using the selected 5-year storm are shown in Table 3-7. The model was also used to simulate CSO reductions resulting from the implementation of various proposed CSO mitigation alternatives. Estimates of CSO reduction after implementation of the Recommended Plan are presented in Section 5.

3.2 CSO Pollutant Concentrations

This section summarizes the combined sewer sampling program developed to characterize CSO pollutant loads and presents the results of the program. The information is presented in detail in TM 8, CSO Pollutant Evaluation.

Table 3-6
Summary of CSO Frequency, Volume, and Duration under Existing Conditions[1]

Receiving Water	CSO No.	Drainage Area (acres)	Annual			Summer		
			No. of Events	Vol. (MG)	Duration (hours)	No. of Events	Vol. (MG)	Duration (hours)
Casco Bay	1	14	10	0.2	19	5	0.1	7
	3	3	0	0	0	0	0	0
	4	0	0	0	0	0	0	0
	20	29	30	54	185	14	21	69
	21	43	7	1.1	9	3	0.5	4
Subtotal:		89	47	55	213	22	22	80
Presumpscot Estuary	2	25	13	1.8	50	6	0.6	20
Back Cove	5	74	34	100	273	14	33	78
	6	101	23	1.6	47	12	1.1	22
	7	1,051	24	100	141	12	42	59
	8	18	5	4.1	5	2	0.8	1
	9	6	0	0	0	0	0	0
	10	140	27	8.2	151	14	3.0	43
	11	20	8	0.6	9	3	0.3	4
	12	171	40	26	357	19	9.2	96
	13	86	44	4.6	223	19	1.8	93
	14	0	0	0	0	0	0	0
	15	102	11	0.4	11	5	0.2	4
	16	92	38	14	301	19	4.8	86
	17	528	25	110	133	12	42	54
	18	46	22	46	94	11	19	39
	19	177	5	0.2	6	2	0.1	2
Subtotal:		2,612	306	416	1,751	114	157	581
Portland Harbor	23	112	33	27	125	17	12	54
	24	32	30	1.7	68	17	0.9	30
	25	86	38	79	196	18	33	99
	26	95	12	1.2	18	6	0.5	6.4
	27	39	38	11	150	18	5.0	83
	28	59	43	21	202	19	9.1	91
	29	28	33	3.9	113	17	1.7	48
Subtotal:		451	227	145	872	112	62	411
Fore River	30	7	18	3.5	54	11	2.2	26
	31	Eliminated	--	--	--	--	--	--
	32	32	14	0.8	69	6	0.3	23
	33	94	2	0.1	1	0	0	0
	34	3	18	0.2	40	10	0.1	19
	35	11	10	0.2	15	5	0.1	6.1
	36	415	36	68	181	18	29	94
	39	37	0	0	0	0	0	0
Subtotal:		599	98	73	360	50	32	168
Capisic Brook	37	Eliminated	--	--	--	--	--	--
	38	21	10	4.4	33	5	1.5	9.7
	40	Eliminated	--	--	--	--	--	--
	41	11	2	0.4	6	1	0.4	2.8
	42	339	26	19	96	14	8.0	40
	43	35	26	5.6	107	14	2.3	44
Subtotal:		406	64	29	242	34	12	97
Total		4,182	755	720	3,488	368	286	1,357

[1]Based on the 1966 annual precipitation record from the Portland International Jetport.

Table 3-7
Results of a 5-Year Storm Simulation under Existing Conditions

Receiving Water	CSO No.	Drainage Area (acres)	Volume (MG)	Duration (hours)
Casco Bay	1	14	1	11
	3	3	0	8
	4	0	0	0
	20	29	22	51
	21	43	0.6	3
Subtotal:		89	24	NA
Presumpscot Estuary	2	25	0.5	2
Back Cove	5	74	3	6
	6	101	0.5	19
	7	1,051	62	38
	8	18	1	2
	9	6	0.2	2
	10	140	5	17
	11	20	1	11
	12	171	8	50
	13	86	6	51
	14	0	0.1	5
	15	102	4	13
	16	92	8	51
	17	528	41	15
	18	46	17	14
	19	177	0.6	10
Subtotal:		2,612	157	NA
Portland Harbor	23	112	25	15
	24	32	0.1	6
	25	86	16	16
	26	95	1.6	8
	27	39	0.4	2
	28	59	13	23
	29	28	29	30
Subtotal:		451	85	NA
Fore River	30	7	0.5	9
	31	Eliminated	--	--
	32	32	0.6	21
	33	94	0.5	9
	34	3	0.2	20
	35	11	2	22
	36	415	33	38
	39	37	0.4	6
Subtotal:		599	37	NA
Capisic Brook	37	Eliminated	--	--
	38	21	1	18
	40	Eliminated	--	--
	41	11	0	2
	42	339	21	24
	43	35	9	27
Subtotal:		406	31	NA
Total		4,182	335	NA

NA = Not Applicable

Combined Sewer Sampling Program

The Monitoring Plan also identified the need to conduct a CSO sampling program to characterize Portland's CSO pollutant loads to its receiving waters. A sampling program, including dry and wet weather monitoring, was conducted during the spring and summer of 1992. Sampling locations for collection of CSO water quality data were chosen based on the size of the contributing drainage area, land use within the drainage area, receiving water, hydraulic characteristics of the diversion structure, and frequency of overflows.

Pollutants of Concern

Table 3-8 shows three lists of parameters containing a total of 23 pollutants of concern. Each of these three lists was employed differently in the monitoring program as described under Sample Collection. The pollutants listed were identified in the Consent Order issued by the State of Maine to the City of Portland.

Table 3-8
Analytical Parameters of the CSO Sampling Plan

List A*	List B	List C
Total Suspended Solids (TSS)	Petroleum Hydrocarbons (PHs)	E. coli
5-Day Biochemical Oxygen Demand (BOD_5)	Polyaromatic Hydrocarbons (PAHs)	Total Suspended Solids
Total Kjeldahl Nitrogen (TKN)	Polychlorinated Biphenols (PCBs)	
Ammonia	Herbicides (2,4-D; Dicamba; and MCPP)	
Nitrate/Nitrite	pH	
Total Phosphorus (TP)	Temperature	
Arsenic		
Metals (Cadmium; Chromium; Copper; Iron; Lead; Mercury; Nickel; Silver; Zinc)		

*All nutrient analysis were performed on unfiltered samples.

Sample Locations

The five sites chosen for CSO quality sampling were:

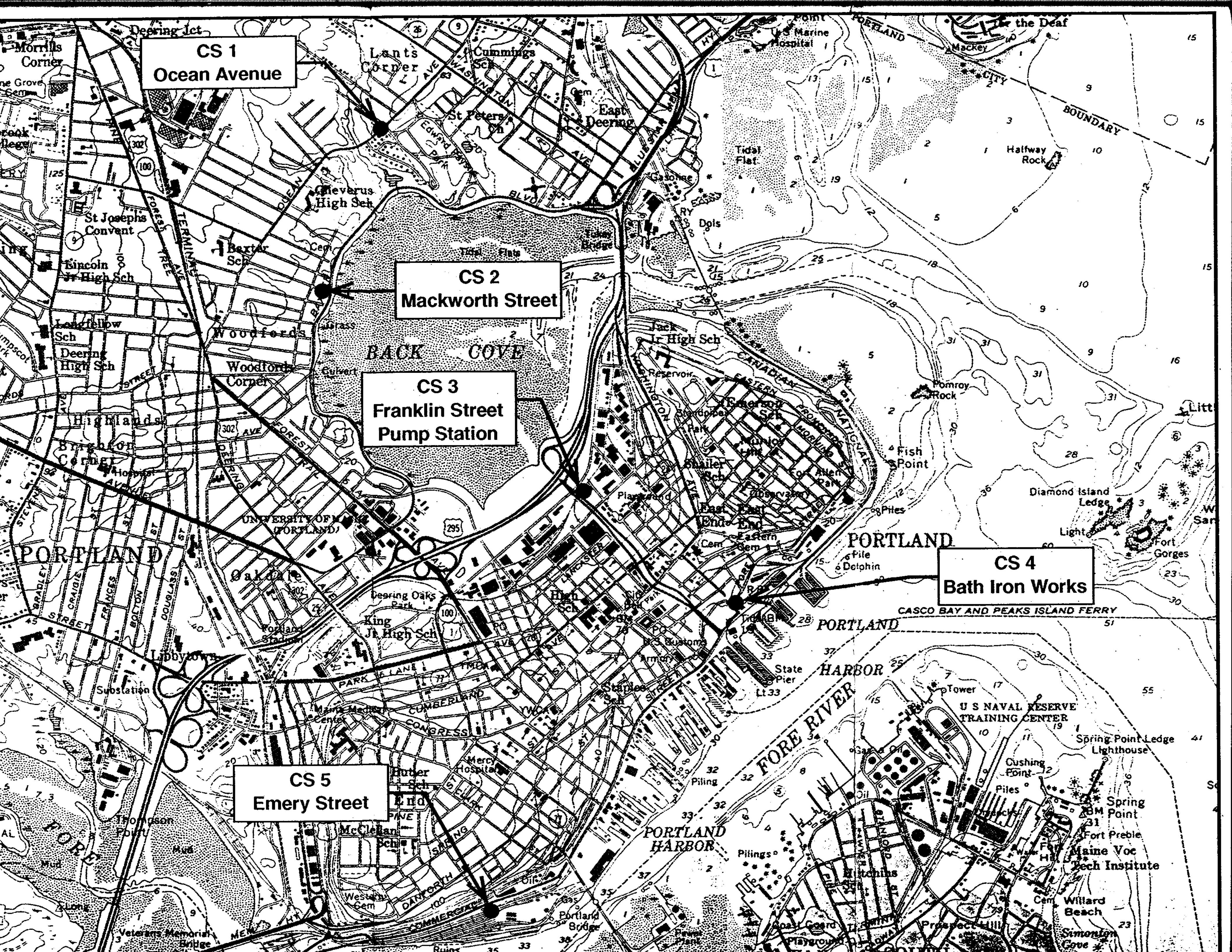
- Ocean Avenue (CS1)
- Mackworth Street (CS2)
- Franklin Street Pump Station (CS3)
- Bath Iron Works (CS4)
- Emery Street (CS5)

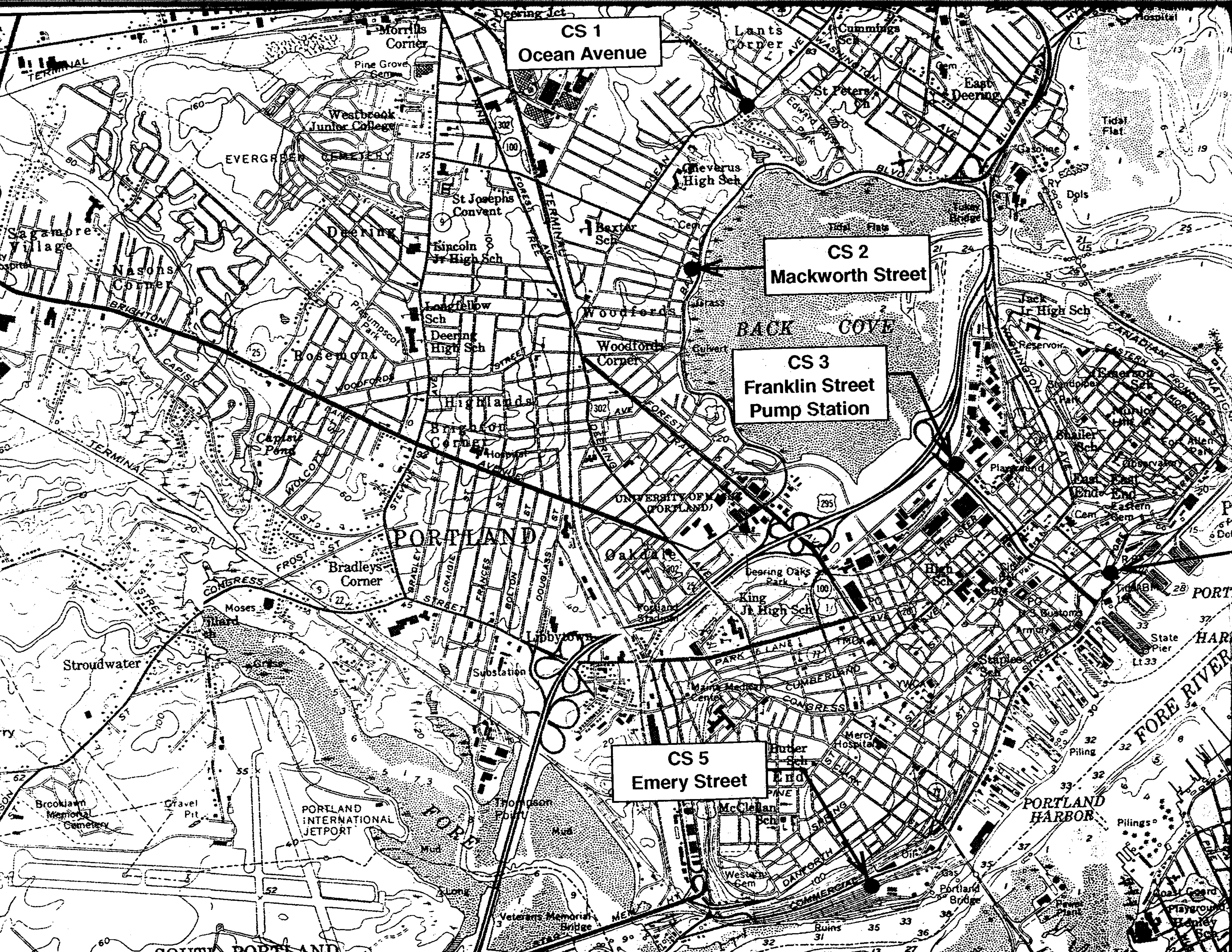
A map showing the location of the five sampling sites is included as Figure 3-2.

Sample Collection

Dry and wet weather sampling were conducted to characterize the difference between normal or baseflow conditions during dry periods and the impact of stormwater inflow and associated scour on pollutant concentrations in the interceptor. Samples were collected in the regulator structure immediately upstream of the overflow weir. Dry weather sampling was performed on May 21 for four sites and on May 29 for one site (sampler failed at CS4 on May 21) and on August 22 for all five sites. Wet weather sampling was performed during two storm events, the first on June 6, and the second on July 9.

Dry Weather. One dry weather 24-hour composite and one dry weather grab sample were taken at each of the sites for the dry weather sampling events. The dry weather sampling was performed once during a regular business week (May sampling) and once on a weekend (August sampling) to represent Portland's weekday and weekend sewerage flows. The composite samples were analyzed for the List A parameters, and the grab samples were analyzed for the List B parameters shown on Table 3-5.


CS 1
Ocean Avenue
CS 2
Mackworth Street
CS 3
Franklin Street
Pump Station
CS 4
Bath Iron Works
CS 5
Emery Street
BACK COVE
PORTLAND
PORTLAND HARBOR
FORE RIVER
CASCO BAY AND PEAKS ISLAND FERRY
Lants Corner
East Deering
Deering Jct
Morrills Corner
Woodfords
Woodfords Corner
Highlands
Libbytown
Oakdale
Cheverus High Sch
St Josephs Convent
Lincoln Jr High Sch
Deering High Sch
Longfellow Sch
Baxter Sch
University of Maine (Portland)
Deering Oaks Park
King Jr High Sch
Portland Stadium
Jack Jr High Sch
Reservoir
Shailer Sch
Eastern Cem
Staples Sch
Mercy Hospital
Maine Medical Center
McClellan Sch
Western Cem
Butler Sch
Thompson Point
Veterans Memorial Bridge
Portland Bridge
State Pier
U S Naval Reserve Training Center
Spring Point Ledge Lighthouse
Spring Point
Fort Preble
Maine Voc Tech Institute
Willard Beach
Cushing Point
Fish Point
Pomroy Rock
Diamond Island Ledge
Fort Gorges
Halfway Rock
Tidal Flat
Tidal Flats
City Boundary
U S Marine Hospital
Prospect Hill
Simonton Cove
Substation


CS 1
Ocean Avenue
CS 2
Mackworth Street
CS 3
Franklin Street
Pump Station
CS 5
Emery Street
BACK COVE
PORTLAND
PORTLAND HARBOR
FORE RIVER
PORTLAND INTERNATIONAL JETPORT

Wet Weather. Two successful wet weather sampling events were conducted. Crews were activated several times between March and August when there was a forecast of rain. However, the conditions for a rainfall event were often not met (i.e., minimum of 3 days of dry weather prior to the wet weather event and a minimum of 0.2 inches of rainfall for 2 hours), and no sampling was performed. The first sampling event occurred on June 6 when 2.39 inches of rain fell on Portland with a peak-hour intensity of 0.45 inches. The second sampling event was on July 9 when 0.52 inches of rain fell with a peak-hour intensity of 0.15 inches.

The first samples collected at each site were segregated as "first flush" samples to verify that higher pollutant loads exist in the flows generated at the start of a storm due to the scouring effect of increased flows on the surface and in the sewer system. Visual observation and the Imhoff Cone method were used to estimate the end of the first flush for the composite sample. Sample bottles collected representing the first flush were then composited by flow weighting. The remaining bottles, representing the remainder of the hydrograph after the end of the first flush (termed the "falling limb" sample), were also composited by flow weighting. Each composite sample (first flush and falling limb) was analyzed for the parameters shown on List A of Table 3-5.

Two grab samples were collected from each location during each wet weather sampling event. The first was drawn during the collection of the first seven interval composite samples, and the second was drawn during the collection of the last nine interval samples. The first grab sample was analyzed for parameters identified in Lists B and C of Table 3-5; the second was analyzed only for List C parameters.

Sample Analysis

The samples were retrieved, composited, iced, and delivered to RAI Laboratories (now Pace, Inc.), located in Hampton, New Hampshire for analytical testing.

Results of the Sampling Program

The analytical results of the samples collected during the monitoring program were evaluated to determine:

- Similarities and/or differences between monitoring sites
- Presence or absence of a first flush effect
- Area-wide or basin-specific event mean concentrations (EMCs)

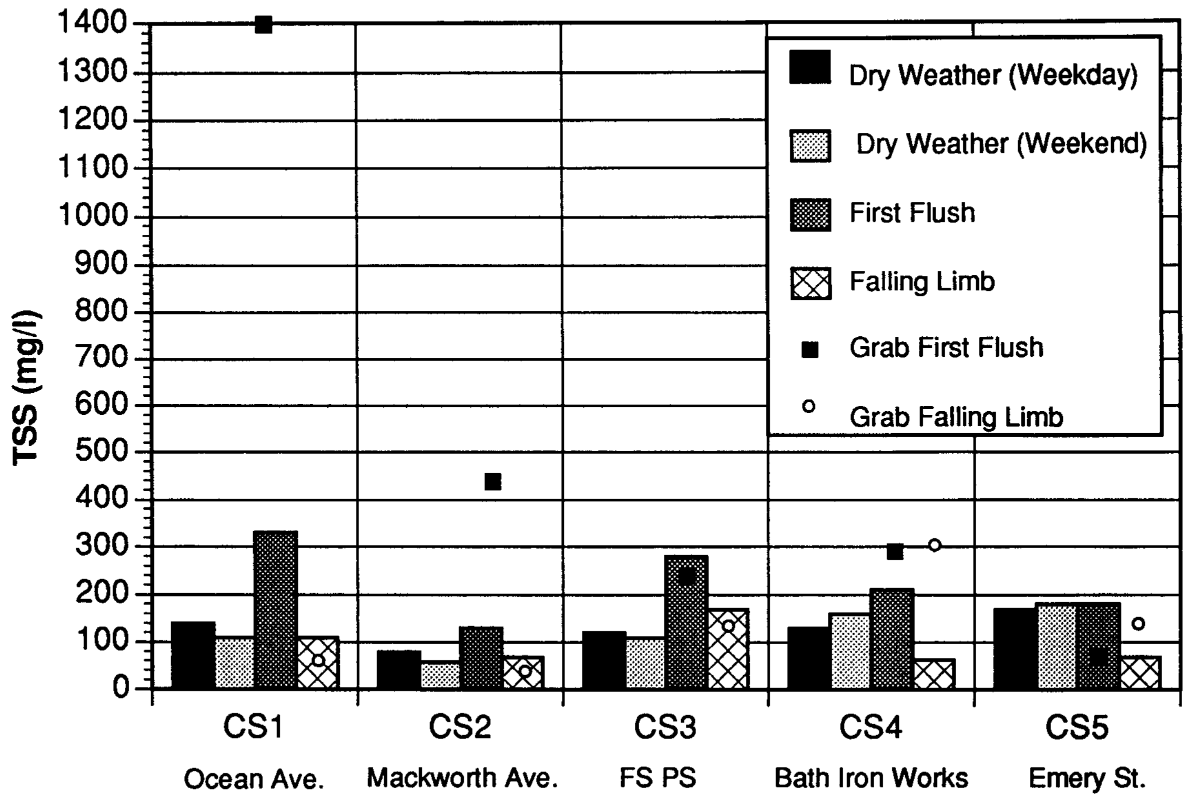
EMCs represent flow weighted average pollutant concentrations of a representative runoff event. A detailed documentation of the analyses performed and the results is contained in TM 8.

Data Analyses

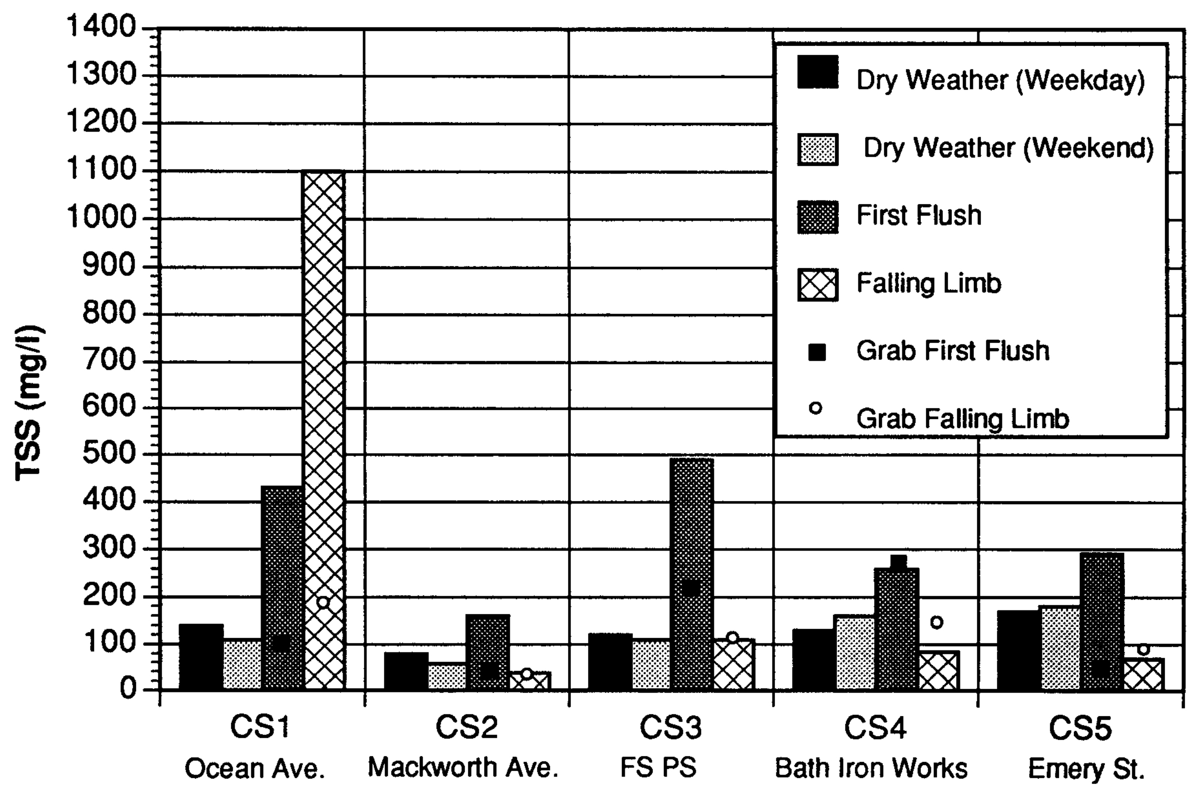
Standard Parameters (Lists A and C). Monitoring data was evaluated by plotting dry weather, first flush, and falling limb concentration for each CSO monitoring site grouped by parameter and wet weather event. For example, Figure 3-3 represents the data collected during dry weather and wet weather events for the parameter TSS.

The plots indicate whether there is a difference between pollutant levels at the various sites and whether a first flush is evident. When a first flush is evident, the first flush composite concentration is consistently greater than the falling limb concentration, as shown on Figure 3-3, except for the anomaly at CS1, event 2. The plotting parameters chosen show most of the sample concentrations exceeding the detection limit. Plots were developed for the following parameters (see TM 8 for plots):

- 5-Day Biochemical Oxygen Demand (BOD_5)
- Total Suspended Solids (TSS)
- Total Kjeldahl Nitrogen (TKN)
- Total Phosphorus (TP)



Wet Weather Event 1



Wet Weather Event 2

Portland CSO Abatement Study

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Figure 3-3

TSS Monitoring Results

BOS31506 Date: Oct. 1992

- E. coli
- Cadmium
- Copper
- Iron
- Lead
- Zinc

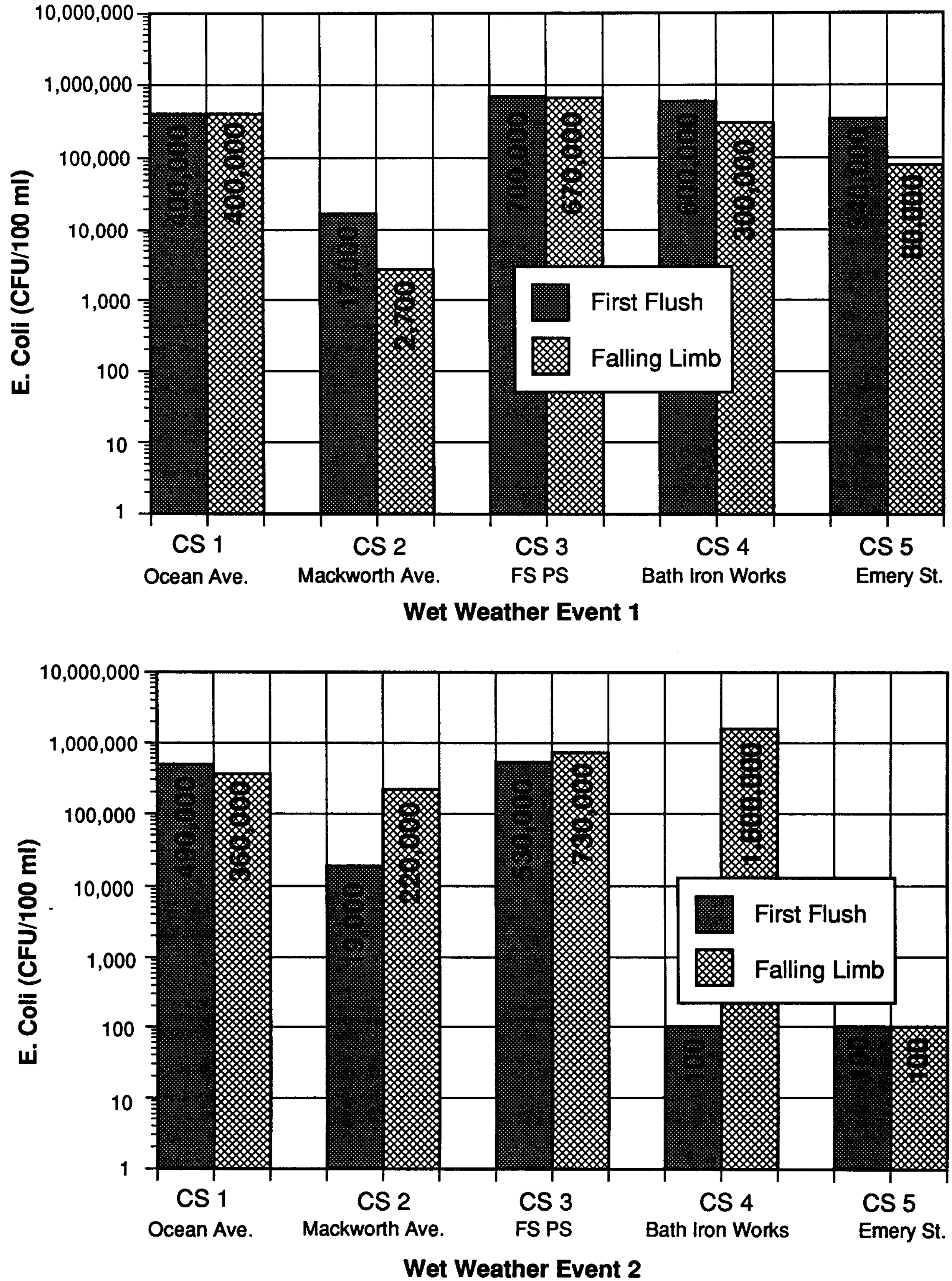
There were not sufficient data to warrant statistical testing to justify the use of area-wide EMCs or for varying EMCs by area or land use. Therefore, data were evaluated qualitatively by inspection of plots and tables.

EMCs were computed for each parameter at each sampling site by flow weighting the recorded concentrations. Therefore, each EMC for a specific sampling site incorporates the volume of CSO passing the sampler when the sample was composited. For example, all of the first flush composite samples represented less flow volume than the falling limb composite samples, and were thus weighted proportionately less.

Nonstandard Parameters (List B). The nonstandard parameters were analyzed from first flush grab samples. The results have been summarized in a pair of tables and presented in the "Results" portion of this Section. The first table identifies the detected parameters, sampling sites, and events, and the second table presents concentrations of the detected parameters.

Results—Standard Parameters (Lists A and C)

First Flush. All of the parameters except E. coli (see Figure 3-4) were found to exhibit a first flush effect based on visual analysis of the plots and tabular summaries of the data. The absence of a first flush effect for E. coli is documented in several studies, including the Bangor CSO Facilities Plan performed by CH2M HILL in 1991.



Portland CSO Abatement Study

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Figure 3-4

E. Coli Monitoring Results

BOS31506 Date: Oct. 1992

Variability. Parameter levels were variable between sites and between events, typical of CSO data. One consistent observation was that CS2 had slightly lower parameter concentrations than the other sites even during dry weather. CS2 represents a relatively small residential area typical of the areas along the western side of Back Cove.

EMCs. Because the data exhibited variability typical of CSO data, and because CS2 represents a very small portion of the total volume of CSO representing the samples, EMCs were computed on an area-wide basis. Sample site CS1 represented 76 percent of the total flow volume generated at the sample sites during the monitoring period. Sample site CS3 represented 20 percent of the total flow, with the remaining 4 percent split among the other three sample sites. The flow weighted parameter concentrations are presented in Table 3-9.

Table 3-9
Summary of Pollutant Concentrations

Parameter	CS1 Ocean Ave.	CS2 Mackworth St.	CS3 Franklin St. PS	CS4 Bath Iron Works	CS5 Emery St.	Area-wide EMCs[a]
BOD_5 (mg/l)	28	12	56	38	39	34
TSS (mg/l)	239	56	164	87	76	217
TKN (mg/l)	4	4	7	9	9	5
TP (mg/l)	0.7	0.5	1.3	1.4	1.5	0.8
E. coli (CFU/100 ml)	400,000	40,000	700,000	960,000	90,000	430,000[b]
Cadmium (μg/l)	0.4	0.4	1.3	0.7	0.4	0.6
Copper (μg/l)	29	17	69	54	138	38
Iron (μg/l)	3,400	1,800	4,400	2,700	1,300	3,500
Lead (μg/l)	28	29	98	113	65	44
Zinc (μg/l)	78	65	156	172	98	95

[a] Weighted by the volume of CSO recorded during both sampling periods at each sample site.
[b] Volume weighted geometric mean.

Table 3-10 presents a comparison of area-wide CSO EMCs for several typical parameters for data from Portland and other cities in the northeast and nationally. The Portland monitoring data compares well with the data collected in other cities. All of the Portland parameter concentrations are of a magnitude similar to those shown in the table.

Table 3-10
Comparison of CSO EMCs Between Portland, ME, and Other Cities

Parameter	Units	Portland, ME	Bangor, ME[a]	MWRA Boston[b]	Portland, OR[c]	EPA[d]
BOD_5	mg/l	34	24.5	90	30	115
Cadmium	μg/l	0.6	0.61	–	–	–
Copper	μg/l	38	30	85	–	–
E. coli[e]	CFU/100 ml	430,000	156,000	–	23,000	–
Fecal Coliform[e]	CFU/100 ml	–	181,000	680,000	163,000	670,000
Lead	μg/l	44	57	110	–	370
TSS	mg/l	217	250	188	148	370
Zinc	μg/l	95	114	110	110	–

[a] Bangor, ME, CSO Facilities Plan, CH2M HILL, 1991.
[b] MWRA CSO Facilities Plan, CH2M HILL, 1989
[c] Portland, OR, CSO Facilities Plan, CH2M HILL, 1990
[d] Nonweighted average of data collected in Des Moines, Milwaukee, New York City, Racine, Rochester. Summary appeared in EPA document EPA-600/8-77-0 14, September, 1977.
[e] Geometric Mean computed for bacteria samples

Results—Nonstandard Parameters (List B)

The nonstandard parameters include the polyaromatic hydrocarbons (PAHs), PCBs, and herbicides. Table 3-11 lists all the specific parameters analyzed and indicates the sites and events of those parameters detected. Seventeen of the 33 parameters were not detected at any site during any storm event. Four parameters were detected during the weekday dry weather sampling event; none were detected on the weekend. Only three parameters were detected during wet weather event 2. However, 15 of the 33 parameters were detected during wet weather event 1.

Table 3-11
Nonstandard Parameters (List B) Analyzed

Parameter		Not Detected	Detection Location and Event[a]				
			CS1	CS2	CS3	CS4	CS5
PHs	TPHs		D,1,2	1	D,1,2	D,1,2	D
PAHs	Acenaphthene		1				
	Acenaphthylene		1				
	Anthracene		1	1	1	1	
	Benzo(a)anthracene			1			1
	Benzo(a)pyrene		1	1		1	
	Benzo(b)fluoranthene	✓					
	Benzo(g,h,i)parylene		1	1	1	1	1
	Benzo(k)fluoranthene			1		D,1	1
	Chrysene		1	1	1	1	
	Dibenz(a,h)anthracene		1	1	1	1	1
	Fluoranthene		1	1		D,1	
	Fluorene		1		1	D,1	
	Ideno(1,2,3-c,d)pyrene	✓					
	Naphthalene		1,2			1	
	Phenanthrene		1	1	1	1	1
	Pyrene			1	1		1
PCBs	PCB-1016	✓					
	PCB-1221	✓					
	PCB-1232	✓					
	PCB-1242	✓					
	PCB-1248	✓					
	PCB-1254	✓					
	PCB-1260	✓					
Herbicides	DALAPON	✓					
	DICAMBA	✓					
	DICHLOROPROP	✓					
	MCPA	✓					
	MCPP	✓					
	SILVEX (2,4,5-TP)	✓					
	2,4,5-T	✓					
	2,4-D						2
	2,4-DB	✓					

[a]D = Dry Weather Event during week; no parameters detected for dry weather event during weekend
1 = Wet Weather Event 1
2 = Wet Weather Event 2

No EMCs were computed for the List B parameters because they were analyzed for only one grab sample per site per sample event. Table 3-12 summarizes the detected concentrations, water quality criteria, and detection limits. It should be noted that the water quality criteria are for relative comparison purposes. These criteria are based on protection of human health over a lifetime from exposure to the substances through ingestion of fish and shellfish. These criteria are also based on an assumed health risk for carcinogens of one in one million and are normally regulated based on dilution considerations at mean annual hydrologic conditions, not in undiluted discharges.

The concentrations of the organics detected showed relatively low levels of herbicides and hydrocarbons. All sites showed some detectable levels of organics. The detected levels are in many cases above the water quality criterion; however, the detection limits are also often above the criterion. No apparent pattern for substances detected at particular CSO discharge sites was discerned. A potential source of fluorinated compounds at CS4 is being investigated through the City of Portland Industrial Pretreatment Program. Although the concentrations are low, data indicate that a variety of PAHs can occasionally be found in Portland CSO.

3.3 CSO Pollutant Loads

The CSO pollutant load estimates were computed using volume and frequency data developed in the modeling task, presented in Section 3.1, and pollutant concentrations developed from the monitoring data, presented in Section 3.2. The annual load estimates for each outfall are summarized according to receiving water in Table 3-13.

Because area-wide EMCs were used in computing the loads, each load value is linearly related to the annual CSO volume. From a receiving water perspective, it is interesting to note that just under 58 percent of Portland's annual CSO volume and pollutant load is discharged to Back Cove, followed by just over 20 percent to Portland Harbor, and over 10 percent to Fore River. The remaining 12 percent is discharged to Casco Bay, Capisic

Table 3-12 Nonstandard Parameters (List B) Detected Page 1 of 2						
Parameter	Site	Event[a]	Concentration	Det. Limit	Water Quality Criterion[b]	Units
2,4-D	CS5	2	2.2	2	0.3	μg/l
Acenaphthene	CS1	1	25	5.2	20	μg/l
Acenaphthylene	CS1	1	9	5.2	0.0311	μg/l
Anthracene	CS1	1	24	5.2	0.0311	μg/l
	CS2	1	5.2	5.2		μg/l
	CS3	1	6	5.1		μg/l
	CS4	1	6	5		μg/l
Benzo(a)anthracene	CS2	1	11	5.2	0.0311	μg/l
	CS5	1	10	5.1		μg/l
Benzo(a)pyrene	CS1	1	37	5.2	0.0311	μg/l
	CS2	1	6	5.2		μg/l
	CS4	1	8	5		μg/l
Benzo(g,h,i)perylene	CS1	1	20	5.2	0.0311	μg/l
	CS2	1	8	5.2		μg/l
	CS3	1	5.1	5.1		μg/l
	CS4	1	13	5		μg/l
	CS5	1	6	5.1		μg/l
Benzo(k)fluoranthene	CS2	1	7	5.2	0.0311	μg/l
	CS4	1	16	5		μg/l
	CS4	D	190	100		μg/l
	CS5	1	8	5.1		μg/l
Chrysene	CS1	1	23	5.2	0.0311	μg/l
	CS2	1	10	5.2		μg/l
	CS3	1	6	5.1		μg/l
	CS4	1	23	5		μg/l
Dibenz(a,h)anthracen	CS1	1	27	5.2	0.0311	μg/l
	CS2	1	12	5.2		μg/l
	CS3	1	6	5.1		μg/l
	CS4	1	19	5		μg/l
	CS5	1	9	5.1		μg/l

Table 3-12
Nonstandard Parameters (List B) Detected

Parameter	Site	Event[a]	Concentration	Det. Limit	Water Quality Criterion[b]	Units
Fluoranthene	CS1	1	14	5.2	54	µg/l
	CS2	1	13	5.2		µg/l
	CS4	1	10	5		µg/l
	CS4	D	100	100		µg/l
Fluorene	CS1	1	36	5.2	0.031	µg/l
	CS3	1	7	5.1		µg/l
	CS4	1	6	5		µg/l
	CS4	D	100	100		µg/l
Napthalene	CS1	1	12	5.2	No Criterion	µg/l
	CS1	2	12	5.6		µg/l
	CS4	2	23	5.6		µg/l
Phenanthrene	CS1	1	32	5.2	0.0311	µg/l
	CS2	1	8	5.2		µg/l
	CS3	1	7	5.1		µg/l
	CS4	1	8	5		µg/l
	CS5	1	5.1	5.1		µg/l
Pyrene	CS2	1	16	5.2	0.0311	µg/l
	CS3	1	24	5.1		µg/l
	CS5	1	7	5.1		µg/l
TPHs	CS1	1	9.3	2.1	No Criterion	mg/l
	CS1	2	1.3	1.1		mg/l
	CS1	D	25	5		mg/l
	CS2	1	35	10		mg/l
	CS3	1	2.3	1		mg/l
	CS3	2	2.3	1.2		mg/l
	CS3	D	2.1	1		mg/l
	CS4	1	1.6	1.1		mg/l
	CS4	2	1.4	1.1		mg/l
	CS4	D	1.3	1		mg/l
	CS5	D	2.8	1		mg/l

[a]D (Dry Weather Event during week; no parameters detected for dry weather event during weekend); 1 (Wet Weather Event 1); 2 (Wet Weather Event 2)

[b]Water quality criterion to protect public health based on consumption of aquatic organisms and a 10^{-6} risk level; Criterion listed are for comparison purposes only and not applicable to undiluted CSO samples.

Table 3-13
Annual Pollutant Load Estimates
(Based on Year 1966 Simulation Results)

Outfall	Drainage Area (acres)	Annual Overflow Events	Annual Overflow Volume (MG)	Estimated Annual Pollutant Loads and (EMCs) Load Units (lbs) except E. coli units (10^{12} CFU); EMC Units as Shown									
				BOD_5 (34 mg/L)	TSS (217 mg/L)	TKN (5 mg/L)	Total P (0.8 mg/L)	E. coli (430,000 CFU/100ml)	Cadmium (0.6 µg/L)	Copper (38 µg/L)	Iron (3,500 µg/L)	Lead (44 µg/L)	Zinc (95 µg/L)
Casco Bay													
1	14	10	0.2	60	400	8	1	3	0.0	0.1	6	0.1	0.2
3	3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0
20	29	30	54	15,000	98,000	2,000	400	880	0.3	17	1,600	20	43
21	43	7	1.1	310	2,000	50	7	18	0.0	0.35	32	0.40	0.87
Subtotal	89	47	55	16,000	100,000	2,000	400	900	0.3	17	1,600	20	44
Presumpscot Estuary													
2	25	13	1.8	510	3,300	80	10	29	0.0	0.57	53	0.66	1.4
Back Cove													
5	74	34	100	28,000	180,000	4,000	700	1,600	0.5	32	2,900	37	79
6	101	23	1.6	450	2,900	70	10	26	0.0	0.51	47	0.59	1.3
7	1,051	24	100	28,000	180,000	4,000	700	1,600	0.5	32	2,900	37	79
8	18	5	4.1	1,200	7,400	200	30	67	0.0	1.3	120	1.5	3.3
9	6	0	0	0	0	0	0	0	0	0	0	0	0
10	140	27	8.2	2,300	15,000	300	60	130	0.0	2.6	240	3.0	6.5
11	20	8	0.6	200	1,000	30	4	10	0.0	0.2	20	0.2	0.5
12	171	40	26	7,400	47,000	1,000	200	420	0.1	8.2	760	9.5	21
13	86	44	4.6	1,300	8,300	200	30	75	0.0	1.5	130	1.7	3.6
14	0	0	0	0	0	0	0	0	0	0	0	0	0
15	102	11	0.4	100	700	20	3	7.0	0.0	0.1	10	0.2	0.3
16	92	38	14	4,000	25,000	600	90	230	0.1	4.4	410	5.1	11

Table 3-13
Annual Pollutant Load Estimates
(Based on Year 1966 Simulation Results)

Outfall	Drainage Area (acres)	Annual Overflow Events	Annual Overflow Volume (MG)	Estimated Annual Pollutant Loads and (EMCs) Load Units (lbs) except E. coli units (10^{12} CFU); EMC Units as Shown									
				BOD_5 (34 mg/L)	TSS (217 mg/L)	TKN (5 mg/L)	Total P (0.8 mg/L)	E. coli (430,000 CFU/100ml)	Cadmium (0.6 μg/L)	Copper (38 μg/L)	Iron (3,500 μg/L)	Lead (44 μg/L)	Zinc (95 μg/L)
17	528	25	110	31,000	200,000	5,000	700	1,800	0.6	35	3,200	40	87
18	46	22	46	13,000	83,000	2,000	300	750	0.2	15	1,300	17	36
19	177	5	0.2	60	400	8	1	3	0.0	0.1	6	0.1	0.2
Subtotal	2,612	306	416	120,000	753,000	20,000	3,000	6,800	2.1	130	12,000	150	330
Portland Harbor													
23	112	33	27	7,700	49,000	1,000	200	440	0.1	8.6	790	10	21
24	32	30	1.7	480	3,100	70	10	28	0.0	0.54	50	0.62	1.4
25	86	38	79	22,000	140,000	3,000	500	1,300	0.4	25	2,300	29	63
26	95	12	1.2	340	2,200	50	8	20	0.0	0.38	35	0.44	0.95
27	39	38	11	3,100	20,000	500	70	180	0.1	3.5	320	4.0	8.7
28	59	43	21	6,000	38,000	900	200	340	0.1	6.7	610	7.7	17
29	28	33	3.9	1,100	7,100	200	30	63	0.0	1.2	110	1.4	3.1
Subtotal	451	227	145	41,000	262,000	6,000	1,000	2,400	0.7	46	4,200	53	120
Fore River													
30	7	18	3.5	990	6,300	200	20	57	0.0	1.1	100	1.3	2.8
32	32	14	0.8	200	1,000	30	5	10	0.0	0.3	20	0.3	0.6
33	94	2	0.1	30	200	4	1	2	0.0	0.0	3	0.0	0.1
34	3	18	0.2	60	400	8	1	3	0.0	0.1	6	0.1	0.2
35	11	10	0.2	60	400	8	1	3	0.0	0.1	6	0.1	0.2
36	415	36	68	19,000	120,000	3,000	500	1,100	0.3	22	2,000	25	54
39	37	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	599	98	73	21,000	130,000	3,000	500	1,200	0.4	23	2,100	27	58

Table 3-13
Annual Pollutant Load Estimates
(Based on Year 1966 Simulation Results)

Outfall	Drainage Area (acres)	Annual Overflow Events	Annual Overflow Volume (MG)	Estimated Annual Pollutant Loads and (EMCs) Load Units (lbs) except E. coli units (10^{12} CFU); EMC Units as Shown									
				BOD_5 (34 mg/L)	TSS (217 mg/L)	TKN (5 mg/L)	Total P (0.8 mg/L)	E. coli (430,000 CFU/100ml)	Cadmium (0.6 µg/L)	Copper (38 µg/L)	Iron (3,500 µg/L)	Lead (44 µg/L)	Zinc (95 µg/L)
Capisic Brook													
38	21	10	4.4	1,200	8,000	200	30	72	0.0	1.4	130	1.6	3.5
41	11	2	0.4	100	700	20	3	7	0.0	0.1	10	0.2	0.3
42	339	26	19	5,400	34,000	800	100	300	0.1	6.0	560	7.0	15
43	35	26	5.6	1,600	10,000	200	40	91	0.0	1.8	160	2.1	4.4
Subtotal	406	64	29	8,300	53,000	1,000	200	480	0.1	9.3	860	11	23
Totals	*4,182*	*755*	*720*	*200,000*	*1,300,000*	*30,000*	*5,000*	*12,000*	*4*	*230*	*21,000*	*260*	*570*

Brook, and the Presumpscot Estuary. Because of the complex operation of the system of regulators as a whole, and variations in runoff rates between areas, the volume of annual overflow for any CSO was not necessarily directly related to the size of the drainage area.

3.4 Receiving Water Monitoring

This section summarizes the receiving water monitoring program and presents the results of the program. This information is presented in detail in TM 9, Receiving Water Assessment.

Receiving Water Monitoring Program

The Monitoring Plan also outlined a receiving water monitoring program. The need for the program and the program scope was discussed at several progress meetings during the summer of 1992. On September 10, 1992, a revised program was agreed upon between the City and DEP. Requirements for the dry weather monitoring program were developed based on the completion of a dry weather monitoring event conducted on September 1, 1992. The dry and wet weather monitoring program outlined on September 10 served to fulfill the requirements of the Consent Order. The purpose of the program was two-fold: 1) to determine the impact of CSO on Portland's receiving waters, and 2) to determine whether or not receiving water quality meets state standards. Pre- and post-storm conditions were monitored as the primary method of measuring CSO impacts. Pollutants of concern were limited to pathogens.

Monitoring Locations

Eight sites were selected to obtain data from various water bodies under different impact conditions. Fresh waters and marine waters, as well as water bodies receiving direct

CSO discharges and waterbodies not receiving direct CSO discharges, were chosen. The sites selected were:

- Back Cove at Tukey's Bridge (marine)
- Casco Bay at East End Beach (marine)
- Portland Harbor at State Pier (marine)
- Portland Harbor at Clark Street (marine)
- Fore River at I-295 Bridge (marine)
- Fore River at Congress Street (marine)
- Capisic Brook at Lucas Street (fresh)
- Capisic Brook at Warwick Street (fresh)
- Fall Brook at Ocean Avenue (fresh)

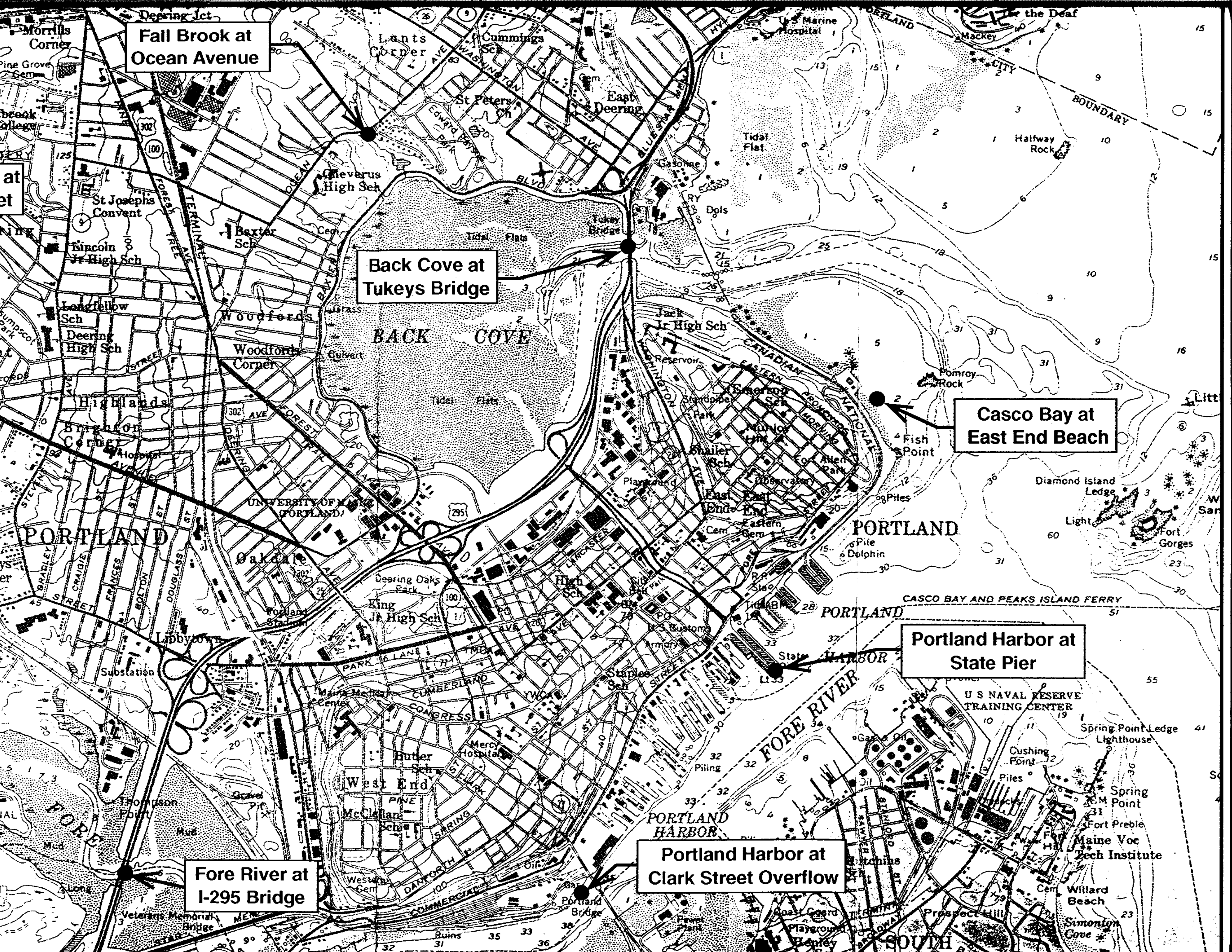
Figure 3-5 shows the location of each of the sites.

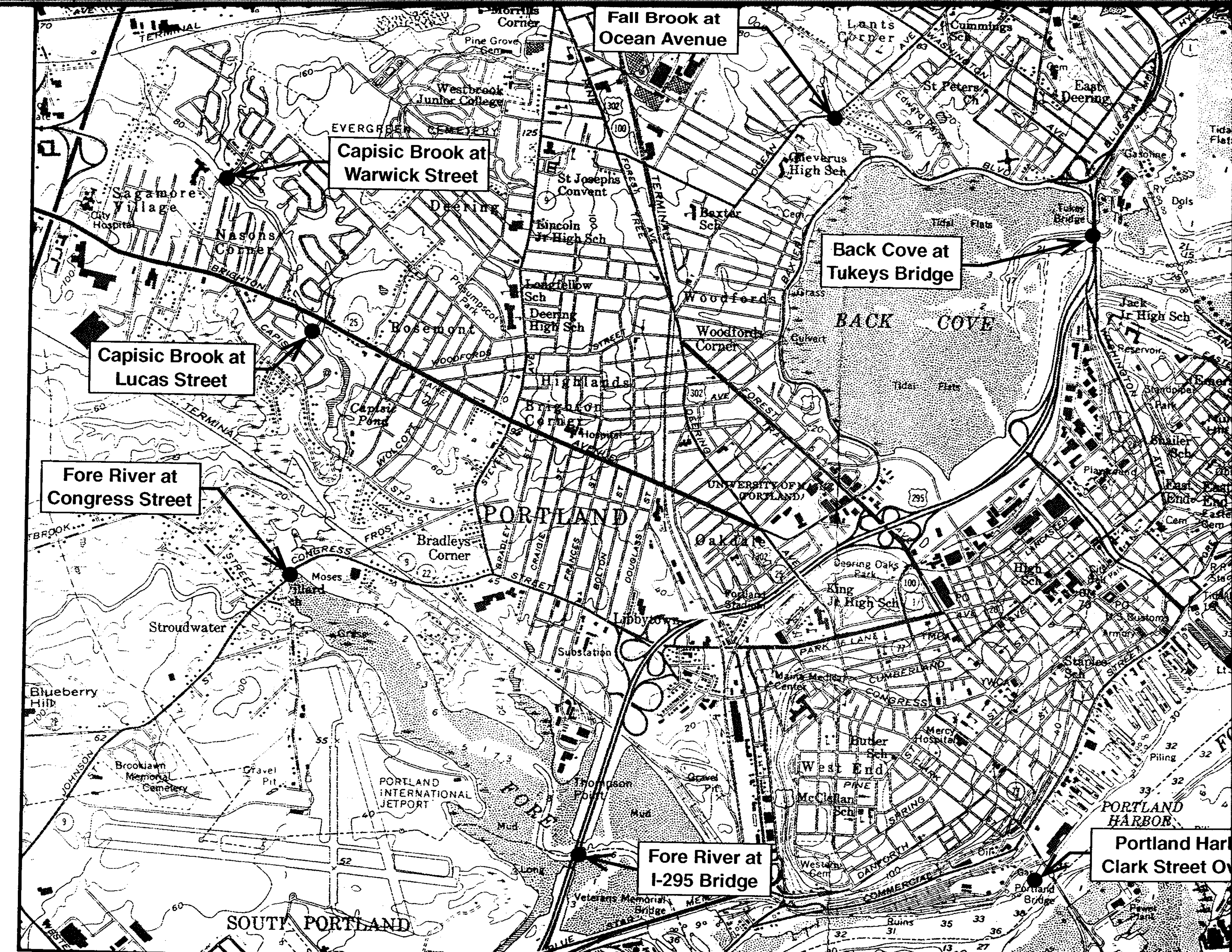
Pollutants of Concern

The indicator bacteria analyzed were E. coli in freshwater locations and fecal coliform and Enterococcus bacteria in marine locations. Fecal coliform have an important impact on shellfish standards while E. coli and Enterococcus bacteria have an important impact on swimming and recreational use. Field parameters, including temperature and conductivity, were measured at all locations.

Sample Collection

Receiving waters were sampled during one dry weather event, with an antecedent condition of 3 or more dry days. Receiving waters were also sampled during and after two wet weather events with a rainfall of at least 0.2 inches per hour for a minimum of one hour. The frequency of sample collection is summarized in Table 3-14 for dry weather monitoring and Table 3-15 for wet weather monitoring.


Fall Brook at Ocean Avenue
Back Cove at Tukeys Bridge
Casco Bay at East End Beach
Portland Harbor at State Pier
Portland Harbor at Clark Street Overflow
Fore River at I-295 Bridge
BACK COVE
PORTLAND
PORTLAND HARBOR
FORE RIVER
CASCO BAY AND PEAKS ISLAND FERRY
U S NAVAL RESERVE TRAINING CENTER



Fall Brook at Ocean Avenue
Capisic Brook at Warwick Street
Back Cove at Tukeys Bridge
Capisic Brook at Lucas Street
Fore River at Congress Street
Fore River at I-295 Bridge
Portland Harl
Clark Street O
BACK COVE
PORTLAND
SOUTH PORTLAND
PORTLAND HARBOR
PORTLAND INTERNATIONAL JETPORT
Westbrook Junior College
Evergreen Cemetery
Sagamore Village
Nasons Corner
Deering
Rosemont
Highlands
Brighton Corner
Woodfords
Woodfords Corner
Oakdale
Libbytown
Bradleys Corner
Stroudwater
Blueberry Hill
Lants Corner
East Deering
West End
Deering Oaks Park
Thompson Point

Table 3-14 Dry Weather Receiving Water Quality Sampling Frequency	
Location	**Frequency**
Back Cove at Tukey's Bridge	1 Outgoing Tide 1 Incoming Tide
Casco Bay at East End Beach	1 Outgoing Tide
Portland Harbor at State Pier	1 Outgoing Tide 1 Incoming Tide
Portland Harbor at Clark Street Overflow	1 Outgoing Tide
Fore River at I-295 Bridge	1 Outgoing Tide
Fore River at Congress Street	1 Outgoing Tide
Capisic Brook at Lucas Street	1 Sample
Capisic Brook at Warwick Street	1 Sample
Fall Brook at Ocean Avenue	1 Sample

Dry Weather Event. The dry weather monitoring event was conducted on September 1, 1992. According to records from the NOAA Weather Station located at the Portland International Jetport, the previous appreciable rainfall event was August 18 and 19, 1992. A total of 1.13 inches fell on August 18, 1992 and 0.04 inches fell on August 19, 1992. On August 29, 1992, a nominal 0.01 inches fell in 24 hours.

Wet Weather Events. Two wet weather events were monitored on September 3-4, 1992, and September 27-29, 1992. The first event occurred after two weeks with no appreciable rainfall. A total of 1.35 inches of rain fell on September 3, 1992, between 11 a.m. and 12 midnight. The two peak hourly intensities were 0.20 inches between 1 and 2 p.m. and 0.18 inches between 8 and 9 p.m., closely approximating sampling requirements of greater than 0.20 inches per hour for one hour minimum.

The second wet weather event occurred after antecedent conditions of 72 dry hours. On September 23, 1992, 0.18 inches of rain fell ending at 3 a.m. Rain did not fall again until 4 p.m. on September 26, 1992, meeting the three dry days requirement. A total of

Table 3-15
Wet Weather Receiving Water Quality Sampling Frequency

Location	Event #	Sampling Frequency
Back Cove at Tukey's Bridge	1	1 During outgoing tide 1 During outgoing tide, 12 hours later
	2	During outgoing tide (over 3 days) - 1 every 6 hours for 2 days - 1 every 12 hours for 3rd day
Casco Bay at East End Beach	1	1 During outgoing tide
	2	During outgoing tide (3 days) - 1 every 6 hours for 2 days - 1 every 12 hours for 3rd day
Portland Harbor at State Pier	1	1 During outgoing tide
	2	During outgoing tide - 1 every 6 hours until the first outgoing tide after 1 complete tidal cycle - minimum of 4 samples
Portland Harbor at Clark Street Overflow	1	1 During outgoing tide
	2	During outgoing tide - 1 every 6 hours until the first outgoing tide after 1 complete tidal cycle - minimum of 4 samples
Fore River at I-295 Bridge	1	1 During outgoing tide
	2	During outgoing tide - 1 every 6 hours until the first outgoing tide after 1 complete tidal cycle - minimum of 4 samples
Fore River at Congress Street	1	1 During outgoing low tide after overflow
	2	During outgoing tide - 1 every 6 hours until the first outgoing tide after 1 complete tidal cycle - minimum of 4 samples
Capisic Brook at Lucas Street	1	2 Samples
	2	Over 3 days - 1 every 6 hours for 2 days - 1 every 12 hours for 3rd day if necessary
Capisic Brook at Warwick Street	1	Sample
	2	Nothing required
Fall Brook at Ocean Avenue	1	1 Sample
	2	Over 3 days - 1 every 6 hours for 2 days - 1 every 12 hours for 3rd day if necessary

1.11 inches fell during the second event, 0.24 inches on September 26 and 0.87 inches on September 27, 1992. The two peak hourly intensities were 0.54 inches falling between 12 midnight and 1 a.m., and 0.32 inches falling between 1 and 2 a.m., both on the morning of September 27, 1992.

Results of the Monitoring Program

Tables 3-16, 3-17, and 3-18 present the results of the monitoring program for the dry weather, first wet weather, and second wet weather events, respectively. The results are discussed in detail in TM 9, Receiving Water Assessment. In general, levels of indicator bacteria in both fresh and marine receiving waters were greatly elevated during wet weather events. The concentrations in some locations were observed to fluctuate significantly with the tidal cycle (Fore River at Congress Street, Portland Harbor at Clark Street Overflow, and Casco Bay at East End Beach). However, the remaining marine sites exhibited little significant fluctuation with the tidal cycle, indicating that the specific hydraulic characteristics of the site are critical in evaluating the flushing action of the tides on CSO.

3.5 Receiving Water Impacts

Based on the CSO pollutant concentrations (Section 3.2), the corresponding pollutant loads (Section 3.3), and the receiving water monitoring (Section 3.4), the analysis of receiving water impacts focuses on toxicants and bacteriological indicators. Toxicant indicators are associated with impacts to aquatic life and human health through either drinking water supply (after treatment) uses or aquatic organism consumption. Bacteriological indicators are associated with impacts on drinking water supply, recreational uses, and shellfishing waters.

CSO impacts can also be evaluated relative to Maine's narrative criterion pertaining to floating solids. Significant floating solids are often associated with CSO events;

Table 3-16
Receiving Water Quality Sampling Results
Dry Weather Event—September 1 and October 29, 1992

Sample No.	Location	Time[1]	Temp °C	Conductivity	Bacteria (CFU/100ml)[2]		
					Escherischia Coliform	Fecal Coliform	Enterococcus
601	Fore River at Congress St.	9/1 @ 3:47 p.m.	16.9	47.2 mS/cm	*	60	10
602	Capisic Brook at Lucas St.	9/1 @ 3:58 p.m.	18.6	548 μS/cm	30	*	*
603	Capisic Brook at Warwick St.[3]	9/1 @ 4:10 p.m.	18.6	615 μS/cm	260[4]	*	*
604	Fall Brook at Ocean Avenue	9/1 @ 4:30 p.m.	18.4	996 μS/cm	20	*	*
605	Back Cove at Tukey's Bridge[3]	9/1 @ 4:45 p.m.	14.7	47.7 mS/cm	*	88	10
610	Back Cove at Tukey's Bridge	10/29 @ 10:35 a.m.	9.2	46.4 mS/cm	*	36	120[4]
606	Casco Bay at East End Beach	9/1 @ 5:00 p.m.	13.9	48.3 mS/cm	*	10	110[4]
607	Portland Harbor at State Pier	9/1 @ 5:05 p.m.	13.9	48.2 mS/cm	*	180	BDL(10)
611	Portland Harbor at State Pier	10/29 @ 10:25 a.m.	9.4	48.2 mS/cm	*	32	8
608	Portland Harbor at Clark Street Overflow	9/1 @ 5:20 p.m.	14.9	47.9 mS/cm	*	60	BDL(10)
609	Fore River at I-295 Bridge	9/1 @ 5:45 p.m.	15.9	47.9 mS/cm	*	30	BDL(10)

[1]All samples collected during outgoing tide, N/W breeze @ 10 knots, except samples 610 and 611 collected during incoming tide.
[2]Maine surface water quality criteria: E. coli ≤ 949 CFU/100 ml (instantaneous); E. coli ≤ 142 CFU/100 ml (geometrric mean); Enterococcus ≤ 94 CFU/100 ml (instantaneous); Enterococcus ≤ 14 CFU/100 ml (geometric mean); fecal coliform-not applicable.
[3]Bacteria counts for Capisic Brook at Warwick Street and Back Cove at Tukey's Bridge are geometric means of duplicate samples.
[4]Exceeds Maine surface water quality criteria.
*No sample analyzed.
BDL(#)—below detection limit (detection limit)

Table 3-17
Receiving Water Quality Sampling Results
Wet Weather Event 1—September 3 and 4, 1992

Sample No.	Location	Date/Time[1]	Temp °C	Conductivity	Bacteria (CFU/100ml)[2]		
					Escherischia Coliform	Fecal Coliform	Enterococcus
701	Fore River at Congress St.	9/3 @ 5:15 p.m.	15.2	45.6 mS/cm	*	100	BDL (100)
702	Capisic Brook at Lucas St.	9/3 @ 5:30 p.m.	15.1	444 μS/cm	23,000[3]	*	*
711	Capisic Brook at Lucas St.	9/4 @ 8:00 a.m.	15.4	207 μS/cm	5,000[3]	*	*
703	Capisic Brook at Warwick St.	9/3 @ 5:35 p.m.	15.5	162 μS/cm	100,000[3]	*	*
704	Fall Brook at Ocean Avenue	9/3 @ 5:50 p.m.	15.0	114 μS/cm	18,000[3]	*	*
705	Back Cove at Tukey's Bridge	9/3 @ 5:02 p.m.	14.1	46.0 mS/cm	*	2,300	400
710	Back Cove at Tukey's Bridge	9/4 @ 7:30 a.m.	14.1	46.1 mS/cm	*	100	100
706	Casco Bay at East End Beach	9/3 @ 6:00 p.m.	13.6	47.6 mS/cm	*	BDL (100)	BLD (100)
707	Portland Harbor at State Pier	9/3 @ 6:10 p.m.	13.9	47.2 mS/cm	*	100	BDL
708	Portland Harbor at Clark Street Overflow	9/3 @ 6:20 p.m.	13.9	46.2 mS/cm	*	4,900	1,000[3]
709	Fore River at I-295 Bridge	9/3 @ 6:35 p.m.	14.0	47.5 mS/cm	*	100	BDL (100)

[1]All samples collected during outgoing tide.
[2]Maine surface water quality instantaneous criteria: E. coli ≤ 949 CFU/100 ml; Enterococcus = ≤ 94 CFU/100 ml; fecal coliform - not applicable.
[3]Exceeds Maine surface water quality instantaneous criteria.
*No sample analyzed.
BDL (#) - below detection limit (detection limit)

Table 3-18
Receiving Water Quality Sampling Results
Wet Weather Event 2—September 27-29, 1992

Sample No.	Location	Date/Time	Temp °C	Conductivity	Bacteria (CFU/100 ml)[2]		
					Escherichia Coliform	Fecal Coliform	Enterococcus
801	Fore River at Congress St.	9/27 @ 9:20 a.m.	14.8	28.3 mS/cm	*	5,500	4,500[3]
811	Fore River at Congress St.	9/27 @ 1:00 p.m.	14.6	45.8 mS/cm	*	350	210[3]
821	Fore River at Congress St.	9/27 @ 5:30 p.m.	15.8	12.5 mS/cm	*	4,500	8,700[3]
802	Capisic Brook at Lucas St.	9/27 @ 9:35 a.m.	14.2	196.4 μS/cm	6,000[3]	*	*
812	Capisic Brook at Lucas St.	9/27 @ 1:10 p.m.	14.9	230 μS/cm	4,000[3]	*	*
822	Capisic Brook at Lucas St.	9/27 @ 5:45 p.m.	15.2	265 μS/cm	3,800[3]	*	*
832	Capisic Brook at Lucas St.	9/27 @ 10:30 p.m.	15.4	300 μS/cm	3,700[3]	*	*
842	Capisic Brook at Lucas St.	9/28 @ 8:00 a.m.	14.2	537 μS/cm	1,000[3]	*	*
852	Capisic Brook at Lucas St.	9/28 @ 1:00 p.m.	([1])	([1])	BDL (10)	*	*
862	Capisic Brook at Lucas St.	9/28 @ 9:00 p.m.	16.0	403 μS/cm	200	*	*
872	Capisic Brook at Lucas St.	9/29 @ 8:00 a.m.	13.9	684 μS/cm	800	*	*
882	Capisic Brook at Lucas St.	9/29 @ 4:00 p.m.	14.9	495 μS/cm	BDL (100)	*	*
804	Fall Brook at Ocean Ave.	9/27 @ 7:45 a.m.	14.6	51.0 μS/cm	6,000[3]	*	*
814	Fall Brook at Ocean Ave.	9/27 @ 1:30 p.m.	15.1	81 μS/cm	7,900[3]	*	*
824	Fall Brook at Ocean Ave.	9/27 @ 6:00 p.m.	15.2	90 μS/cm	5,000[3]	*	*
805	Back Cove at Tukey's Bridge	9/27 @ 8:00 a.m.	13.9	43.2 mS/cm	*	1,300	1,000[3]
815	Back Cove at Tukey's Bridge	9/27 @ 1:45 p.m.	13.6	47 mS/cm	*	190	190[3]
825	Back Cove at Tukey's Bridge	9/27 @ 6:30 p.m.	14.2	46.9 mS/cm	*	120	60

Table 3-18
Receiving Water Quality Sampling Results
Wet Weather Event 2—September 27-29, 1992

Sample No.	Location	Date/Time	Temp°C	Conductivity	Bacteria (CFU/100 ml)[2]		
					Escherischia Coliform	Fecal Coliform	Enterococcus
835	Back Cove at Tukey's Bridge	9/27 @ 11:00 p.m.	13.3	47.9 mS/cm	*	60	10
845	Back Cove at Tukey's Bridge	9/28 @ 7:00 a.m.	13.5	44.5 mS/cm	*	90	250[3]
855	Back Cove at Tukey's Bridge	9/28 @ 1:45 p.m.	([1])	([1])	*	10	50
865	Back Cove at Tukey's Bridge	9/28 @ 8:15 p.m.	14.7	42 mS/cm	*	200	90
875	Back Cove at Tukey's Bridge	9/29 @ 7:30 a.m.	13.5	47.2 mS/cm	*	10	BDL (10)
885	Back Cove at Tukey's Bridge	9/29 @ 4:30 p.m.	13.9	47.9 mS/cm	*	50	30
806	Casco Bay at East End Beach	9/27 @ 8:20 a.m.	14.2	43.5 mS/cm	*	160	170[3]
816	Casco Bay at East End Beach	9/27 @ 2:00 p.m.	13.4	48.1 mS/cm	*	50	470[3]
826	Casco Bay at East End Beach	9/27 @ 7:00 p.m.	14.9	45.7 mS/cm	*	200	800[3]
836	Casco Bay at East End Beach	9/27 @ 11:15 p.m.	13.0	48.6 mS/cm	*	10	10
846	Casco Bay at East End Beach	9/28 @ 7:15 a.m.	13.2	43.1 mS/cm	*	1,000	230[3]
856	Casco Bay at East End Beach	9/28 @ 2:00 p.m.	([1])	([1])	*	10	460[3]
866	Casco Bay at East End Beach	9/28 @ 8:30 p.m.	14.1	42 mS/cm	*	440	40
876	Casco Bay at East End Beach	9/29 @ 7:45 a.m.	13.2	44.9 mS/cm	*	100	60
886	Casco Bay at East End Beach	9/28 @ 4:45 p.m.	13.2	48.5 mS/cm	*	200	60
807	Portland Harbor at State Pier	9/27 @ 8:35 a.m.	13.5	44.9 mS/cm	*	2,400	2,100[3]
817	Portland Harbor at State Pier	9/27 @ 2:15 p.m.	13.5	46.9 mS/cm	*	260	260[3]
827	Portland Harbor at State Pier	9/27 @ 7:15 p.m.	13.9	46.8 mS/cm	*	90	100[3]
837	Portland Harbor at State Pier	9/27 @ 11:30 p.m.	13.7	47.6 mS/cm	*	120	20

Table 3-18
Receiving Water Quality Sampling Results
Wet Weather Event 2—September 27-29, 1992

Sample No.	Location	Date/Time	Temp°C	Conductivity	Bacteria (CFU/100 ml)[2]		
					Escherischia Coliform	Fecal Coliform	Enterococcus
847	Portland Harbor at State Pier	9/28 @ 7:30 a.m.	13.2	47.7 mS/cm	10	*	*
808	Portland Harbor at Clark St. Overflow	9/27 @ 8:45 a.m.	13.9	46.9 mS/cm	*	390	220[3]
818	Portland Harbor at Clark St. Overflow	9/27 @ 2:30 p.m.	14.1	47.1 mS/cm	*	60	220[3]
828	Portland Harbor at Clark St. Overflow	9/27 @ 7:30 p.m.	14.5	46.1 mS/cm	*	290	250[3]
809	Fore River at I-295 Bridge	9/27 @ 9:00 a.m.	14.2	47.1 mS/cm	*	60	110[3]
819	Fore River at I-295 Bridge	9/27 @ 2:45 p.m.	14.9	45.4 mS/cm	*	130	130[3]
829	Fore River at I-295 Bridge	9/27 @ 7:45 p.m.	15.4	38.7 mS/cm	*	430	770[3]
839	Fore River at I-295 Bridge	9/28 @ 12:00 a.m.	14.6	47.3 mS/cm	*	50	70

[1]Temperature/conductivity meter failed during this sample.
[2]Maine surface water quality instantaneous criteria: E. coli ≤ 949 CFU/100 ml; Enterococcus = ≤ 94 CFU/100 ml; fecal coliform - not applicable.
[3]Exceeds Maine surface water quality instantaneous criteria.
Note:
Field conditions on 9/27/92 @ 8:00 a.m. - Swift incoming tide. Current at 801, 805, 809. Water murky with some surface debris and oil sheen. Capisic Brook velocity 0.5 - 1.0 fps.
Field conditions on 9/27/92 @ 2:00 p.m. - Strong outgoing tide at outer Congress Street and Tukey's Bridge. Wind at west 5 knots.
Field conditions on 9/27/92 @ 6:30 p.m. - Fore River at Congress Street still draining, but very low. Capisic Brook velocity at 0.25 ft/sec. Fall Brook had no movement. Tukey's Bridge at dead low, no flow.
Field conditions on 9/27/92 @ 11:00 p.m. - Tukey's Bridge had lots of turbulence and mixing. No wind.
*No sample analyzed.
BDL (#) - below detection limit (detection limit)

therefore, CSO has the potential to violate this water quality criterion for floating solids every time there is an overflow. Floatables were observed immediately downstream of the Capisic Dam overflow (CSO 36) and the Ocean Avenue overflow (CSO 7) during wet weather sampling performed as part of the Monitoring Plan.

For both toxicants and bacteriological indicators, other pollutant sources such as upstream sources and separate storm water in Portland are not considered quantitatively in the analysis. Quantification of the effects of these other sources would require a long-term, comprehensive receiving water monitoring program far beyond the scope of this effort. For Portland, DEP has taken an approach to CSO facilities planning which allows municipalities to focus their efforts on assessing the contribution of their own CSOs to the receiving waters.

The concentrations of toxicants, nutrients, and bacteriological indicators in Portland's CSOs were summarized in Section 3.2, and the corresponding annual loads to each receiving water were presented in Section 3.3. Tidal influences complicate the dilution characteristics of each receiving water. Also, data are limited at appropriate points in the receiving water. A greater factor in evaluating toxicity of CSO discharge to the receiving waters is the specific mixing characteristics of the receiving water at the time of discharge. The mixing characteristics may be influenced by factors such as flow volume in a freshwater stream, tidal amplitude in bays and harbors, and backwater effects due to tidal influence.

TM 9 presents the results of a dye and drogue study used to help evaluate the effects of wind, currents, and tidal fluctuations on the mixing characteristics of the receiving water. Some of the general observations during the study included:

- "Freshwater" CSO flows on top of saltwater

- Wind influenced movement of floatables primarily when currents were slow (low and high slack tides)

- Liquid movement was not greatly influenced by wind, even in choppy waters

- Liquid and floatable movement can be significantly delayed in the pipe during high tide

- Liquid moves quickly to the main channels during outgoing tides

Toxicants

One method of evaluating the impact on aquatic life of the discharge of toxicants into receiving waters is to compare the EMCs for CSO with acute criteria. EPA and many states have in some cases conservatively used the Final Acute Values (FAV) for aquatic life criteria for evaluating acutely toxic releases on an end-of-pipe basis. For freshwater criteria which vary with hardness, the comparison is most appropriate at the hardness of the discharge. Table 3-19 lists Portland's EMCs for several toxicants and the corresponding FAVs (adjusted for hardness where appropriate).

Table 3-19
Comparison of Portland CSO EMCs and FAVs

Parameter	EMC (μg/L)	FAV[a] (μg/L)	
		Freshwater	Marine
Cadmium	0.6	3.59[b]	86
Copper	38	18.5[b]	5.8
Iron	3,500	*No Criterion*	*No Criterion*
Lead	44	67.6[b]	280
Zinc	95	130[b]	190

[a]FAV is an estimate of the concentration of a toxicant corresponding to a cumulative probability of 0.05 in the acute toxicity values for all genera for which acceptable acute tests have been conducted.
[b]EPA criteria adjusted to hardness of 50 mg/L.

The comparison of EMC values with FAVs does not indicate acutely toxic releases, although copper exceeds its FAV and lead and zinc are close to their FAVs. The EMCs represent flow weighted average values. Some instantaneous values in CSO, particularly in the first flush, may exceed FAV level. However, it is important to note that FAVs are computed based on a longer time of exposure (typically 96 hours) than would be encountered in a first flush. In addition, FAVs are typically used for fully-mixed in-stream comparisons rather than end-of-pipe EMCs for undiluted CSOs.

In addition to metals, ammonia-nitrogen can cause toxicity to aquatic life dependent on species present, pH, and temperature. As with metals, the levels of ammonia-nitrogen encountered during a first flush may be significant but will be of short duration.

Bacteriological Indicators

The limited receiving water monitoring results (Section 3.4), in addition to the EMCs developed for Portland's CSOs (Section 3.2), indicate that Portland's CSOs periodically cause bacteria levels to exceed the Maine E. coli criterion (instantaneous value not to exceed 949 CFU/100 ml) in the fresh Class C receiving waters. The E. coli EMC of 430,000 CFU/100 ml presented in Section 3.2, indicates that short-term exceedances of the criterion will depend greatly on the dilution characteristics of the receiving water at the time of CSO discharge. The marine receiving water monitoring results indicated that state criteria for Enterococcus bacteria for Class SC waters (instantaneous value not to exceed 94 CFU/100 ml) are frequently exceeded. Portland's shellfishing waters are closed. However, if they were classified as restricted, the state criterion for fecal coliform for shellfishing waters (top 10 percent of samples collected not to exceed 300 CFU/100 ml) would also be frequently exceeded as indicated by the monitoring results.

It should be noted that although the receiving water monitoring indicated compliance during dry weather, wet weather discharges contribute significant amounts of indicator bacteria of undetermined origin to receiving waters (City of Bangor, ME, CSO Facilities

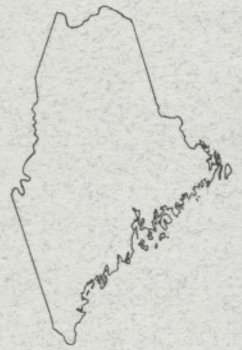
Plan, CH2M HILL, 1992; MWRA CSO Facilities Plan, CH2M HILL, 1990). Therefore, during wet weather events, Portland's separate stormwater discharges contribute significantly to the bacterial concentrations in the receiving water. It is highly possible that elimination of all CSOs in Portland would not avoid exceedance of the bacterial criteria during some runoff events.

Summary

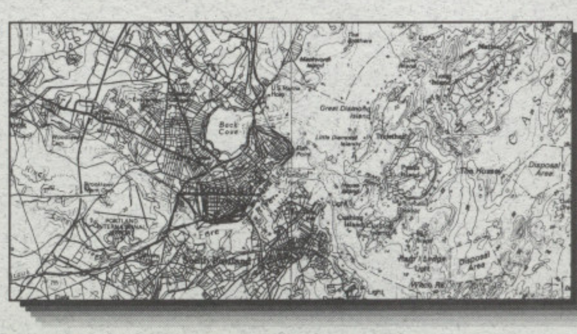
CSO EMC data indicate little potential for acute toxicity at end-of-pipe, even with little or no dilution in the receiving water. In general, CSO is flushed from the marine receiving waters by the tidal cycles and currents. The time required for flushing varies with the time, duration, and volume of overflow.

E. coli data indicates concentrations exceeding the state criteria. Similarly, Enterococcus data was observed to exceed marine criteria during the monitoring program. Therefore, pathogens and bacterial indicators should be a primary focus of water quality based controls.

Aesthetic issues concerning floatable solids, and the corresponding water quality standard, will also impact the alternative analysis for all receiving waters.



CSO Control Options



Section 4
CSO Control Options

Many technologies and approaches are available for controlling CSOs. Each technology has different performance characteristics, requirements, costs, and benefits. A list of approximately 40 CSO control technologies was reviewed for applicability to Portland, Maine. These technologies are described in Section 4.1. Screening of the CSO control technologies is described in Section 4.2.

The 1972 Clean Water Act (CWA) established the framework for regulating water pollutant discharges from all sources. The principal goals of the CWA were the restoration of all water of the nation to fishable/swimmable condition (where attainable) and the elimination of all pollutant discharges to surface waters. Subsequent amendments, notably in 1977, 1981, and 1987, extended the time frame for the mandated nationwide cleanup. However, the basic goal of achieving fishable/swimmable conditions was not revised.

In 1989, the U.S. Environmental Protection Agency (EPA) issued a National Combined Sewer Overflow Control Strategy (National Strategy) which established that six minimum technology-based limitations be included in NPDES permits for CSO systems. These limitations were to be established based on best professional judgement (BPJ) and are:

- Proper operation and regular maintenance for the sewer system and overflow points
- Maximum use of the collection system for storage
- Review and modification of the pretreatment program to assure that CSO impacts from industrial contributors are minimized

- Maximization of flow to the WWTF for treatment

- Prohibition of dry weather overflows

- Control of solid and floatable materials in CSO discharges

EPA Region I has adopted a CSO policy to ensure that the statutory requirements are met. The policy requires that BPJ be used on a case-by-case basis to determine technology based limitations for CSOs which address both the statutory requirements of the CWA as well as the State of Maine Water Quality Standards.

All technology-based permit limitations established using BPJ must consider costs in accordance with EPA regulations. EPA specifically indicated in the National Strategy that BPJ limitations should include low cost management and operational practices and that more expensive control measures be included only where necessary to meet water quality standards. Cost is also a factor in determining whether water quality standards are attainable through the implementation of CSO controls in accordance with 40 CFR 131.10(g). Therefore, economic optimization, detailed in TM 5, was employed to determine the most cost-effective level of CSO control. A field reconnaissance was performed to determine applicability of specific technologies to available sites. Technologies and combinations of technologies were reviewed with respect to technical, environmental, and implementation criteria to determine how technologies could be applied to achieve target levels of CSO control.

Setting target levels of CSO control is discussed in Section 4.3. Three systemwide alternatives were developed, each reflecting different levels of CSO control. Section 4.3 concludes with a table presenting a preliminary CSO control plan based on preliminary modeling results. Comments received on the Draft Master Plan to explore additional alternatives in Back Cove and Portland Harbor are addressed in Section 4.4. The recommended plan, detailed in Section 5, is based on the estimates of CSO activity presented in Table 3-6 and the site-specific application and analysis of the preliminary plan summarized in Section 4.

It should be noted that EPA solicited input on proposed revisions to the national CSO strategy from a range of affected parties during 1992. On December 18, 1992, EPA issued the "Draft Combined Sewer Overflow Policy," intended to expedite compliance with the CWA and EPA's National CSO Control Strategy issued on September 8, 1989. As outlined in the 1992 Draft CSO Policy, immediate requirements for permittees with CSOs include the following:

- Accurately characterize combined system
- Implement minimum controls
    1. Proper operation and maintenance
    2. Maximum use of collection system
    3. Review and modify pretreatment program
    4. Maximize flow to the WWTF
    5. Eliminate dry weather overflows
    6. Control solids and floatables
    7. Pollution prevention for contaminant reduction
    8. Public notification of occurrences and impacts
    9. Monitor CSO impacts and efficacy of controls
- Develop a long-term CSO control plan

Minimum elements of the long-term CSO control plan include the following:

- Characterization, monitoring, and mapping of the combined sewer system
- Consideration of sensitive areas
- Evaluation of alternatives
- Cost/performance considerations
- Operational plan
- Maximizing treatment at the WWTF

- Implementation schedule
- Post-construction compliance monitoring
- Public participation

The evaluation of alternatives includes a choice of one of the following two approaches:

1. Demonstration approach

    i. Controls are adequate to meet WQS, and
    ii. Controls provide maximum benefits reasonably attainable, and
    iii. Control program allows cost-effective expansion

2. Presumptive approach (will not apply if the permitting authority determines that the control plan will not result in attainment of CWA requirements)

    i. No more than four overflows per year (permitting authority may allow up to two additional), or

    ii. Eliminate or capture for treatment 85% or more of combined sewage collected, or

    iii. Eliminate no less than the mass of pollutants necessary to meet WQS for the volume captured in "ii" above.

The 1992 Draft CSO Policy was issued after submittal of the Draft Master Plan to the regulatory agencies on December 1, 1992; however, many of the elements outlined in the Policy overlap with requirements in the Consent Order and comments received on the Draft Master Plan since December 1992. Therefore, many of the Policy elements are addressed in this Final Master Plan submitted in December 1993.

4.1 Description of CSO Control Technologies

CSO control technologies are categorized according to their method of control. The categories are:

- Sewer system optimization
- Pollutant source control
- Inflow reduction
- Physical/chemical treatment
- Biological treatment
- Storage

Figure 4-1 presents a summary of the various CSO control technologies, listed by method of control. A description of the various technologies is presented in the following paragraphs.

Sewer System Optimization

Sewer system optimization refers to controls that operate within the existing combined sewer system. Sewer system optimization techniques use various levels of in-system flow control to increase temporary storage and/or transport of wet weather flow directly to the wastewater treatment facility. The result is that overflow is minimized without major structural additions or modifications. Sewer system optimization technologies include:

Static Flow Control. Static flow control represents the installation or modification of static in-line flow control devices used to create in-line storage in the sewer system. Examples of these devices include fixed weirs, orifice plates,and in-line vortex valves.

Variable Flow Control. Variable flow control represents the installation of in-line flow control devices that can be adjusted, usually manually, before occurrence of wet weather in response to hydraulic conditions and used to create in-line storage in the sewer system.

CSO CONTROL TECHNOLOGIES

Sewer System Optimization	Pollutant Source Control	Inflow Reduction
Static flow control	Street cleaning	Stormwater detention
Variable flow control	Combined sewer flushing	Stormwater sumps
Real time control	Catchbasin cleaning	Infiltration/inflow reduction
Optimize conveyance	Industrial pretreatment	Flow slipping
Maximize flow to WWTF	Construction site control	Vortex valves
	Pesticide/fertilizer control	Swales / greenways
	On-site domestic storage	Sewer separation
	Litter control	Tidewater intrusion reduction
		Stream diversion

Physical / Chemical Treatment	Biological Treatment	Storage
Swirl concentrator	Expand WWTF Capacity	Earthen basins
Vortex separator	Wetland treatment	Open concrete tanks
Coarse screening		Closed concrete tanks
Microscreening		Storage conduits
Sedimentation		Storage tunnels
Flocculation		Flow balancing method
Dissolved air flotation		
High rate filtration		
Chlorination - Dechlorination		
High-rate disinfection		

Figure 4-1
CSO Control Technologies

Real Time Control. Real time control is a network of instrumentation and remote system controls that provides for the operation of in-line flow controls and diversion structures from a central location during a storm event. Hydraulic manipulation of the sewer system can maximize the system's response to a storm event and minimize overflows.

Optimize Conveyance. Perform regular sewer system maintenance and maximize flows through pumping stations that are operating below capacity or can be enlarged to handle additional flows.

Maximize Flow to WWTF. Flows to the Portland WWTF can be maximized where feasible. This can be accomplished by storing or delaying wastewater flow until the plant is able to handle the flow, or with relatively minor modifications to the plant to increase its wet weather primary treatment capacity.

Pollutant Source Control

Pollutant source controls are techniques, often referred to as BMPs, that reduce pollutant loading by intercepting or preventing the accumulation of contaminants before they enter the sewer system or the overflow stream. Because they operate on selected pollutant sources and not on the overflow stream, source controls do not reduce the frequency, volume, or duration of CSO; however, the pollutant concentrations associated with the overflow are reduced. Source control technologies include:

Street Sweeping. Street sweeping removes surface accumulations of litter, debris, dust, and dirt to reduce the transport of these materials into the sewer system.

Combined Sewer Flushing. Combined sewer flushing is the introduction of a controlled volume of water into the combined sewer system to resuspend and transport deposited sediment and solids to a treatment facility during dry weather.

Catch Basin Cleaning. Catch basin cleaning removes accumulated deposits of litter, debris, and grit from catch basins to reduce the transport and sediment buildup of these materials into the sewer system.

Industrial Pretreatment. Industrial pretreatment involves imposing and enforcing limitations on industrial discharges to the sewer system to reduce industrial pollutant loads.

Construction Site Erosion Control. Construction site erosion control involves imposing and enforcing erosion controls at construction sites to reduce the transport of debris, grit, and dirt into the sewer system.

Pesticide/Fertilizer Use Control. Control of pesticide and fertilizer use involves imposing and enforcing limitations on pesticide and fertilizer use to reduce the transport of toxic chemicals into the sewer system, groundwater, or overland into surface waters.

On-Site Domestic Wastewater Storage. On-site storage of domestic wastewater requires that individual or groups of homes and establishments have local storage tanks to retain wastewater during storm events.

Litter Control. Litter control is a program to increase public awareness of litter concerns, to encourage or require pet owners to clean up after their animals, and increase the use and emptying of available trash cans.

Inflow Reduction

Inflow reduction techniques reduce the amount of surface runoff entering the combined sewer system. Subsequently, overall hydraulic loading is reduced, diminishing the frequency, volume, and duration of CSO. Inflow reduction technologies include:

Stormwater Detention. Storage of stormwater provides detention of stormwater before it enters the combined sewer system so that it can be released later at a controlled rate. Stormwater detention in separated areas tributary to a combined sewer can be either on-line or off-line.

Stormwater Sumps. Sumps are similar to manhole structures, constructed with perforated walls and backfilled with granular media to enhance subsurface infiltration of stormwater.

Infiltration/Inflow Reduction. Infiltration into the sewer system can be reduced by repairing, lining, or replacing problematic portions of the sewer system. Inflow can also be reduced by disconnecting roof drains and basement sump pumps.

Flow Slipping. Flow slipping involves raising or blocking stormwater inlets to force the transport of stormwater to an alternate location resulting in surface storage and detention of stormwater reducing peak sewer flows and thus CSO.

Vortex Valves. Vortex valves, usually used in conjunction with flow slipping, are inlet control devices that restrict flow into the sewer system and force flow slippage or surface ponding of stormwater with a gradual release of ponded water into the sewer system.

Swales/Greenways. Creation of swales and greenways provides areas with enhanced percolation capabilities and slower runoff, as well as aesthetic and recreational values.

Sewer Separation. Sewer separation is the implementation of separate collection systems for stormwater and wastewater.

Tidewater Intrusion Reduction. Reduction of tidewater intrusion is accomplished by the placement of tidegates or the correction or replacement of ineffective tide gates.

Stream Diversion. Stream diversion is the rerouting or removal of direct inflow of streams, drainage ditches, and surface ponding from the combined sewer system to an alternate location.

Treatment

Treatment technologies are physical, chemical, or biological controls that provide end-of-pipe treatment to the CSO before discharge to the receiving water. Physical/chemical treatment technologies include:

Swirl Concentrator. A swirl concentrator is a device that uses an inertia differential to separate the combined sewage into a small volume of concentrated waste for transport to a WWTF and a large volume of clearer overflow for discharge.

Vortex Separator. A vortex separator is similar in theory to a swirl concentrator but varies in the design of its chamber and alignment of the concentrated waste outlet.

Coarse Screening. Coarse screening provides for the removal of coarse materials to prevent blockage of the sewer system and damage to equipment located downstream.

Microscreening. Microscreening consists of screens with typical openings of less than 1/250-inch which can remove significant amounts of material such as BOD, suspended solids, toxic pollutants.

Sedimentation. Sedimentation removes suspended solids by gravitational setting.

Flocculation. Flocculation aggregates colloidal particles to increase solids removal in downstream treatment facilities.

Dissolved Air Flotation. Dissolved air flotation removes suspended solids by providing air bubbles which can easily adhere to suspended particles, particularly small particles.

High-Rate Filtration. High-rate filtration typically refers to a dual-media filter which removes suspended solids.

Chlorination-Dechlorination. Chlorination of wastewater reduces levels of pathogens and other microorganisms. Dechlorination reduces the chlorine residual in treated wastewater which can be toxic to aquatic organisms.

High-Rate Disinfection. High-rate disinfection includes alternatives to chlorine disinfection such as the use of ozone and ultraviolet light.

Biological treatment technologies include:

Expansion of Portland WWTF. Enlarging the primary treatment facilities at the existing Portland WWTF or modifying hydraulic structures to utilize existing primary capacity are CSO control options.

Wetlands Treatment. This alternative involves channeling stormwater or CSOs to constructed wetlands for treatment.

Storage

Storage systems are constructed to retain wastewater that would have ordinarily overflowed and to release the stored wastewater to a pump station or directly to the downstream WWTF. Storage technologies include:

Earthen Basins. Earthen basins are open, off-line storage basins in the ground, usually lined to prevent groundwater contamination.

Open Concrete Tanks. Open concrete tanks are off-line storage basins equipped with aeration and washdown facilities.

Closed Concrete Tanks. Closed concrete tanks are covered, off-line storage basins equipped with aeration and washdown facilities. The tanks can be buried with other facilities, such as playing fields or tennis courts, constructed above them.

Storage Conduits. Storage conduits provide near-surface, off-line storage of flows from one or more combined sewer outfalls. All conduits conveying or consolidating combined sewer flow inherently provide storage also.

Storage Tunnels. Storage tunnels provide deep off-line storage of consolidated combined sewer flows in tunnels excavated in bedrock below the sewer system and other existing utilities.

Flow Balancing. Flow balancing is a method of retaining combined sewage at a storage location in the receiving water, typically confining the wastewater in a bermed or lined area, and pumping it back into the sewer system at a later time.

4.2 Screening of CSO Control Technologies

The first step in evaluating CSO control alternatives is to develop a shortlist of technologies with the greatest probability of reducing CSOs and being implemented in the City of Portland and to eliminate those technologies that are technically inappropriate, provide little or no environmental improvement, and/or are difficult to implement in Portland.

The initial list of CSO control technologies described in Section 4.1 was presented at a workshop held on January 17, 1992. Each technology was reviewed for applicability to Portland. City of Portland, Portland Water District, Friends of Casco Bay, Casco Bay Estuary Program, and Maine Department of Environmental Protection personnel provided input to the application and implementation of specific technologies in Portland. As a result of this review, technologies were either eliminated or selected for further consideration as a CSO control alternative for Portland.

Technologies Eliminated

Several technologies were eliminated from further consideration for the following reasons:

- Implementation and operational complexity were not well suited for regional or site-specific application in Portland (i.e., variable flow and real time control, on-site domestic wastewater storage, stormwater sumps).

- Best management practices such as street sweeping and catch basin cleaning do not greatly reduce CSO volume, frequency, or duration. BMPs are most useful in reducing pollutant loads in stormwater that would normally enter the sewer system and decrease the sewer's capacity. BMPs are in use and being considered for expansion programs in several areas throughout the City. Although BMPs are being considered in CSO quality reduction programs, they have been eliminated as CSO quantity reduction techniques.

- Some treatment technologies are either complex, have difficult land and siting requirements, limited application, or do not provide sufficient advantages in comparison with other CSO treatment alternatives (i.e., microscreening, sedimentation, flocculation).

- Some storage technologies have land, siting, environmental, and safety concerns, such as open concrete tanks, or are very complex and expensive to implement in Portland, such as storage tunnels.

Technologies Considered

Critical factors considered in screening of alternatives for Portland include:

- Ease of implementation
- Land requirements
- Maximum use of the existing system
- Low operation and maintenance requirements
- Low nuisance characteristics (i.e., odor, visual aesthetics, etc.)

In a series of workshops with the City, PWD, DEP, and other interested groups, possible alternatives were reviewed and screened. Through these workshops, a shortlist of alternatives to be further evaluated was developed. This shortlist included the following:

- Sewer system optimization
  - Static flow control
  - Optimize conveyance
  - Maximize flows to the WWTF

- Inflow reduction technologies
  - Stormwater detention
  - Infiltration/inflow reduction
  - Flow slipping
  - Vortex valves
  - Swales/greenways
  - Sewer separation
  - Stream diversion

- Treatment
  - Vortex separators

- Chlorination-dechlorination
- Expand WWTF capacity

- Storage
  - Closed concrete tanks
  - Storage conduits

- Sewer separation

- BMPs for both separated and combined areas

Some of these technologies have limited regional application because their effectiveness depends on site-specific sewer design, land use, and drainage characteristics. Sewer system optimization is such a technology. Some inflow reduction techniques are also site-specific; however, some inflow reduction methods, such as stormwater detention and flow slipping, may be applied regionally in the more undeveloped areas where space is available. This regional application is referred to as stormwater management. Treatment and storage systems can also be evaluated at a regional level because their design is flexible enough to accommodate site and load requirements. Maximizing flows through the existing WWTF and WWTF expansion will be considered as separate alternatives.

4.3 Setting Target Levels of CSO Control

CH2M HILL developed a regional optimization process to identify and cost-effectively scale applicable CSO control alternatives. The regional analysis, described in detail in TM 5, provided direction for the size or scale of facilities necessary to achieve a target level of control. Preliminary optimization model results indicated that the total annual CSO volume and number of events could be cost-effectively reduced by 90 percent with the implementation of inflow reduction techniques and the addition of storage and treatment capacity to the existing combined sewer system.

The optimization results also indicated that 90 percent event control is easier to achieve than 90 percent volume control. For example, a facility achieving 90 percent event control may only achieve 60-70 percent volume control. This is because most storms are small and relatively easy to control. High volumes from larger storms are harder to control. To achieve 90 percent volume control, expansion of the facility would be required. Ninety percent volume control is a higher target level of control than 90 percent event control.

A field reconnaissance was performed to determine how the technologies could be applied to specific sites and how they can be combined to achieve the specified levels of control. Application of specific controls depends on a variety of evaluation criteria including site-specific characteristics, costs, level of improvement in receiving water quality, and City preference. DEP and the City have both commented that stormwater separation in developed areas is expensive and has potentially adverse water quality impacts; therefore, sewer separation should only be considered for residential or undeveloped areas or for small drainage areas where other alternatives would not be cost-effective. However, sewer separation may also be cost-effective in moderately developed areas where quality control can be achieved through BMPs. The adverse impacts and high costs of separation may be mitigated by application of source controls and alternate means of stormwater management. The City and the PWD provided the following additional guidelines for final screening:

1. Consider greenways and other inflow reduction or stormwater inlet control methods wherever possible.

2. Avoid remote (i.e., satellite) treatment facilities, especially those facilities which include chlorination or other disinfection methods.

3. Minimize the construction of new pumping facilities.

4. Coordinate CSO control with flood control projects and urban park projects.

5. Maximize the use of the existing WWTF capacity.

As a result of comments collected during this study, greater emphasis was placed on stormwater management in low density residential or undeveloped areas and storage facilities that could discharge accumulated flows back into the sewer system via gravity in high density residential, commercial, or industrial areas. Discharging stored wastewater back into the combined sewer system maximizes the use of the sewer system, pump stations, and the significant treatment capacity at the Portland WWTF; that is, existing facilities would operate at maximum capacity for longer durations.

Alternative Development

TM 6 described a variety of CSO control technology combinations. Order-of-magnitude costs were used in the evaluation. Since economic optimization model results indicated that 90% CSO reduction would be a cost-effective goal, these technologies were arranged into three systemwide alternatives with the following target levels of CSO control:

- Limited Action Alternative. This alternative includes those CSO control actions which are relatively easy and inexpensive to implement. There is no specific CSO reduction goal associated with the limited action alternative.

- Intermediate Level CSO Control Alternative. This alternative is based on reducing the average annual *frequency* of overflow to a receiving water by at least 90 percent.

- High Level CSO Control Alternative. This alternative is based on reducing the average annual *volume* of CSO by at least 90 percent at each outfall.

For additional comparison, the capital cost of 100% areawide CSO elimination through sewer separation was calculated as $105 million; however, separation alone does not assure significant improvement in water quality. Because of specific system hydraulics, separation may be cost-effective but may not guarantee deactivation of a CSO, such as in the hydraulics associated with CSO 20 and described in Section 5.

The receiving waters have different uses, tributary areas, and sources of pollution; therefore, the alternatives were reviewed by receiving water. Each of these systemwide alternatives was compared on the basis of CSO impacts on use, CSO benefits, costs, and implementation. Table 4-1 describes the components of the systemwide alternatives and their capital costs. The cost-benefit evaluation is presented in Table 4-2. The incremental costs indicate a significant increase from the intermediate action level to the high level. Figures 4-2 through 4-7 present curves of capital cost versus CSO reduction per receiving water. Figure 4-8 combines the information presented on Figures 4-2 through 4-7 to provide a comparison of costs and CSO reduction among the six receiving waters.

A preliminary CSO control plan was developed based on the results of the screening, economic optimization, and the evaluation of systemwide alternatives. Costs were reevaluated and adjusted, where necessary, to account for site-specific conditions. The least-cost combination of technologies that achieved the indicated level of control and was easiest to implement was selected for each receiving water. The preliminary CSO control plan is presented in Table 4-3.

The recommended plan detailed in Section 5 is based on the evaluation presented in Section 4. Although the recommended plan incorporates revised estimates of CSO activity based on the recalibrated sewer system model, the adjustments to CSO activity estimates do not substantially alter the analysis presented in Section 4.

The evaluation and the preliminary CSO control plan presented in Tables 4-2 and 4-3, respectively, served as the basis for the recommended plan presented in the Draft Master

Table 4-1
Definition of Action for CSO Control

Page 1 of 3

CSO	Action		
	Limited	Intermediate (≥ 90% CSO event control)	High (≥ 90% CSO volume control)
Casco Bay			
1	Disconnect 4 remaining catch basins from combined system	Limited action eliminates CSO	
3	Block outfall	Limited action eliminates CSO	
4	None	Control provided by Back Cove facilities	Intermediate action eliminates CSO
20	Investigate vortex valve installation	Storage tank (1 MG)	Storage tank (3.9 MG)
21	Flow slippage	Limited action eliminates CSO	
Capital Cost	$370,000	$2,007,000	$5,055,000
Presumpscot Estuary			
2	Review raising weir and installing tide gate; reroute separate stormflow if possible; review ASPS operations	Storage tank (0.07 MG)	Storage tank (0.25 MG)
Capital Cost	$0	$187,000	$536,000
Back Cove			
5	Adjust tipping gate for optimum performance	Storage tank (0.74 MG)	Storage tank for control of CSOs 5-7 (24.5 MG)
6	None	Storage tank (0.37 MG)	See above
7	Maximize storage in outfall conduit (0.12 MG); investigate flow slippage	Storage tank (5.4 MG)	See above
8 through 16	None	Storage conduit (3.1 MG)	Storage conduit (11.6 MG)
17 through 19	None	Implement Libbytown project (flow slippage, sewer separation, and storage conduit) plus storage tank (0.59 MG)	Implement Libbytown project plus storage tank (2.6 MG)
Capital Cost	$17,000	$35,087,000	$63,531,000

Table 4-1
Definition of Action for CSO Control

CSO	Action		
	Limited	Intermediate (≥ 90% CSO event control)	High (≥ 90% CSO volume control)
Portland Harbor			
23	Investigate raising ISPS weir and enlarging influent pipe	Storage conduit for control of CSOs 23-25 (2.5 MG)	Storage conduit for control of CSOs 23-25 (6.2 MG)
24	None	See above	See above
25	Adjust tipping gate for optimum performance; implement static flow controls to move overflow volume to upstream/downstream CSO(s)	See above	See above
26	Flow slippage	Storage tank (0.09 MG)	Storage tank (0.23 MG)
27	Flow slippage	Storage tank (0.23 MG)	Storage tank (0.59 MG)
28	Flow slippage	Storage tank (0.64 MG)	Storage tank (1.6 MG)
29	Flow slippage	Storage tank (0.10 MG)	Storage tank (0.25 MG)
Capital Cost	$475,000	$9,602,000	$15,463,000
Fore River			
30	None	Separation (part of Libbytown project)	Intermediate action
32	Investigate potential in-line storage in 30-inch sewer on Sewall Street; investigate increasing flow through TPPS; review weir configuration	Storage tank (0.02 MG)	Storage tank (0.06 MG)
33	Maximize flow to FRPS	Storage tank (0.08 MG)	Storage tank (0.21 MG)
34	Separate	Limited action eliminates CSO	
35	Separate	Limited action eliminates CSO	
36	Modify control structure to maximize in-system storage (0.87 MG)	Storage tank (1.0 MG)	Storage tank (3.9 MG)
39	Block	Limited action eliminates CSO	
Capital Cost	$406,000	$2,321,000	$5,655,000

Table 4-1
Definition of Action for CSO Control

CSO	Action		
	Limited	**Intermediate (≥ 90% CSO event control)**	**High (≥ 90% CSO volume control)**
Capisic Brook			
38	Remove brook flow under Brighton Avenue bridge	Sewer separation	Intermediate action eliminates CSO
40	Separate (scheduled)	Limited action eliminates CSOs	
41	Separate (scheduled)	Limited action eliminates CSOs	
42 through 43	Remove brook flows; investigate flow slippage	Storage tank (1.1 MG)	Storage tank (2.7 MG)
Capital Cost	$858,000	$3,040,000	$4,858,000
Areawide			
Capital Cost	**$2,126,000**	**$52,244,000**	**$95,098,000**

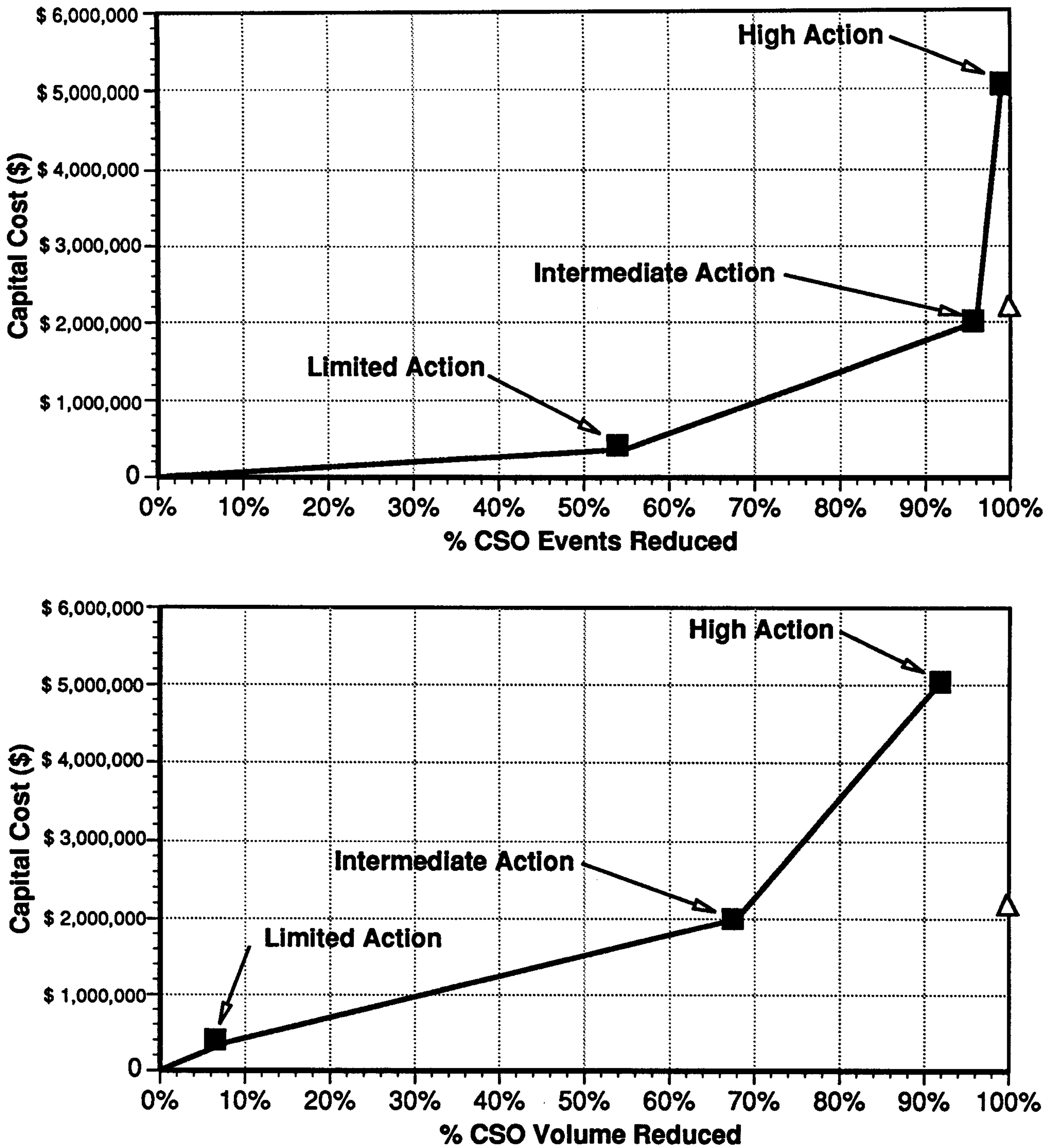
Table 4-2
Evaluation of Targeted Levels of CSO Control by Receiving Water

Receiving Water	Level of Control	Incremental Annual Cost and Benefit Estimates*						Implementation
		Benefit		Incremental Annual Cost	Benefit		Incremental Annual Cost	
		Remaining Events/yr	Event Reduction from Existing Conditions	($/event reduced)	Remaining Volume (MG)/yr	Volume Reduction from Existing Conditions	($/1000 gal reduced)	
Casco Bay—The tributary area extends from the shoreline of Martin's Point to the southern end of the Eastern Promenade. It includes residential abutters north of Tukey's Bridge, industrial facilities, the Portland WWTF, and East End Beach. An **intermediate** level of CSO control is recommended.	Existing Conditions	56	0%	$0	37	0%	$0	—
	Limited	25	55%	$1,000	34	8%	$12	Easy
	Intermediate	2	96%	$8,200	12	68%	$9	Moderate
	High	1	99%	$174,000	2.8	92%	$37	Difficult
Presumpscot Estuary—The tributary area is a residential/commercial area located near the Arcadia Street Pumping Station. The I-295 fill east of the area separates a small body of water from the main body of the Presumpscot Estuary. The small waterbody has limited flushing. CSO is the primary point source of pollution. A **high** level of CSO control is recommended.	Existing Conditions	13	0%	$0	1.8	0%	$0	—
	Limited	13	0%	$0	1.8	0%	$0	Easy
	Intermediate	1	92%	$1,800	0.8	56%	$21	Moderate
	High	0	100%	$5,000	0	100%	$8	Moderate
Back Cove—The tributary area includes the Fall Brook drainage area, an area west of Baxter Boulevard, Libbytown, and Marginal Way. Almost 60 percent of Portland's CSO volume is discharged to Back Cove. The perimeter of Back Cove includes a high use recreation area, and windsurfers frequent the waters. Back Cove is subject to tidal action which nearly drains all of Back Cove on an outgoing low tide. An **intermediate** level of CSO control is recommended.	Existing Conditions	392	0%	$0	327	0%	$0	—
	Limited	385	2%	$400	322	2%	$1	Easy
	Intermediate	21	95%	$19,000	134	59%	$18	Moderate
	High	3	99%	$159,800	33	90%	$29	Difficult
Portland Harbor—The tributary area includes commercial/industrial properties from the Veterans Memorial Bridge to the Eastern Promenade. Its use as a port is not severely impacted by Portland's CSO discharges. Portland Harbor also receives discharges from South Portland's CSOs and sewage treatment plant. The tributary area is highly developed and congested with very limited land available for implementation of CSO controls. A **limited** level of CSO control is recommended.	Existing Conditions	296	0%	$0	100	0%	$0	—
	Limited	264	11%	$1,300	95	5%	$8	Easy
	Intermediate	21	93%	$3,600	27	73%	$13	Difficult
	High	1	99%	$44,500	0.3	99%	$33	Difficult

Table 4-2
Evaluation of Targeted Levels of CSO Control by Receiving Water

Receiving Water	Level of Control	Incremental Annual Cost and Benefit Estimates*						Implementation
		Benefit		Incremental Annual Cost	Benefit		Incremental Annual Cost	
		Remaining Events/yr	Event Reduction from Existing Conditions	($/event reduced)	Remaining Volume (MG)/yr	Volume Reduction from Existing Conditions	($/1000 gal reduced)	
Fore River—The tributary area includes residential neighborhoods, the Jetport, and commercial/industrial zones near Thompson's Point. Three major streams discharge into the Fore River: the Stroudwater River, Nason Brook, and Capisic Brook. The Fore River spans an area from the Stroudwater River and Capisic dam at its upper reaches to the Veterans Memorial Bridge. The river is subject to tidal action that nearly drains the river during an outgoing low tide. An **intermediate** level of CSO control is recommended.	Existing Conditions	96	0%	$0	58	0%	$0	---
	Limited	54	44%	$900	30	48%	$1	Easy
	Intermediate	4	96%	$4,400	15	74%	$15	Moderate
	High	2	98%	$127,700	5.4	91%	$40	Difficult
Capisic Brook—The tributary area includes undeveloped land near the Westbrook/Portland border and moderate to dense residential areas in the lower reaches of the drainage area just north of the Capisic Dam. Numerous house lots abut the brook. Potential uses of the brook corridor are adversely impacted by CSO discharges. A **high** level of CSO control is recommended.	Existing Conditions	90	0%	$0	33	0%	$0	---
	Limited	55	39%	$2,100	29	12%	$20	Easy
	Intermediate	4	96%	$4,600	8.0	76%	$11	Moderate
	High	1	99%	$69,000	2.9	91%	$41	Moderate
Areawide	Existing Conditions	943	0%	$0	557	0%	$0	---
	Limited	796	16%	$1,300	512	8%	$4	Easy
	Intermediate	53	94%	$6,700	197	65%	$16	Moderate
	High	14	99%	$113,600	54	90%	$31	Difficult

*Cost and benefit calculations based on preliminary model estimates of CSO activity. Costs do not include land acquisition.



Legend

■ Corresponds to CSO controls identified in Table 4-1

△ Sewer Separation

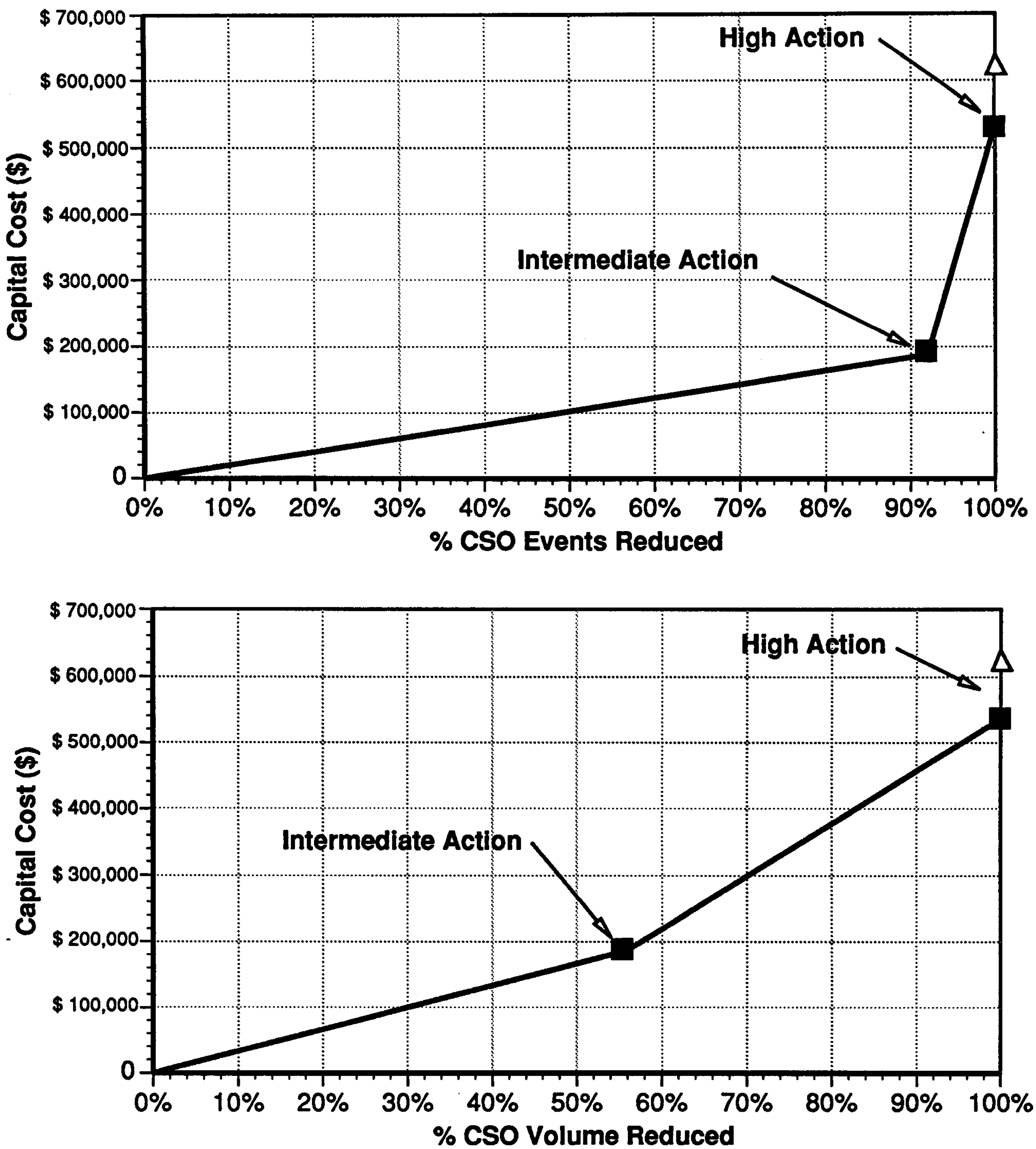
Note:

CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-2
Capital Cost vs. CSO Reduction for Casco Bay

CH2M HILL

1506F4-2 14 Dec. 1993



Legend

■ Corresponds to CSO controls identified in Table 4-1

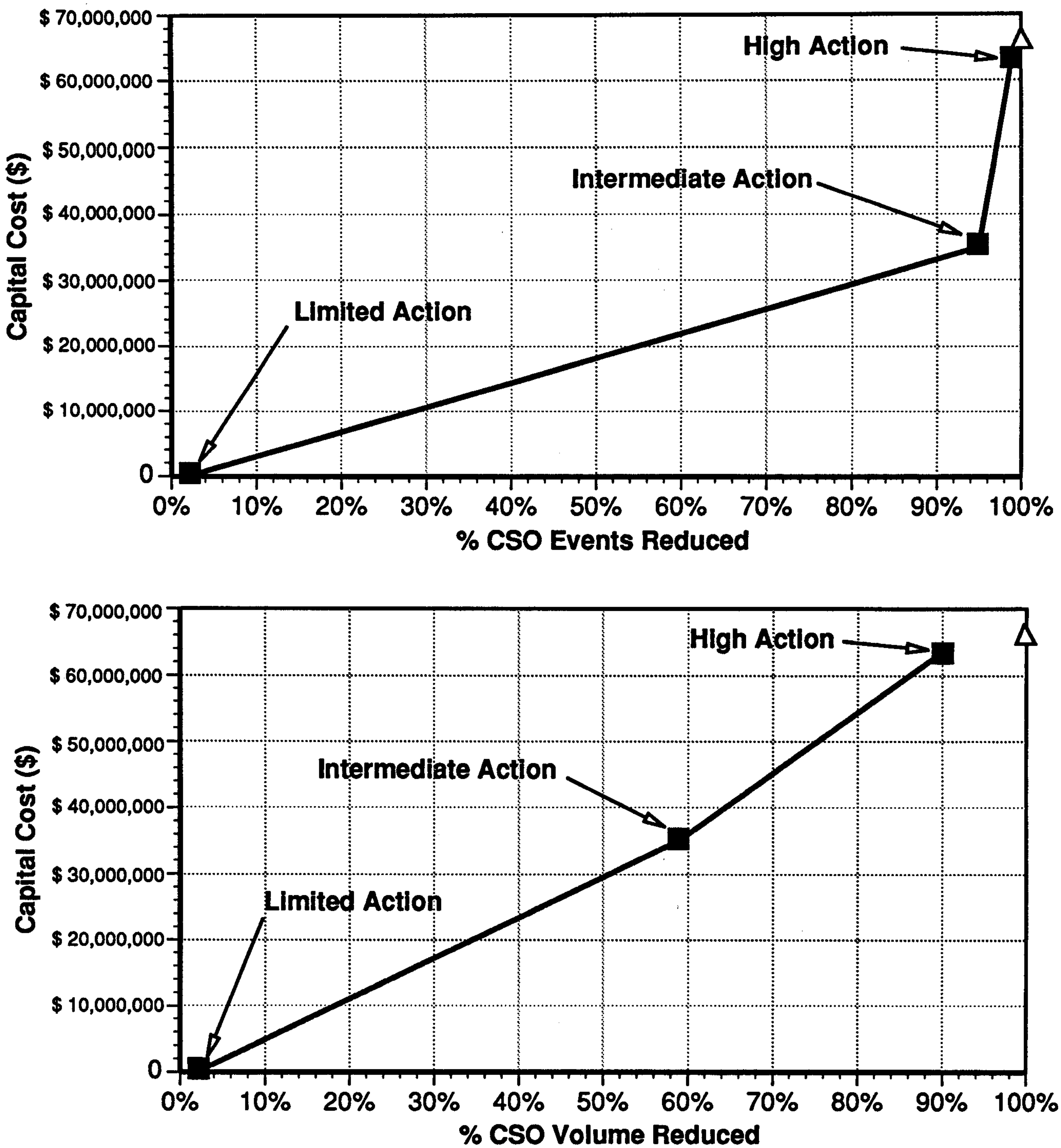
△ Sewer Separation

Note:

CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-3
Capital Cost vs.CSO Reduction for Presumpscot Estuary

1506F4-3 14 Dec. 1993



Legend

■	Corresponds to CSO controls identified in Table 4-1
△	Sewer Separation

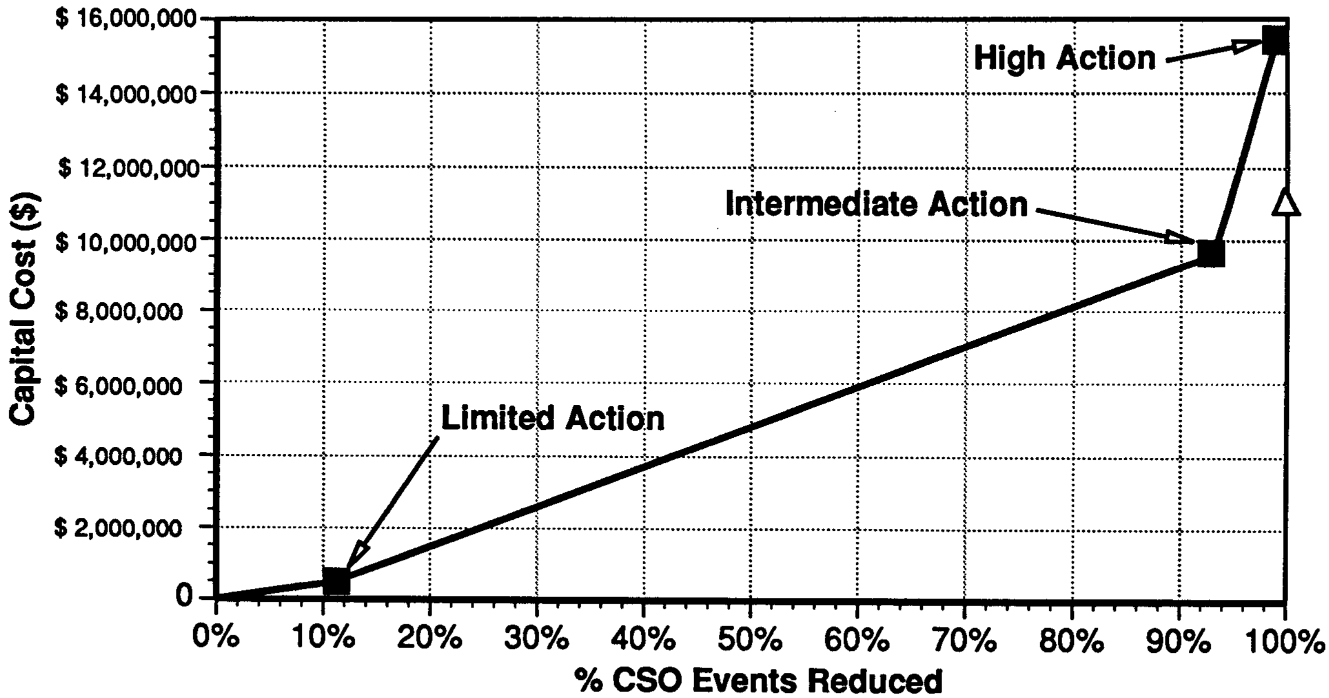
Note:

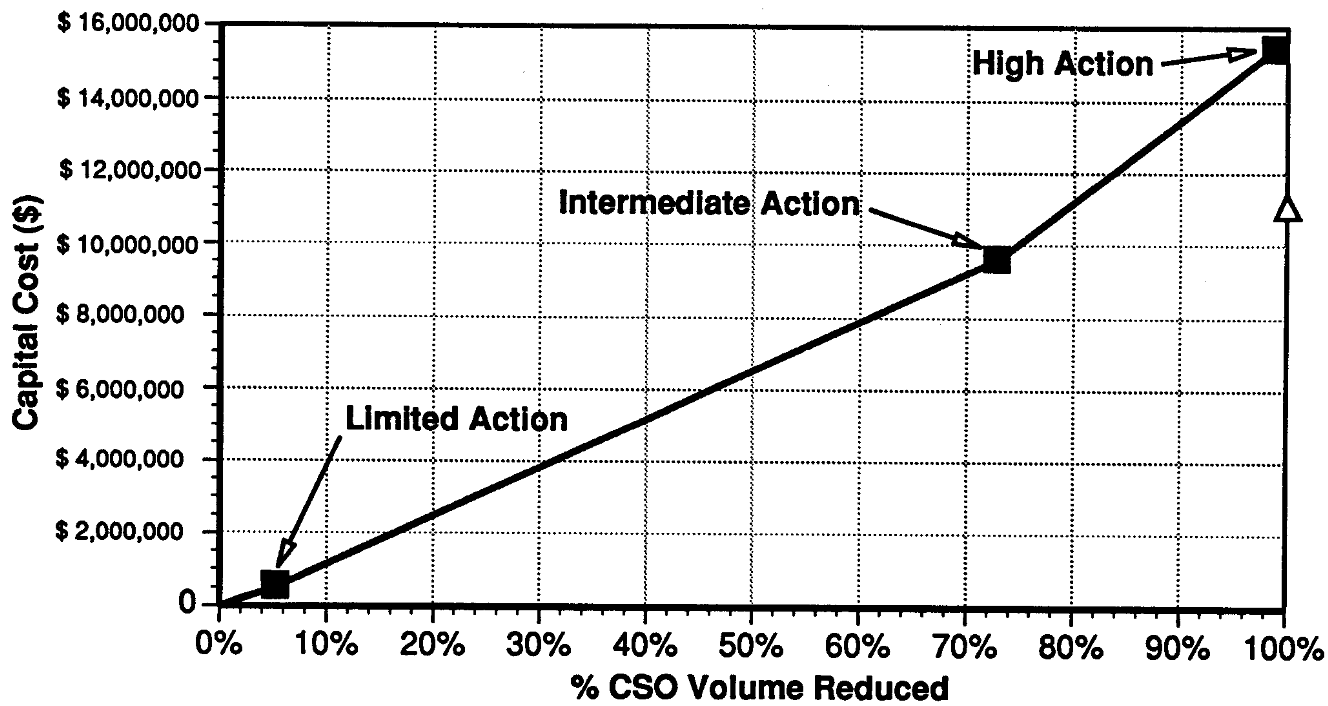
CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-4
Capital Cost vs. CSO Reduction for Back Cove

CH2M HILL

1506F4-4 14 Dec. 1993





Legend

■ Corresponds to CSO controls identified in Table 4-1

△ Sewer Separation

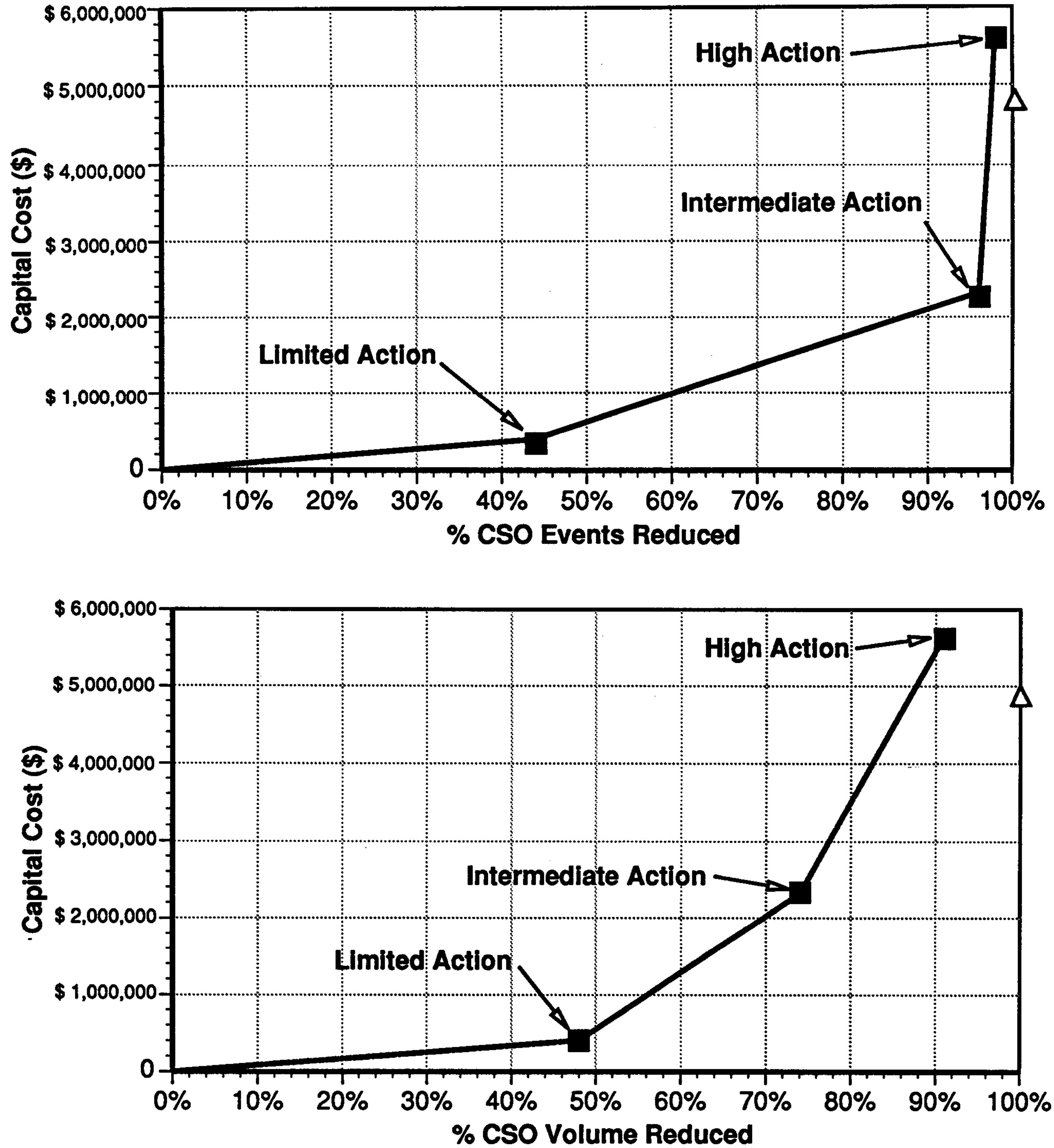
Note:

CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-5
Capital Cost vs.
CSO Reduction for Portland Harbor

CH2M HILL

1506F4-5 14 Dec. 1993



Legend

■ Corresponds to CSO controls identified in Table 4-1

△ Sewer Separation

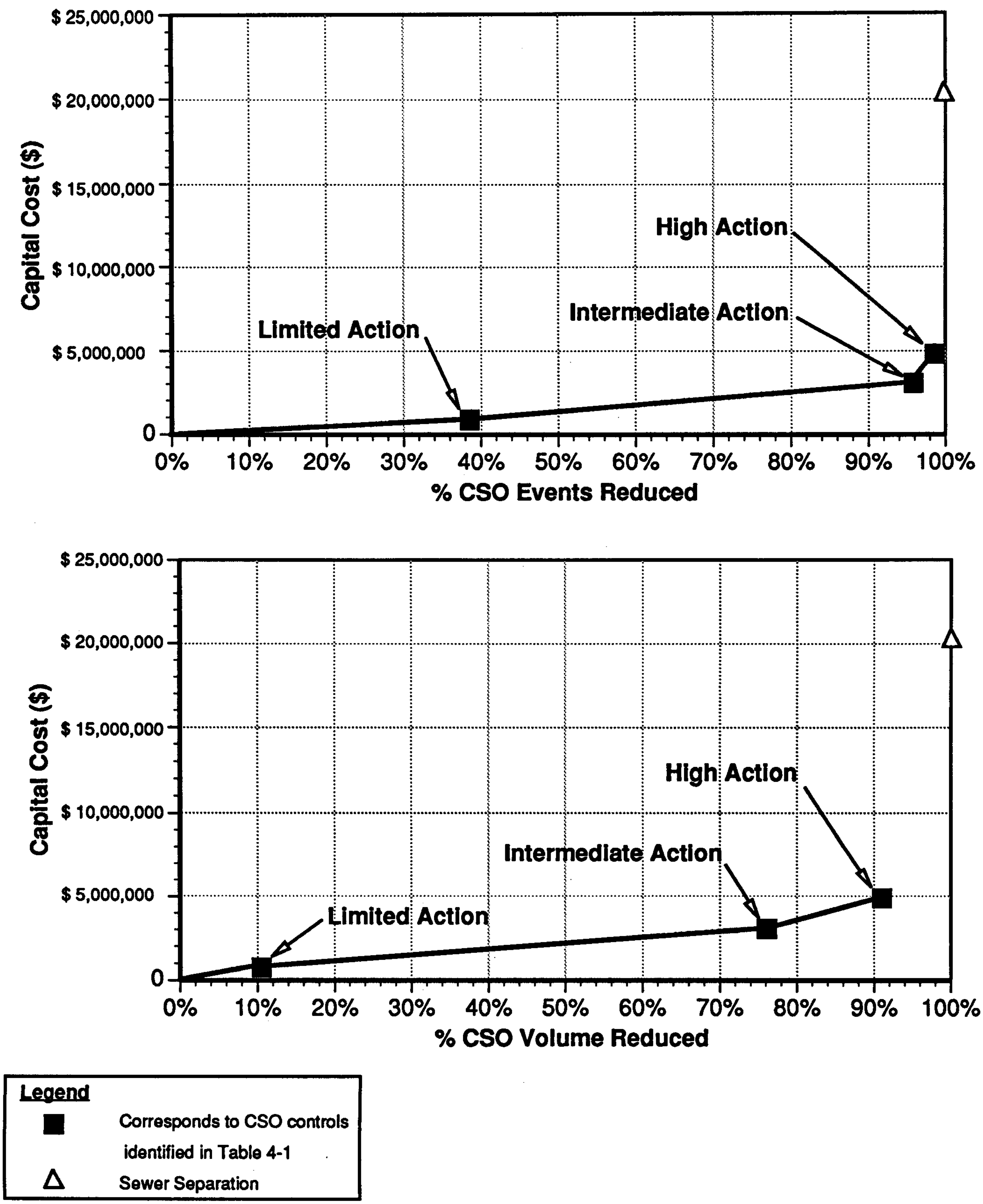
Note:

CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-6
Capital Cost vs.
CSO Reduction for Fore River

CH2M HILL

1506F4-6 14 Dec. 1993



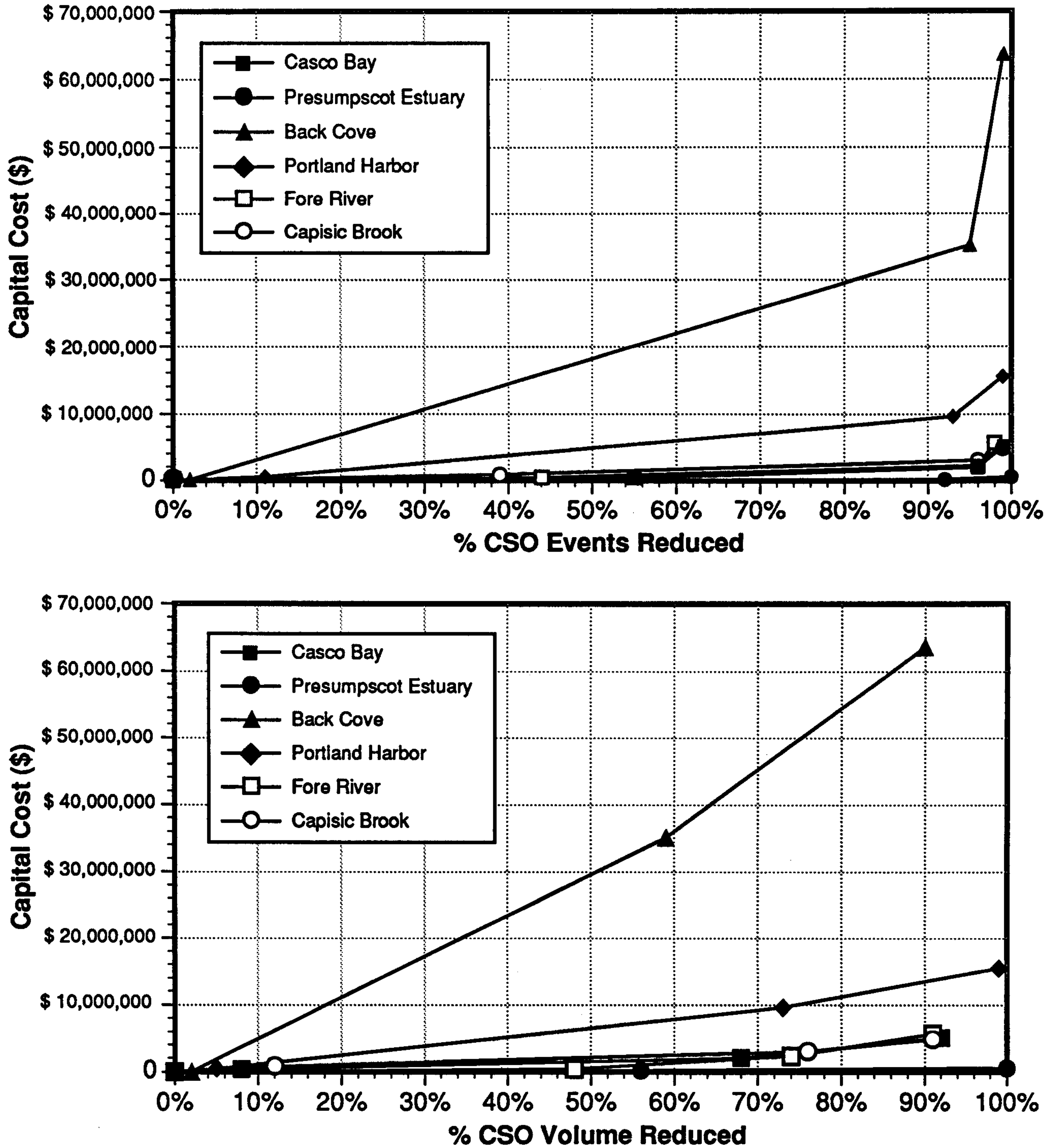
Note:

CSO controls identified in Table 4-1 and sewer separation do not have equivalent pollutant load reductions.

Figure 4-7
Capital Cost vs.
CSO Reduction for Capisic Brook

CH2M HILL

1506F4-7 14 Dec. 1993



Note:
Specific CSO controls are identified in Table 4-1.

Figure 4-8
Comparison of Capital Costs vs. CSO Reduction for the Six Receiving Waters

CH2M HILL

1508F4-8 14 Dec. 1993

Table 4-3
Preliminary CSO Control Plan

CSO	Facility/Action	Implementation	Costs ($1,000)		Baseline Annual Average CSO		Remaining Annual Average CSO		Percent Reduction		Level of Control
			Capital	O & M	Events	Volume (MG)	Events	Volume (MG)	Events	Volume	
Casco Bay											
1	Disconnect 4 remaining catch basins from combined system	Easy	20	0	5	0.3	0	0	100	100	High
3	Block outfall	Easy	0	0	1	<0.01	0	0	100	100	High
4	Block outfall	Easy	0	0	5	6	0	0	100	100	High
20	Storage tank (1 MG)	Moderate	1,637	33	20	28	2	12	90	57	Intermediate
21	Flow slippage	Moderate	350	0	25	2.3	0	0	100	100	High
Subtotal		Moderate	2,007	33	56	37	2	12	96	68	Intermediate
Presumpscot River											
2	Review ASPS operations, raise weir, install new tide gate and a) Storage tank (0.25 MG) or b) Separation; increase street sweeping and catch basin cleaning	a) Difficult b) Easy-Moderate	a) 536 b) 285	a) 11 b) 3	a) 13 b) 13	a) 1.8 b) 1.8	a) 1 b) 0	a) 0.2 b) 0	a) 98 b) 100	a) 90 b) 100	a) High b) High
Back Cove											
5	Adjust tipping gate for optimum performance and a) Storage tank (0.74 MG) or b) Separation; increase street sweeping and catch basin cleaning	a) Difficult b) Moderate-Difficult	a) 1,255 b) 623	a) 25 b) 7	a) 39 b) 39	a) 14 b) 14	a) 4 b) 0	a) 8.8 b) 0	a) 90 b) 100	a) 37 b) 100	Intermediate High
6	a) Storage tank (0.37 MG) or b) Separation; increase street sweeping and catch basin cleaning	a) Difficult b) Moderate-Difficult	a) 720 b) 991	a) 14 b) 11	a) 27 b) 27	a) 9.9 b) 9.9	a) 3 b) 0	a) 4.4 b) 0	a) 90 b) 100	a) 56 b) 100	a) Intermediate b) High
7	In-system storage (0.12 MG) and a) Storage tank (5.4 MG) b) Stormwater management	a) Very Difficult b) Moderate-Difficult	a) 6,003 b) 6,450	a) 120 b) 100	a) 42 b) 42	a) 145 b) 145	a) 4 b) 4	a) 64 b) 64	a) 90 b) 90	a) 56 b) 56	a) Intermediate b) Intermediate

Table 4-3
Preliminary CSO Control Plan

CSO	Facility/Action	Implementation	Costs ($1,000) Capital	Costs ($1,000) O & M	Baseline Annual Average CSO Events	Baseline Annual Average CSO Volume (MG)	Remaining Annual Average CSO Events	Remaining Annual Average CSO Volume (MG)	Percent Reduction Events	Percent Reduction Volume	Level of Control
8-16	Storage conduit (3.1 MG)	Moderate-Difficult	13,213	10	256	83	7	36	90	56	Intermediate
17-18	Implement (1) Libbytown projects and (2) storage conduit (0.59 MG)	Moderate-Difficult	(1) 8,800 (2) 5,096	(1) 5 (2) 21	27	75	3	21	90	72	Intermediate
19	Block outfall	Easy	0	0	1	0.2	0	0	100	100	High
Subtotal		a) Difficult b) Moderate-Difficult	a) 35,087 b) 35,173	a) 195 b) 154	a) 392 b) 392	a) 327 b) 327	a) 21 b) 14	a) 134 a) 121	a) 95 a) 96	a) 59 a) 63	a) Intermediate b) Intermediate
Portland Harbor											
23-25	Investigate raising ISPS weir, enlarging ISPS influent pipe, and adjusting tipping gate at CSO 25 for optimum performance	Easy	0	0	53	66	48	63	9	5	Limited
26-29	Flow slippage	Easy	475	0	159	34	127	29	20	15	Limited
Subtotal		Easy	475	0	296	100	175	92	41	8	Limited
Fore River											
30	Separate (part of Libbytown project - costs included above)	Easy	0	0	38	2.5	0	0	100	100	High
32	Investigate in-line storage in 30" sewer on Sewall Street, review TPPS weir configuration, and provide a storage tank (0.02 MG)	Moderate	79	2	8	0.6	1	0.2	90	67	Intermediate
33	Storage tank (0.08 MG)	Moderate	219	4	1	2.2	1	0.6	90	73	Intermediate
34	Separate	Easy	73	0	8	0.2	0	0	100	100	High
35	Separate	Easy	268	0	8	0.3	0	0	100	100	High
36	a) In-system storage plus storage tank (1.0 MG) b) Stormwater management	a) Very Difficult b) Moderate-Difficult	a) 1,682 b) 3,400	a) 32 b) 51	a) 31 b) 31	a) 51 b) 51	a) 3 b) 3	a) 14 b) 14	a) 90 b) 90	a) 55 b) 55	a) Intermediate b) Intermediate

Table 4-3
Preliminary CSO Control Plan

CSO	Facility/Action	Implementation	Costs ($1,000)		Baseline Annual Average CSO		Remaining Annual Average CSO		Percent Reduction		Level of Control
			Capital	O & M	Events	Volume (MG)	Events	Volume (MG)	Events	Volume	
39	Block outfall; clean 15" sewer downstream	Easy	0	0	2	0.9	0	0	100	100	High
Subtotal		a) Difficult	a) 2,321	a) 38	a) 96	a) 58	a) 5	a) 15	a) 95	a) 74	a) Intermediate
		b) Moderate	b) 4,039	b) 57	b) 96	b) 58	b) 5	b) 15	b) 95	b) 74	b) Intermediate
Capisic Brook											
38	Remove brook flow under Brighton Avenue bridge and provide stormwater management	Moderate	400	6	6	0.6	0	0	100	100	High
40	Sewer separation completed; increase street sweeping and catch basin cleaning	Easy-Moderate	590	7	30	3.4	0	0	100	100	High
41	Sewer separation (scheduled); increase street sweeping and catch basin cleaning	Easy	268	3	5	0.3	0	0	100	100	High
42-43	Remove brook flows and a) Storage tank (2.7 MG)	a) Difficult	a) 3,488	a) 70	a) 49	a) 29	a) 1	a) 2.9	a) 98	a) 90	a) High
	b) Stormwater management	b) Moderate-Difficult	b) 1,217	b) 18	b) 49	b) 29	b) 0	b) 0	b) 100	b) 100	b) High
Subtotal		a) Difficult	a) 4,746	a) 86	a) 90	a) 33	a) 1	a) 2.9	a) 99	a) 91	a) High
		b) Moderate-Difficult	b) 2,475	b) 34	b) 90	b) 33	b) 0	b) 0	b) 100	b) 100	b) High
Areawide Totals		Moderate	44,454	281	943	557	196	240	79	57	

*Event and volume estimates based on preliminary model results.
Note: a) and b) under Facility/Action represent options. Selected options are shaded.

Plan submitted on December 1, 1992. The evaluation summarized in Tables 4-2 and 4-3 was prepared using the 3-year precipitation record for 1966, 1967, and 1968, and the preliminary model estimates of average annual CSO volume and number of events. Comments received on the Draft Master Plan requested additional cost/benefit analysis for the Back Cove and Portland Harbor receiving waters. This analysis is presented in Section 4.4.

4.4 Additional Analysis for Back Cove and Portland Harbor

Comments received on the Draft Master Plan requested that additional alternatives be investigated and documented in the Final Master Plan for the Back Cove and Portland Harbor areas. The options examined to reduce CSO activity further in these two areas are presented in the following subsections. CSO control alternatives were developed and evaluated by comparison of order-of-magnitude costs, benefits of CSO reduction, and implementation issues. Benefits of CSO reduction were determined by utilizing SWMM for the 2-year storm identified in the 1966 annual precipitation record that occurred on November 2nd. For each receiving water, at least one alternative was selected to model using the 1966 annual precipitation record to analyze the alternative's impact on annual event reduction.

Back Cove

CSO controls identified in the Draft Master Plan provided 100 percent CSO reduction on the northern and western banks of Bank Cove, but CSO activity still remained along the southern bank of Back Cove involving primarily the drainage areas tributary to CSOs 16-19. The Draft Master Plan identified a 10-foot-diameter storage conduit linking CSOs 10-18 which would channel stored flows to the FSPS and on to the WWTF with overflow from the conduit channeled in to Back Cove. CSO 19 showed minimal activity, and was therefore recommended for deactivation. As a result of the comments received, two CSO control alternatives were evaluated, and a revised Recommended Plan was developed to reflect the changes during 1993 to the Libbytown Projects affecting the drainage area tributary to CSO 17.

Revised 1992 Recommended Plan: Modification of the Libbytown Projects to include the stormwater pumping station at Hood and to eliminate the 9-foot by 7-foot storage conduit under Fitzpatrick Stadium and Deering Oaks Park.

Alternative 1: Extension of the 10-foot-diameter storage conduit to CSO 20 and the NEPS and increase of the storage tank at CSO 20 from 1 MG to 2 MG.

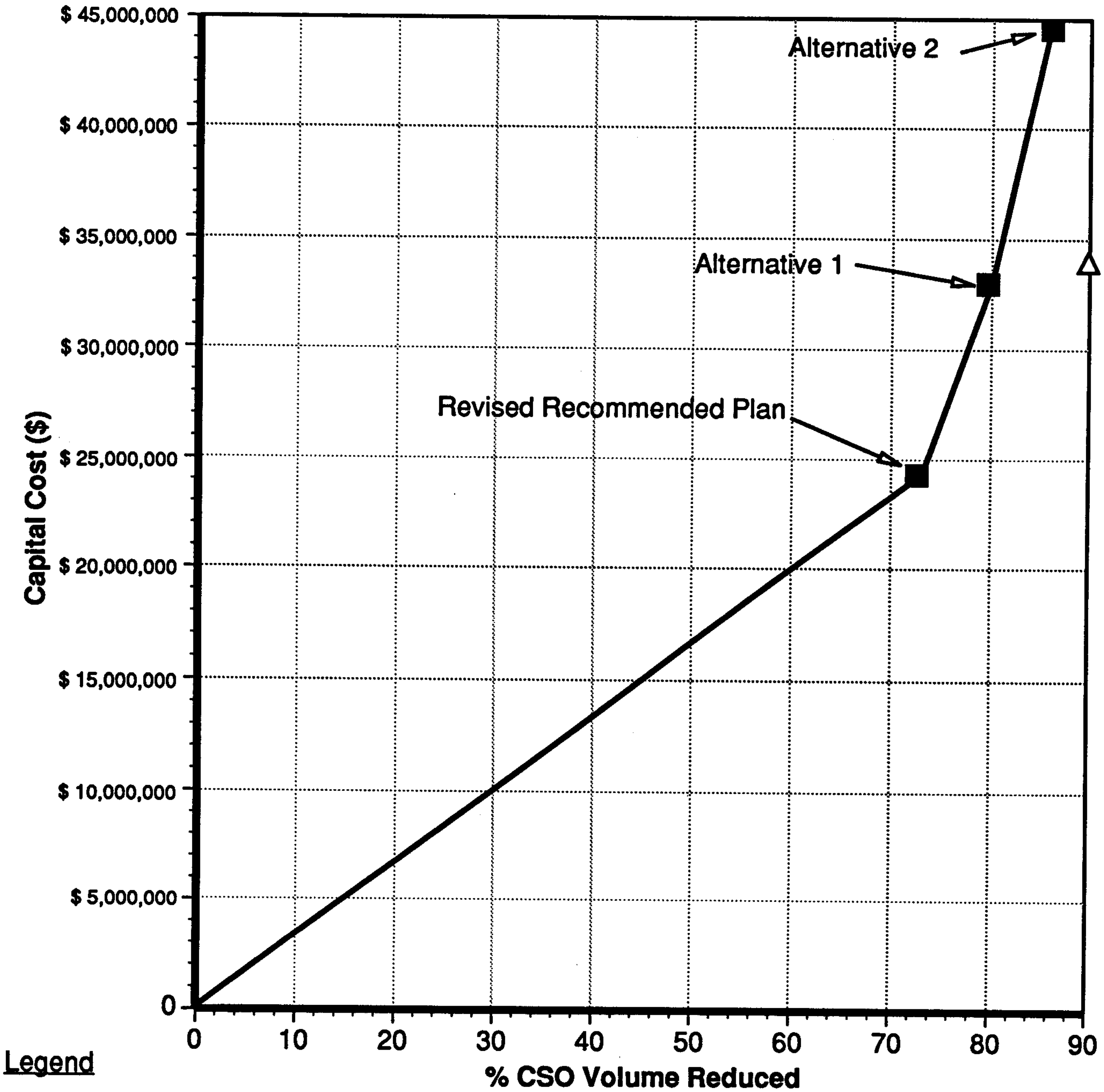
Alternative 2: Increase of the 10-foot-diameter storage conduit to 20 feet between CSOs 16-20 with the 2-MG storage tank at CSO 20.

The results of the cost-benefit analysis impacting CSOs 10-20 are presented in Table 4-4 and Figure 4-9.

Table 4-4
SWMM Results of Additional Back Cove Alternatives

CSO Control	Capital Costs[1] ($ million)	SWMM Results			Percent CSO Reduction	
		2-Year Volume (MG)	Annual No. of Events	Annual Volume (MG)	Annual Events	Annual Volume
Existing Conditions	--	81	44	416	--	--
1992 Recommended Plan	27	22	12	90	73	78
Revised 1992 Recommended Plan	24	21	12	70	73	83
Alternative 1	33	16	8	27	82	93
Alternative 2	45	11	--	--	--	--
Sewer Separation	34	0	0	0	100	100

[1]Costs represent facilities for CSOs 10-20 only.



Legend

■ Storage/Treatment Alternatives

△ Sewer Separation

Note:
CSO Volume reductions based on the selected 2-year storm.

Figure 4-9
Cost vs. CSO Volume Reduction of Additional Back Cove Alternatives

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A meeting was held with City and PWD staff to discuss the options. There was concern over construction of the storage conduit beneath numerous highway lanes passing between Back Cove and the WWTF; the highway construction in the early 1980's had uncovered difficult soil conditions for construction in the vicinity. In addition, the benefit increase for the cost increase was not as great as hoped. Since Back Cove is a highly visible receiving water with critical uses, sensitive areas, and a high use park surrounding it, the greatest water quality concerns include bacteria and floatables; therefore, a modification of the Revised Recommended Plan was developed which recommends disinfecting overflows from the 10-foot-diameter storage conduit. Volume and event reduction would remain the same as for the Revised Recommended Plan; however, this modification would result in a significant reduction to pollutant loads at a relatively small increase in cost. This alternative is further described in Section 5.

Portland Harbor

CSO controls identified in the Draft Master Plan provided limited CSO reduction for CSOs discharging to Portland Harbor. Comments received since publication of the Draft Master Plan indicated that flow slippage could feasibly be extended to include all of the drainage areas tributary to Portland Harbor which is a significant change from the original understanding; however, flow slippage assumptions for this area will be limited to 60% inflow reduction instead of the higher value (80%) assumed in other less commercial areas. During November 1993, the City purchased land south of the railroad tracks between the India Street Pump Station and the Eastern Promenade which provides potential to construct combined sewerage storage facilities and/or stormwater detention facilities. Another comment received to help abate CSO flows into Portland Harbor included restricting and storing influent flows to the Fore River Pump Station to free up capacity in the 48-inch interceptor which conveys combined sewer flows from the Portland Harbor drainage areas. Several preliminary model runs were performed to select the most appropriate storage facility sizes and pumping rate for the Fore River Pump Station. Based on the comments received and the preliminary modelling results, three alternatives were developed for evaluation.

Alternative 1: Implementation of flow slippage throughout drainage areas tributary to CSOs 23-29.

Alternative 2: Implementation of flow slippage throughout drainage areas tributary to CSOs 23-29 plus a 0.75-MG storage tank for CSOs 23-24 and a 2-MG storage tank for CSOs 26-29.

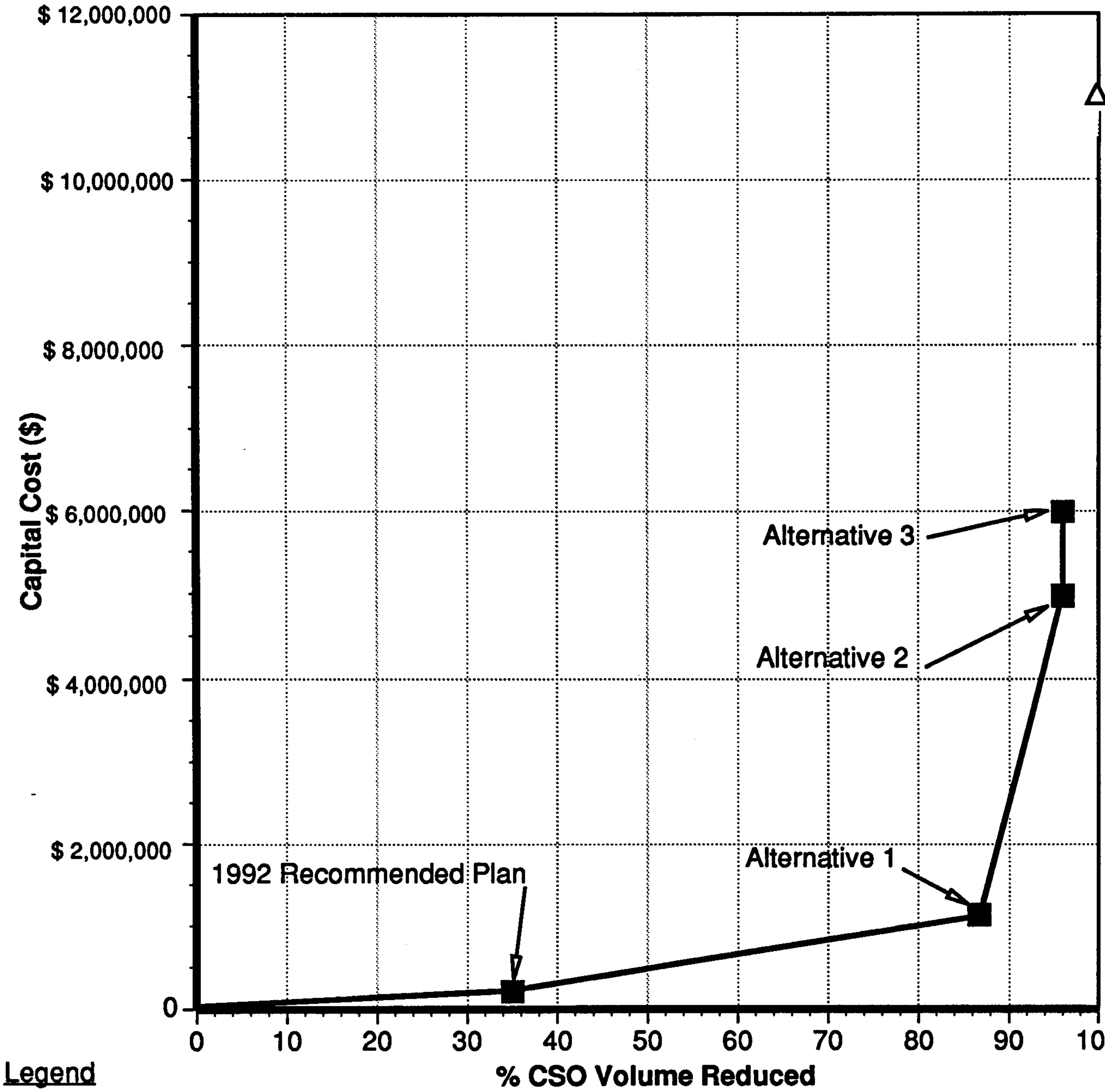
Alternative 3: Implementation of flow slippage throughout drainage areas tributary to CSOs 23-29 plus restriction of flow from 27 cfs to 12 cfs and implementation of a 4-MG storage tank at the Fore River Pump Station.

The results of the cost-benefit analysis impacting CSOs 23-29 are presented in Table 4-5 and Figure 4-10.

Table 4-5
SWMM Results of Additional Portland Harbor Alternatives

CSO Control	Capital Costs ($ million)	SWMM Results			Percent Reduction	
		2-Year Volume (MG)	Annual No. of Events	Annual Volume (MG)	Annual Events	Annual Volume
Existing Conditions	--	23	43	145	--	--
1992 Recommended Plan	0.2	15	36	86	16	41
Alternative 1	1.1	3	22	17	49	88
Alternative 2	5.0	1	21	10	51	93
Alternative 3	5.9	1	--	--	--	--
Sewer Separation	11.0	0	0	0	100	100

A meeting was held with City and PWD staff to discuss the options. It was agreed that Alternative 1 was the most cost-effective solution and that opportunities for stormwater detention of the slipped flows would be pursued during design. This alternative is further described in Section 5.



Legend

■ Storage/Treatment Alternatives

△ Sewer Separation

Note:

CSO Volume reductions based on the selected 2-year storm.

Figure 4-10

Cost vs. CSO Volume Reduction of Additional Portland Harbor Alternatives

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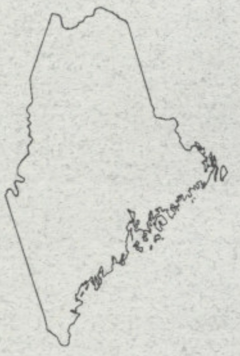

Recommended Plan

Section 5

The Recommended Plan

The preliminary control plan presented in Section 4 was developed with preliminary sewer system modeling results and order-of-magnitude costs. Model recalibration was completed in October 1992. A revised assessment of Portland's CSOs under existing conditions using the recalibrated model is presented in Section 3. Section 5 details the components of the Recommended Plan and presents performance estimates of the proposed CSO controls using the recalibrated model.

Table 5-1 identifies the level of CSO control for each receiving water based on the analysis presented in Section 4 along with the actual control achieved by implementation of the Recommended Plan. The Recommended Plan presented in Section 5 incorporates the comments received during review of the Draft Master Plan. Twenty-nine of thirty-nine CSO locations are proposed for deactivation. Estimated CSO volume reduction is 88 percent with the Recommended Plan. This reduction in CSO volume means that approximately 99 percent of all wastewater flows generated in the City will be treated.

Table 5-2 presents the recommended CSO abatement plan and shows the following related information:

- Future CSO performance compared to existing conditions
- Percent reduction of annual events and volume of CSO
- Minimum rainfall that would "trigger" a CSO after Recommended Plan implementation
- Overall level of control to be achieved

Table 5-1
Summary of Recommended Plan Goals and Results

Receiving Water	CSO Activity*				Percent Reduction			
	Existing Conditions		Recommended Plan		Events		Volume	
	No. of Events	Volume (MG)	No. of Events	Volume (MG)	Goal	Actual	Goal	Actual
Casco Bay	30	55	0	0	90	100	ND	100
Presumpscot Estuary	13	2	0	0	>90	100	90	100
Back Cove	44	416	12	70	90	73	ND	83
Portland Harbor	43	145	22	17	ND	49	ND	88
Fore River	36	73	0	0	90	100	ND	100
Capisic Brook	26	29	0	0	>90	100	90	100
Areawide	NA	720	NA	87	ND	NA	ND	88

*Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record. The number of events approximates the number of days an overflow event is occurring.
NA—Not applicable.
ND—Not defined. The economic optimization analysis performed for Portland and documented in TM5 suggests that 90 percent event reduction typically corresponds to 60 to 70 percent volume reduction.

Table 5-2
Recommended CSO Control Plan

CSO	Facility/Action	Existing Conditions CSO Activity[1]		Remaining CSO Activity[1]		Percent Reduction		Rainfall that Triggers CSO Activity[2]		
		No. of Events	Volume (MG)	No. of Events	Volume (MG)	Events	Volume	Rainfall (inches)	Maximum Itensity (inches/hour)	Storm Recurrence Interval (months)
Casco Bay										
1	Separate	10	0.2	0	0	100	100	NA	NA	NA
3	Deactivate outfall	0	0	0	0	100	100	NA	NA	NA
4	Deactivate outfall	0	0	0	0	100	100	NA	NA	NA
20	Increase the pumping rate at the NEPS by 12 mgd and provide a storage tank (1 MG)	30	54	0	0	100	100	*	*	*
21	Complete on-going Quebec Street flow slippage project	7	1.1	0	0	100	100	NA	NA	NA
Results		30	55	0	0	100	100	*	*	*
Presumpscot Estuary										
2	Separate	13	1.8	0	0	100	100	NA	NA	NA
Back Cove										
5	Increase pumping rate at NEPS by 12 mgd plus backflow prevention and partial separation	34	100	0	0	100	100	NA	NA	NA
6	Increase pumping rate at NEPS by 12 mgd plus partial separation	23	1.6	0	0	100	100	NA	NA	NA
7	Increase pumping rate at NEPS by 12 mgd, sewer separation, in-system storage and stormwater management	24	100	0	0	100	100	NA	NA	NA
8	Separate	5	4.1	0	0	100	100	NA	NA	NA
9	Deactivate outfall	0	0	0	0	100	100	NA	NA	NA
10-18	Implement (1) Libbytown projects and (2) storage conduit along Baxter Boulevard and north of Marginal Way (4.4 MG) with chlorination and dechlorination	44	210	12	70	73	67	0.81	0.21	0.7
19	Deactivate outfall	5	0.2	0	0	100	100	NA	NA	NA

Table 5-2
Recommended CSO Control Plan

CSO	Facility/Action	Existing Conditions CSO Activity[1]		Remaining CSO Activity[1]		Percent Reduction		Rainfall that Triggers CSO Activity[2]		
		No. of Events	Volume (MG)	No. of Events	Volume (MG)	Events	Volume	Rainfall (inches)	Maximum Itensity (inches/hour)	Storm Recurrence Interval (months)
Results		44	416	12	70	73	83	0.81	0.21	0.7
Portland Harbor										
23	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	33	27	14	3	58	89	0.35	0.31	0.3
24	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	30	1.7	12	0.4	60	76	0.35	0.31	0.3
25	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	38	79	21	7	45	91	0.35	0.31	0.3
26	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	12	1.2	0	0	100	100	*	*	*
27	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	38	11	21	2	45	82	0.35	0.20	0.3
28	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	43	21	22	4	49	81	0.35	0.20	0.3
29	Increase pumping rate by 8 mgd at ISPS and implement flow slippage throughout drainage area	33	3.9	14	0.6	58	85	0.35	0.31	0.3
Results		43	145	22	17	49	88	0.35	0.20	0.3
Fore River										
30	Implement backflow prevention plus separation (separation is part of Libbytown projects)	24	3.5	0	0	100	100	NA	NA	NA
32	Storage tank (0.02 MG)	18	0.8	0	0	100	100	*	*	*
33	Deactivate outfall	2	0.1	0	0	100	100	NA	NA	NA
34	Separate	23	0.2	0	0	100	100	NA	NA	NA
35	Separate	13	0.2	0	0	100	100	NA	NA	NA

Table 5-2
Recommended CSO Control Plan

CSO	Facility/Action	Existing Conditions CSO Activity[1]		Remaining CSO Activity[1]		Percent Reduction		Rainfall that Triggers CSO Activity[2]		
		No. of Events	Volume (MG)	No. of Events	Volume (MG)	Events	Volume	Rainfall (inches)	Maximum Itensity (inches/hour)	Storm Recurrence Interval (months)
36	Implement stormwater management and sewer separation	46	68	0	0	100	100	NA	NA	NA
39	Deactivate outfall	0	0	0	0	100	100	NA	NA	NA
Results		103	73	0	0	100	100	NA	NA	NA
Capisic Brook										
38	Remove brook flow under Brighton Avenue bridge and separate	14	4.4	0	0	100	100	NA	NA	NA
40	Sewer separation completed	0	0	0	0	100	100	NA	NA	NA
41	Sewer separation (scheduled)	4	0.4	0	0	100	100	NA	NA	NA
42-43	Remove brook flows and implement stormwater management and sewer separation	69	24.6	0	0	100	100	NA	NA	NA
Results		87	29	0	0	100	100	NA	NA	NA
Areawide		--	**720**	--	**87**	--	**88**	--	--	--

[1]Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record. Number of events approximates the number of days an overflow event is occurring.
[2]Rainfall indicated is the smallest storm in the precipitation record that triggered an overflow.
NA – Not applicable.
*No storm in the 1966 precipitation record triggered an overflow. The 1966 precipitation record indicates a maximum rainfall event of 3.39 inches and a maximum storm intensity of 0.64 inches/hour, approximately equivalent to a storm with a 2-year return frequency. Results of the 5-year return frequency storm (presented in Table 5-3) indicate minor activity at CSO 20 and no activity at CSOs 26 and 32. The 5-year return frequency storm has a depth of 4.56 inches and a maximum intensity of 0.64 inches/hour.

CSO impacts after implementation of the Recommended Plan were also evaluated using a 5-year storm as described in Section 3.1; these impacts are presented in Table 5-3. Map 2 presents a pictorial overview of the recommended plan. The details of the recommended plan are discussed in the following sections.

5.1 System-Wide Improvements

Sewer separation projects are recommended in areas where separation is cost-effective such as in low and medium density neighborhoods and in areas where the pollutant loads associated with separate stormwater can be effectively controlled using pollutant source controls such as street cleaning, catch basin cleaning, construction site erosion control, etc. as described in Section 4. In addition, "active" stormwater management controls are recommended, such as the construction of wet detention ponds, infiltration basins, or wetland systems that provide stormwater quality and quantity control. Opportunities for implementation of "passive" stormwater management through filter strips, vegetated buffers, and maintenance/rehabilitation of riparian areas will also be employed as appropriate. Areas with substantial commercial and/or light industrial development, including major streets with relatively heavy traffic volumes, will continue to be served through combined sewers because of the increased cost of sewer separation and the lack of opportunities to manage the stormwater from a quantity or quality basis if the area is separated. Employment of best management practices in combined sewer drainage areas will focus on those areas with the most active CSOs.

As part of the overall plan, the City's existing Stormwater Management and Erosion Control Design Standards should be expanded to include more definitive requirements for computation of stormwater peak flows and procedures for demonstrating no adverse downstream effects. Also, more specific requirements and specifications for stormwater management facility design and maintenance are required to ensure proper operation and

Table 5-3
CSO Impacts after Implementation of the Recommended Plan under a 5-Year Storm Condition

Receiving Water	CSO No.	Drainage Area (acres)	Volume (MG)	Duration (hours)
Casco Bay	1	14	0	0
	3	3	0	0
	4	0	0	0
	20	29	0.2	8
	21	43	0	0
Subtotal:		89	0.2	NA
Presumpscot Estuary	2	25	0	0
Back Cove	5	74	0	0
	6	101	0	0
	7	1,051	0	0
	8	18	0	0
	9	6	0	0
	10-18	1,185	70	17
	19	177	0	0
Subtotal:		2,612	70	NA
Portland Harbor	23	112	2	9
	24	32	0.1	6
	25	86	6	12
	26	95	0	4
	27	39	1	12
	28	59	2	12
	29	28	0.7	11
Subtotal:		451	12	NA
Fore River	30	7	0	0
	31	Eliminated	--	--
	32	32	0	0
	33	94	0	0
	34	3	0	0
	35	11	0	0
	36	415	0	0
	39	37	0	0
Subtotal:		599	0	NA
Capisic Brook	37	Eliminated	--	--
	38	21	0	0
	40	Eliminated	--	--
	41	11	0	0
	42-43	374	0	0
Subtotal:		406	0	NA
Total		4,182	82	NA

NA—Not applicable.

performance. Provisions for stormwater quality control should also be incorporated into the standards.

Section 5 presents the details of the components of the recommended plan at each CSO. Cost estimates of each component are provided in Section 6. An environmental evaluation is presented in Section 7. The recommended plan is flexible and can be phased to target priority areas first. Implementation issues such as phasing, permit requirements, and proposed monitoring are discussed in Section 8. A financial and ratepayer analysis is presented in Section 9, and Section 10 presents the public participation process performed as part of this study.

5.2 Maximizing the Existing Conveyance and Treatment Systems

Currently the Portland WWTF operates at a peak capacity of 60 mgd. According to the WWTF Waste Discharge License issued by DEP to the PWD dated October 1991, the WWTF has two permitted outfalls: 001A for secondary treated municipal wastewaters and 001B for primary treated combined sewer flows. The current WWTF license limits average monthly flow to 19.8 mgd and peak daily flow to 36.8 mgd for Outfall 001A, and limits peak daily flow to 23 mgd for Outfall 001B. The WWTF also has a NPDES permit issued by EPA for one outfall for treated sanitary/industrial wastewater. Average monthly flow and peak daily flow are limited to 19.8 mgd and 36.8 mgd, respectively.

Flow to the plant is controlled by two pump stations: the NEPS and the ISPS. Both pump stations have four constant speed pumps. Instrumentation at the NEPS and the ISPS is currently configured at a peak flow rate of 33 mgd and 23 mgd, respectively. Operation at these flow rates requires the use of only two out of the four pumps in each station. An additional peak flow of 4 mgd flows to the plant via a gravity sewer from the CSO 21 (Quebec Street) drainage area.

Following coarse screening and flow metering, influent to the WWTF is split to three parallel process trains, each limited to a peak flow of 20 mgd. The plant is designed to provide secondary treatment for peak flows up to 37 mgd and to provide primary treatment for wet weather flows in excess of 37 mgd up to the limit of 60 mgd.

In the past, the Portland conveyance and treatment systems have operated at peak flow rates above 60 mgd, sometimes above 70 mgd, in the interest of minimizing CSO discharges. With the exception of effluent fecal coliform levels, effluent quality was maintained within permit limits during peak wet weather flows above 60 mgd. Inability to consistently meet the strict permit limit of 15 fecal coliform organisms/100 ml during peak wet weather flows has resulted in the current operational procedure of restricting peak wet weather influent flow levels to 60 mgd, to assure permit compliance for effluent fecal coliform.

Additional chlorine contact capacity was recently added; the current configuration includes 0.764 MG of chlorine contact volume for secondary effluent, and 0.506 MG of chlorine contact volume for primary effluent. This provides 30 minutes contact time for secondary effluent at 36 mgd, and 20 minutes contact time for 36 mgd of primary effluent, at an influent flow of 72 mgd.

Impacts of Increased Pumping

Maximizing flows through the existing conveyance and treatment systems is a cost-effective method of reducing CSO frequency, volume, duration, and pollutant loads to receiving waters. The intent of the WWTF's original design was to add a fourth process train to deliver 80 mgd through primary treatment and 50 mgd through secondary treatment. The cost of this expansion has been estimated at $40 million. PWD is suggesting a Waste Discharge License modification to both state and federal regulatory agencies, allowing 80 mgd through three primary clarifiers. PWD personnel have suggested that the WWTF can be modified at a relatively low cost to accept peak flows of 80 mgd through primary without the addition of the fourth process train. This has been estimated at a cost of approximately $600,000, a very cost-effective option. Maximum flows through the plant are presently limited to approximately 70 mgd because of the flow monitoring flumes. One flume has a capacity of 45 mgd; the other has a capacity of 25 mgd. Modifications of plant operations include the following:

- Upgrade one flow monitoring flume and modify the instrumentation of both flumes

- Add two cyclone grit separators to the existing three separators

- Add one mechanically-cleaned bar screen to the existing two mechanically-cleaned bar screens and one manually-cleaned bar screen

- Enlarge 60-feet of primary effluent outfall pipe and the corresponding valves, etc. from 24 inches to 36 inches

Modifications to WWTF discharge limitations (both state and federal permits) include:

- Allowance for additional flow
- Reduced primary treatment effluent limitations

PWD recently (December 1993) contracted CH2M HILL to perform a separate study of its chlorination/dechlorination facilities to examine the following:

- Increasing the flow through the chlorination/dechlorination system from 23 mgd to 43 mgd

- Modifying the existing chlorination/dechlorination system to ensure continued compliance with the WWTF effluent discharge limitations

- Demonstrating that the primary bypass will meet WWTF effluent discharge limitations

CH2M HILL's past experience with similar studies around the country has demonstrated successful bacteria kills using high rate disinfection techniques. Results of this study are expected by March 1993.

PWD indicated that NEPS and ISPS could pump a total additional peak flow of 20 mgd. Past operational records suggested that 60 percent of the additional flow could go through NEPS, and the remaining 40 percent could go through ISPS. Therefore, NEPS' peak pumping rate would be increased by 12 mgd to 45 mgd, and ISPS' peak pumping rate would be increased by 8 mgd to 31 mgd. The only required modification at the pump stations would be to the instrumentation. However, this increase would utilize all four pumps at each station during peak wet weather flow conditions. Modification of the pump stations is required to provide backup pumping capacity. Details are provided in Section 6.

Using the 1966 precipitation record, model estimates indicated that 44 days a year the WWTF flows exceeded 37 mgd. On average, 3 MG per event bypassed secondary treatment. The duration of the bypass event averaged 5 hours. Bypasses receive preliminary and primary treatment and are disinfected.

According to WWTF personnel, expansion of the conveyance and treatment systems to handle peak flows above 80 mgd would be costly and modifications would be extensive. Land availability for expanded facilities is extremely limited at the plant's current site. In addition to expansion of the process trains, major modifications would be required throughout the conveyance system to deliver the high flows. For example, many of the force mains maintain a velocity of 6 to 7 feet per second operating at 60 mgd; 100 mgd would push the velocities to 10 feet per second. A detailed review of the system would be required to consider the costs and benefits of this alternative to CSO control. An order-of-magnitude estimate indicates a cost of approximately $100 million to expand the WWTF to accept peak flows of 100 mgd. Plant expansion to 100 mgd would not provide as significant a benefit in the upper reaches of the combined sewer drainage area as that provided by implementation of the Recommended Plan.

Impacts of Increased Loading at the WWTF

CSO volumes and pollutant loads contained by CSO storage facilities will be conveyed to the Portland WWTF. The storage tanks at CSOs 20 and 32 and the storage conduit for CSOs 10-18 will typically drain immediately following a wet weather event that triggers their use. The storage facilities will drain to the WWTF when wet weather flow levels to the WWTF have begun to recede. Hydraulically, the impact of CSO storage will be to extend the duration of elevated wet weather flow levels. The additional flow will receive a combination of primary and secondary treatment.

Table 3-6 presents event mean concentrations of 217 mg/L TSS and 34 mg/L BOD for Portland's CSOs developed from monitoring program data. These values can be used to estimate the increased pollutant load to the WWTF resulting from capture of wet weather flow through increased pumping and CSO storage facilities. For short term impact, transferring the CSO storage volume to the WWTF at the end of a wet weather event would not increase existing instantaneous peak wet weather flows or loads but rather extend the duration of the flows and loads but rather extend the duration of the flows and loads. The increased load from the CSO storage volume would be felt at the WWTF after the rainfall event had concluded and peak wet weather flows had receded.

Impacts on the WWTF of increased pumping of peak wet weather flows will vary with hydrologic and hydraulic conditions at the time. For example, increased pumping may result in 10 hours of pumping at an additional peak rate of 20 mgd, conveying an additional 10 MG to the WWTF. Based on the EMCs provided, this results in an additional loading of 18,000 lbs. of TSS and 3,000 lbs. of BOD. These loads in addition to average loads of approximately 20,000 lbs/day of TSS and BOD are well within the WWTF design capacity of 63,000 lbs/day TSS and 58,500 lbs/day BOD for wet weather loading.

5.3 Casco Bay

There are five active CSOs which discharge to Casco Bay: CSOs 1, 3, 4, 20, and 21. CSO 20 is by far the most active. Casco Bay is an expansive waterbody with many factors influencing water quality. Shellfish areas and East End Beach are water quality concerns. The targeted level of CSO control in Casco Bay is intermediate, or 90 percent reduction of the annual number of CSO events.

Significant CSO reduction can be achieved by the implementation of relatively simple and cost-effective actions at CSOs 1, 3, 4, and 21. CSO 20 is more complicated and costly to reduce than the other Casco Bay CSOs, primarily due to the hydraulics of the Portland sewer system. Practically, CSO 20 serves as an emergency overflow for the Northeast Pump Station which conveys 60 percent of the combined sewer flows generated in Portland to the WWTF. Details of the proposed actions at each CSO are discussed in the following paragraphs.

CSO 1 (Olympia Street)

The drainage area tributary to CSO 1 is relatively small (14 acres). Most of the drainage area is already separated. Model runs indicate that CSO 1 is a relatively minor overflow. In a typical year, CSO 1 discharges 10 times with an overflow volume of 0.2 MG. CSO 1 can be easily and cost-effectively eliminated by separating the remaining few streets, as shown on Figure 5-1.

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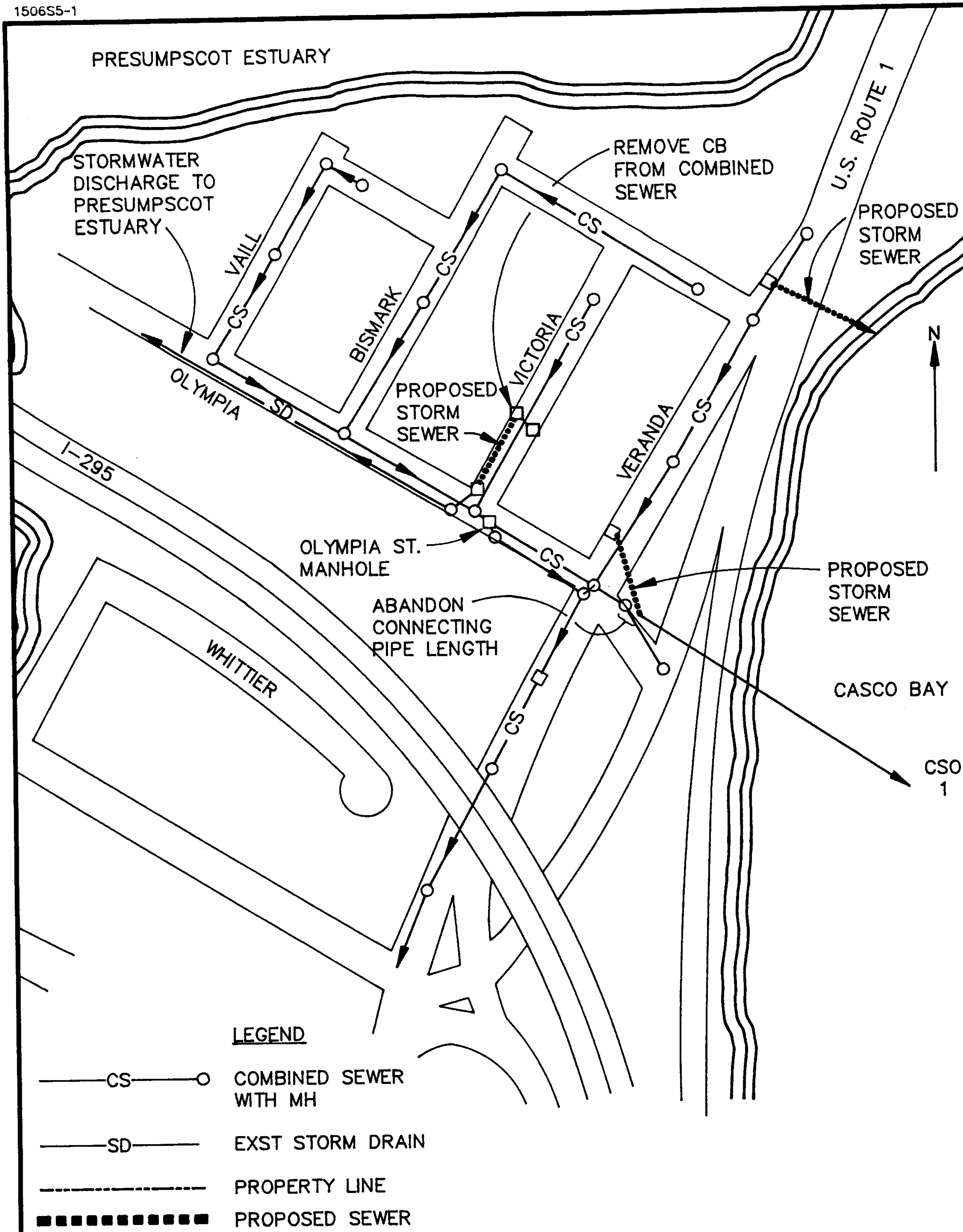

Approximate scale: 1" = 200'

Portland CSO Abatement Study

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Figure 5-1
Location of CSO 1 and Proposed Sewer Separation Area

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CSO 3 (Berwick Street)

The drainage area tributary to CSO 3 totals 3 acres, encompassing less than three city blocks. There are no catch basins. Model results do not indicate any overflow; this is consistent with PWD's periodic visual observations and knowledge of the local system. Block test data do indicate some activity; however, the activity is noted principally during the small volume, less intense rainstorms. The blocks have been known to move by activity that is not CSO-related (i.e. rodents). Sewer system hydraulics and hydrology should be reviewed to confirm the feasibility of deactivating the outfall structure.

CSO 4 (Tukey's Bridge Siphon)

CSO 4 is the overflow just upstream of the Tukey's Bridge siphon. Flows from the Baxter Boulevard and Arcadia Street Pump Stations are conveyed through the Tukey's Bridge siphon to the Northeast Pump Station and the Portland WWTF. Typically, high upstream flows overflow through CSOs 5 through 7 which limits the quantity of water reaching the Tukey's Bridge siphon. CSO 4 has a high weir elevation in comparison to CSO 5 (approximately a 15-foot difference in elevation); therefore, backwater effects from the Northeast Pump Station impact CSO 5 rather than CSO 4.

Model runs do not indicate any overflow at CSO 4 under existing conditions. Block test data currently indicates minimal activity. Although the potential for an overflow event should be significantly reduced after implementation of the recommended plan, sewer system hydraulics and hydrology should be reviewed to confirm the feasibility of deactivating the outfall structure.

CSO 20 (Northeast Pump Station)

Flows from the Franklin Street Pump Station and runoff from drainage area 20 (29 acres) pass through a diversion structure just upstream of the Northeast Pump Station. The overflow from this diversion structure is CSO 20. The site and location of CSO 20 is shown on Figure 5-2.

Model results indicate that CSO 20 produces approximately 30 overflow events per year with a total volume of 54 million gallons per year. Activity at CSO 20 is primarily a result of the constriction of the diversion structure and wet well capacity on flows from the FSPS and the conduit from Anderson Street; therefore, CSO control options such as sewer separation or flow slippage in drainage area 20 will not achieve significant reduction of CSO 20. Significant reductions can be achieved by increasing the flow rate through the NEPS and implementing storage.

Field investigations indicated that there is space adjacent to the NEPS for a storage facility. Increasing the pumping rate of the NEPS by 12 mgd and implementation of a storage facility of 1 MG eliminates overflow at CSO 20 for the typical precipitation year. The 5-year return frequency storm indicated 0.2 MG of overflow. A schematic layout of the facility is provided in Figure 5-3.

CSO 21 (Quebec Street)

CSO 21 is the outfall from drainage area 21 which totals 43 acres. A separate study of CSO 21, the Quebec Street Overflow Control Study, has been conducted concurrent with this project. The study determined the amount of inflow reduction needed to eliminate CSO 21, evaluated flow slippage and inlet control options, and provided an implementation plan showing control options for specific locations. Removing a specified portion of the stormwater inflow to the combined sewer system as determined by the study will eliminate CSO 21. The outfall pipe will be disconnected from the combined sewer system and connected to the stormwater system. The outfall pipe will become a discharge point for stormwater only. Phase 1 of the project, construction of the stormwater collection pipe, is complete. The vortex valve installation, roof leader/sump disconnection, and public information program are currently underway.

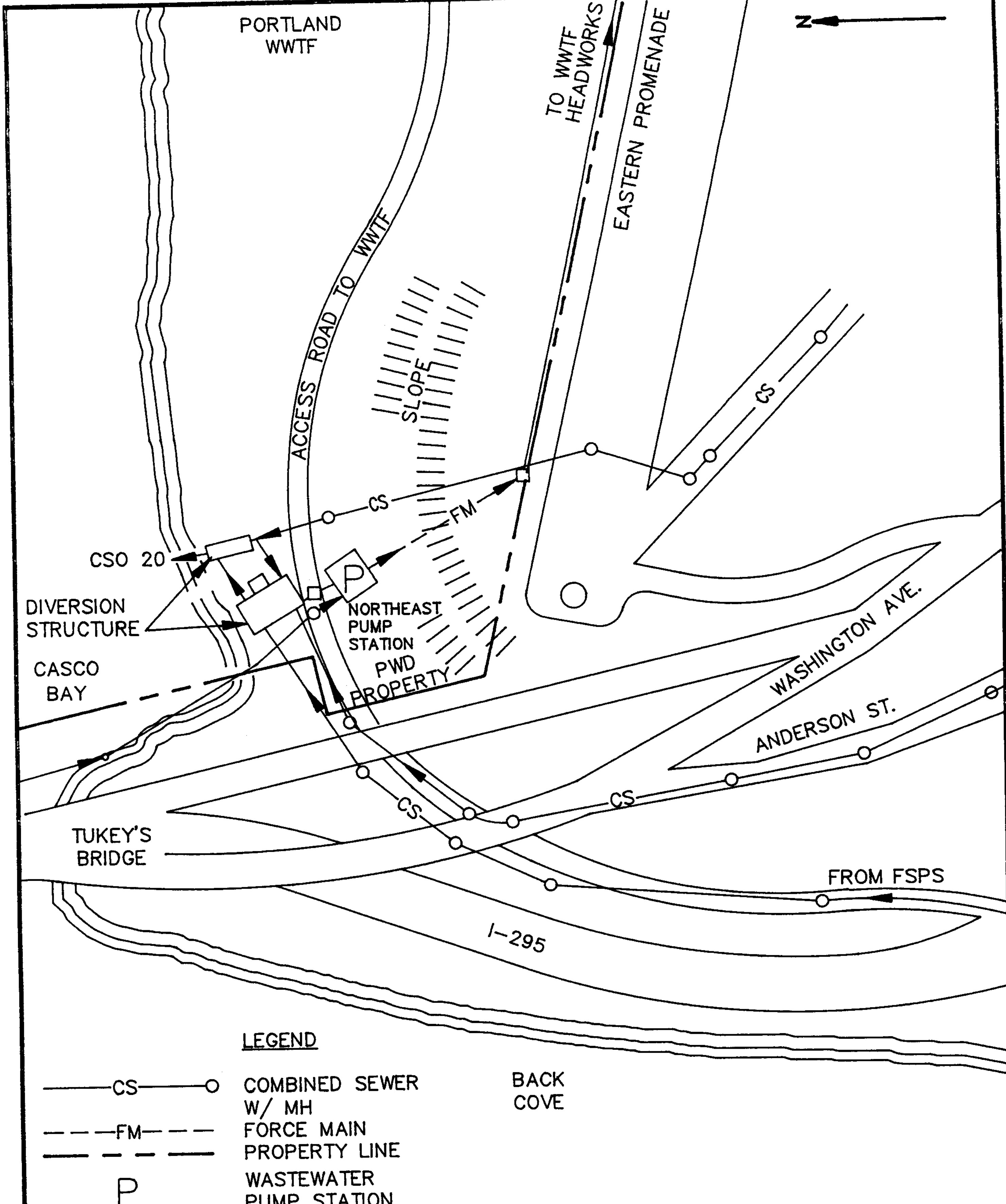

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Figure 5-2
Location of CSO 20

1506S5-3

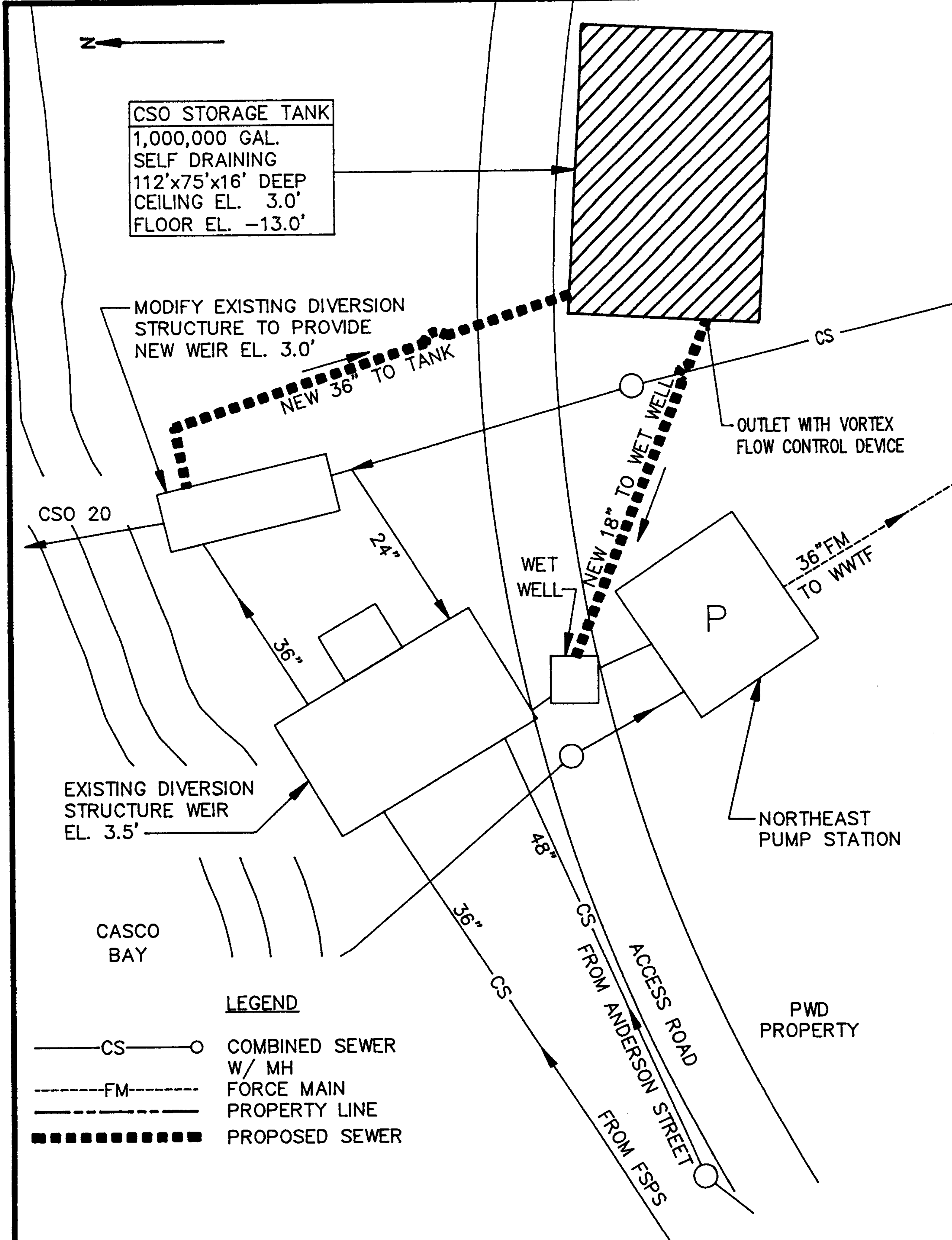

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Figure 5-3
Layout of Proposed Facility for CSO 20

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5.4 Presumpscot Estuary

CSO 2 (Arcadia Street) is the only overflow from the City of Portland into the Presumpscot Estuary. The drainage area of 25 acres is predominantly medium residential.

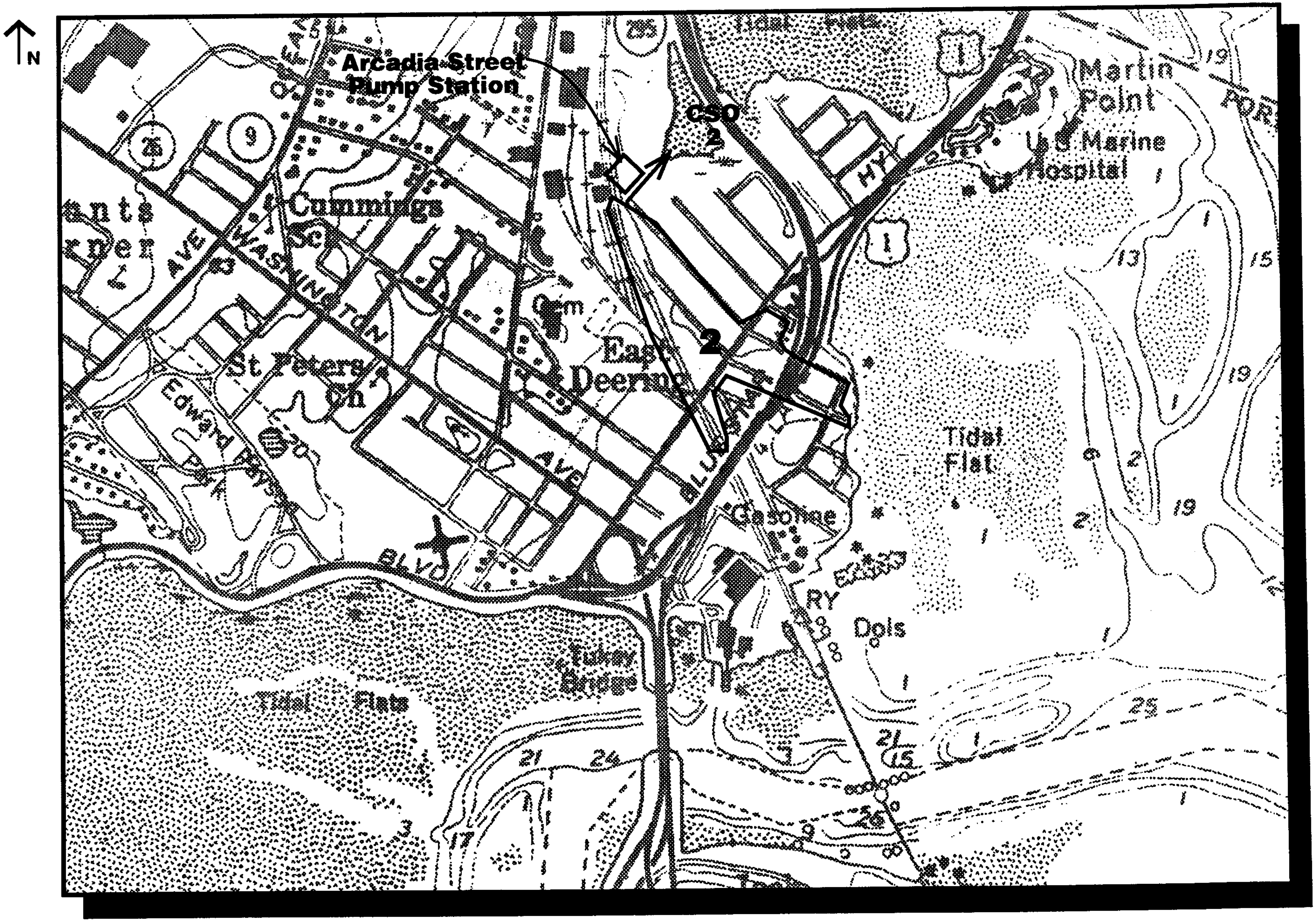
This particular section of the Presumpscot Estuary adjacent to CSO 2 has been separated from the larger portion of the Estuary by the construction of I-295 in the 1980s. Flushing in this smaller portion of the Estuary is constricted by a culvert under the highway. CSO 2 has been targeted as receiving a high level of CSO control for two reasons: 1) its proximity to residential areas and; 2) limited flushing in the receiving water.

Model results estimate that CSO 2 discharges a total of 1.8 million gallons over 13 events. There is some space available at the site for a storage facility; however, it is small and encroaches on the boundary of the wetland. CSO 2 can be cost-effectively eliminated by sewer separation. The location of CSO 2 and the proposed sewer separation area is highlighted on Figure 5-4.

5.5 Back Cove

The combined sewer system encircling Back Cove consists of three subsystems controlled by major downstream hydraulic structures: CSOs 5 through 7 are controlled by the hydraulic capacity of the Tukey's Bridge siphon and the conduit leading to the siphon; CSOs 8 through 16 are controlled by the Baxter Boulevard Pump Station; and CSOs 17 through 19 are controlled by the Franklin Street Pump Station and to some extent by the

Bos31506 Fig 5-4



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Portland CSO Abatement Study

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Figure 5-4

Location of CSO 2 and Proposed Sewer Separation Area

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Northeast Pump Station. There is also a hydraulic connection from CSO 12 to just upstream of CSO 17.

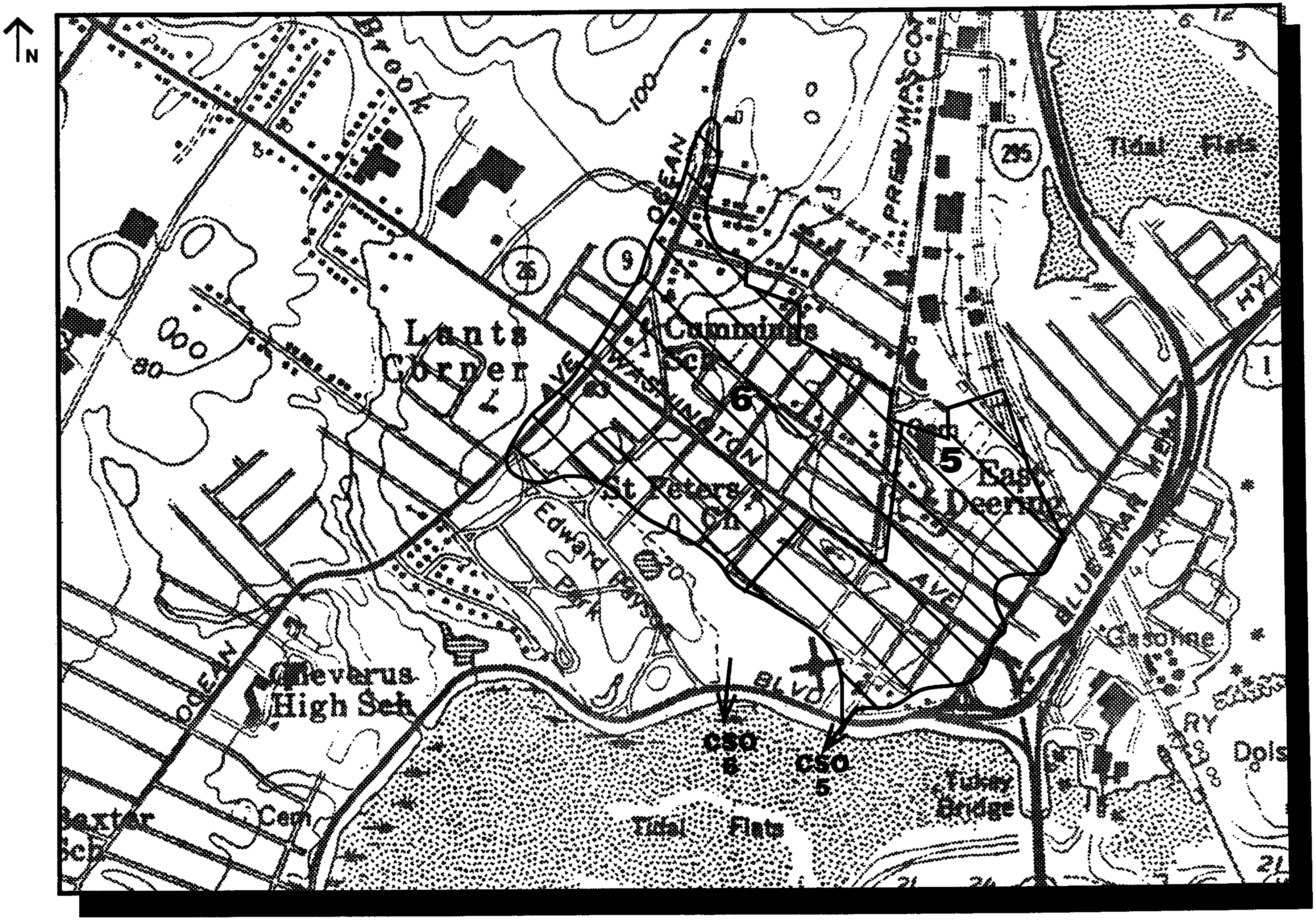
CSOs 5 and 6

CSO 5 (Randall Street). The drainage area to CSO 5 totals 74 acres. This drainage area is located between the northern bank of Back Cove and the southern bank of the Presumpscot Estuary. During the typical test year, CSO 5 had 34 events discharging a total of 100 million gallons annually. CSO 5 discharges a disproportionate amount of overflow for its drainage area size because of the hydraulics of the sewer system. The overflow weir at CSO 4 is approximately 15 feet higher in elevation than the overflow weir at CSO 5; therefore, flows exceeding the capacity of the Tukey's Bridge siphon overflow first at CSO 5.

CSO 6 (Johansen Street #2). The drainage area to CSO 6 totals 101 acres. The drainage area is located north of Back Cove, just west of drainage area 5. Vortex valves have been installed in catch basins to reduce the rate of inflow into the combined sewer system. A separate storm sewer system serving approximately half of the drainage area had been connected to the combined sewer system upstream of the CSO regulator structure. The City recently moved the connection to downstream of the CSO regulator structure.

Control of CSOs 5 and 6. CSO 6 discharges a relatively low volume compared to CSOs 5 and 7; however, the hydraulics between these three CSOs are interdependent. Overflows at CSOs 5 and 6 will be deactivated by: 1) installing a backflow preventor downstream of the CSO 5 regulator; 2) increasing the rate of pumping at the NEPS; and 3) providing partial separation of the drainage areas. Separation will be to the extent necessary to reduce the combined flow to a rate that can be conveyed by the East Side Interceptor. Figure 5-5 shows the locations of CSOs 5 and 6 and the proposed sewer separation area.

Bos31506 Fig 5-5



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Portland CSO Abatement Study

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Bos31506 Date: Oct. 1992

Figure 5-5
Location of CSOs 5 and 6
Proposed Sewer Separation Area

CSO 7 (Ocean Avenue/East Side Interceptor)

Of the 1,520-acre drainage area tributary to CSO 7, about 1,050 acres are served by combined sewers. The drainage area consists of the Fall Brook and Smith Creek watersheds with the East Side Interceptor being the major combined sewer facility.

Land use in the Fall Brook watershed is predominantly medium to low density residential with some commercial development along main streets such as Washington Avenue and Auburn Street and limited light industrial development along Canco Road near Rocky Hill. Large areas of the watershed remain open as woodlands, wetlands, or fields. Many of these open areas currently serve as runoff detention areas.

The East Side Interceptor (ESI), constructed in the 1950s to serve as a combined sewer, conveys sanitary flow and approximately 60 percent of the stormwater discharge of the watershed. The ESI was designed in 1949 to carry projected flows through 1989 (i.e., a 40-year design horizon). The remainder of the stormwater runoff is conveyed by the Fall Brook channel and its tributaries including Milliken Brook. However, at several locations brook flow is channeled into the ESI. Consequently, in many reaches the ESI conveys virtually all of the stream flow for small and medium storms. As a result, the brook channel has been overgrown with trees and bushes in many reaches and has been otherwise covered (e.g., parking lots) in other areas. Several areas of the watershed have separated sanitary and storm sewer systems.

A similar situation exists for the Smith Creek watershed that drains the Read-Bay Street area, which lies just to the east of the lower Fall Brook watershed. In this drainage the stormwater flow is conveyed entirely by the combined sewer which is tributary to the ESI at the Ocean Avenue regulator.

Definition of the CSO Problem. In essence, the CSO problem at the Ocean Avenue regulator is a stormwater management problem in the Fall Brook and Smith Creek watersheds. The ESI is designed to carry combined flow up to a certain rate. Use of the ESI for most of the Brook's stormwater flow results in several problems:

- Overflows at CSO 7; annually about 24 overflows and 100 MG.

- Surcharging of the ESI and its tributary sewers during large storms causing street and basement flooding upstream in the watershed.

- Surcharging of the combined interceptor draining the Smith Creek area causing flooding in the Read-Bay Street area.

The problems in the Fall Brook watershed can be expected to worsen as additional development occurs. Flooding during smaller storms and possibly CSOs directly to Fall Brook further upstream can be expected as additional stormwater is added to the ESI.

Recommendations. A drainage study of the Fall Brook watershed, completed by Hunter-Ballew Associates in 1985, recommended a plan involving continued use of the ESI along with re-establishment of the Fall Brook channel to handle separate stormwater flow. The report added that storm drainage capacity additional to that of the Brook may be required, based on cost and other factors. Through selective separation of combined sewer areas, disconnection of brook connections to the ESI and other measures, stormwater would be redirected to the Brook, off-loading the ESI. This study did not address, nor was it intended to address, CSO or water quality issues. Because the CSO problem in the Fall Brook and Smith Creek watersheds is directly related to stormwater management, most of the Hunter-Ballew study recommendations are, in fact, applicable for CSO control.

The recommendation for CSO control in the Fall Brook and Smith Creek drainages is to implement a watershed management program to progressively reduce wet weather flows to the ESI with the goal of eventually eliminating CSO 7. The program of watershed management will also resolve the street and basement flooding problems in the areas. The program will be accomplished through a variety of projects completed over a period of years. Overflows at CSO 7 will be reduced each year as the following steps are accomplished:

1. Reduce flow to the ESI and Smith Creek Interceptor by rerouting storm flows through flow slippage, selective separation, or other types of stormwater management controls in combined sewer areas.

2. Reduce flow to the ESI by eliminating direct connections of the Brook and its tributaries to the interceptor.

3. Require construction of stormwater management controls which minimize flow to the combined sewer system in areas of future development.

4. Rehabilitate the channels of Fall Brook and its tributaries to allow conveyance of the additional stormwater resulting from Nos. 1, 2, and 3 above.

5. Implement projects for both new and existing developments to control stormwater peak flows and water quality discharged to the brooks and, ultimately, Back Cove.

6. Modify the City's existing BMP program, focusing it on those separate areas of the watersheds that contribute the greatest stormwater pollutant loads.

7. Maintain enough flow to the ESI to maintain its effectiveness as a combined sewer and prevent solids deposition.

Figure 5-6 shows the recommended improvements.

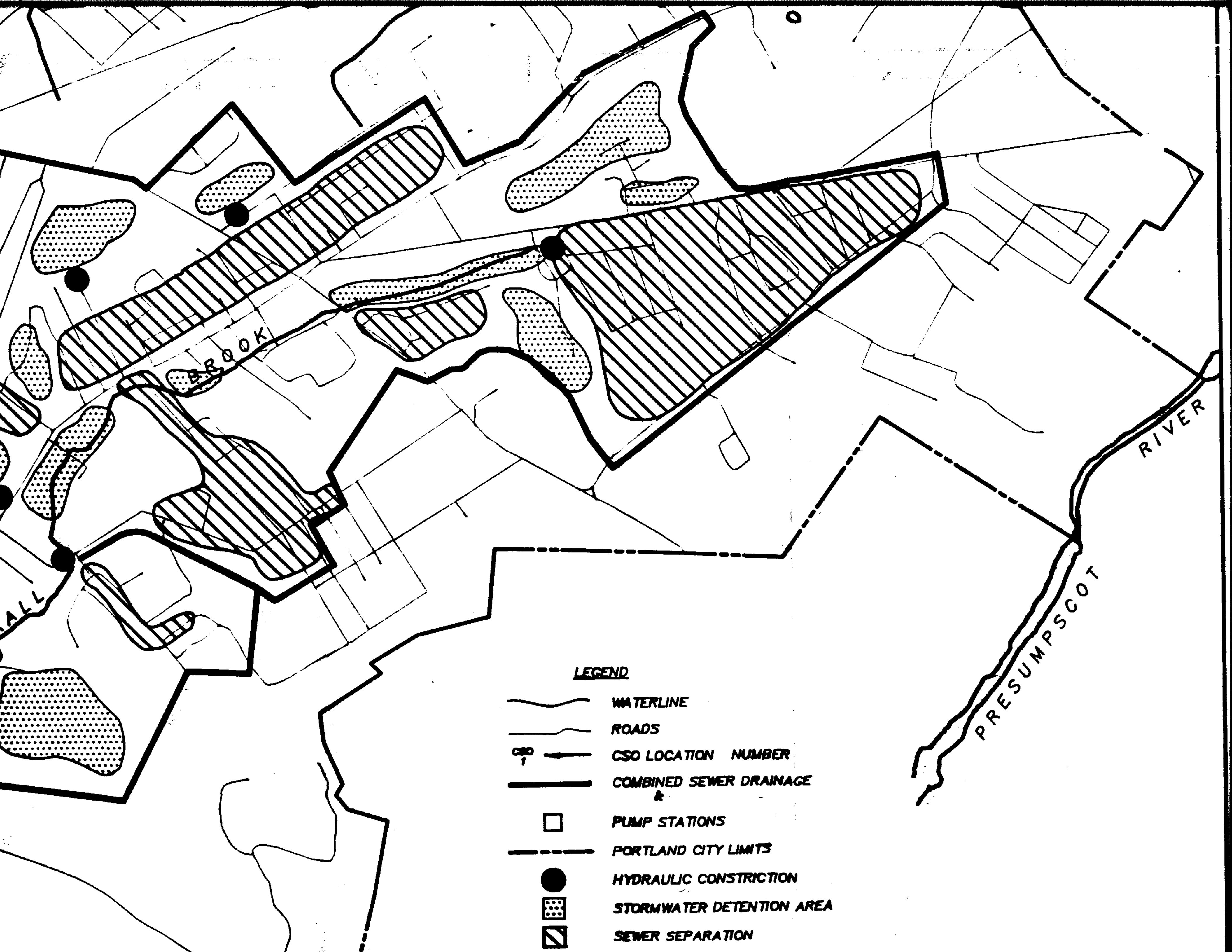
It will also be necessary to add stormwater conveyance capacity, probably in the form of an additional conduit, in locations where existing closed conduits are inadequate for the increased flow. The culvert under the Northport Shopping Center is such an example. Upstream stormwater management will be maximized to reduce the need for such facilities.

Rehabilitation of the Fall Brook channel will require removal of debris, vegetation, sediment accumulations, and constrictions to flow. Regrading of the channel to provide adequate conveyance will be required in many reaches. Several inadequately sized culverts, such as those at the Washington Avenue and Ray Street crossings, will have to be replaced.

This plan provides an excellent opportunity for the City to link the channel rehabilitation program with its long-standing plan to provide recreational benefits in the Fall Brook watershed. The channel improvements should be designed jointly with plans for bike trails, walking trails, ball fields, brookside parks, open space, and other features.

As discussed in Section 8, the program would be phased over a six to ten year period, consistent with City funding constraints and other water quality improvement programs. As discussed in Section 8.4, CSO 7 would be monitored regularly to track the progress in reduction of CSO frequency and volume as watershed management projects are implemented and to reevaluate the priority of future improvements.

In addition to construction funding, a plan for long term management of improvements must be developed. Watershed management will require monitoring operation and maintenance of stormwater facilities and maintenance of stream channels and recreational facilities, including mowing, debris removal, and equipment maintenance. As discussed


BROOK
ALL
PRESUMPSCOT
RIVER
LEGEND
WATERLINE
ROADS
CSO 1
CSO LOCATION NUMBER
COMBINED SEWER DRAINAGE &
PUMP STATIONS
PORTLAND CITY LIMITS
HYDRAULIC CONSTRICTION
STORMWATER DETENTION AREA
SEWER SEPARATION


BROOK
FALL
CSO 9
CSO 8
XTER BLVD.
MP STATION
CSO 7
ACK
OVE
CSO 6
CSO 5
LEGEND
WATERLIN
ROADS
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in Section 9, this plan must include provisions for funding future improvements and maintenance.

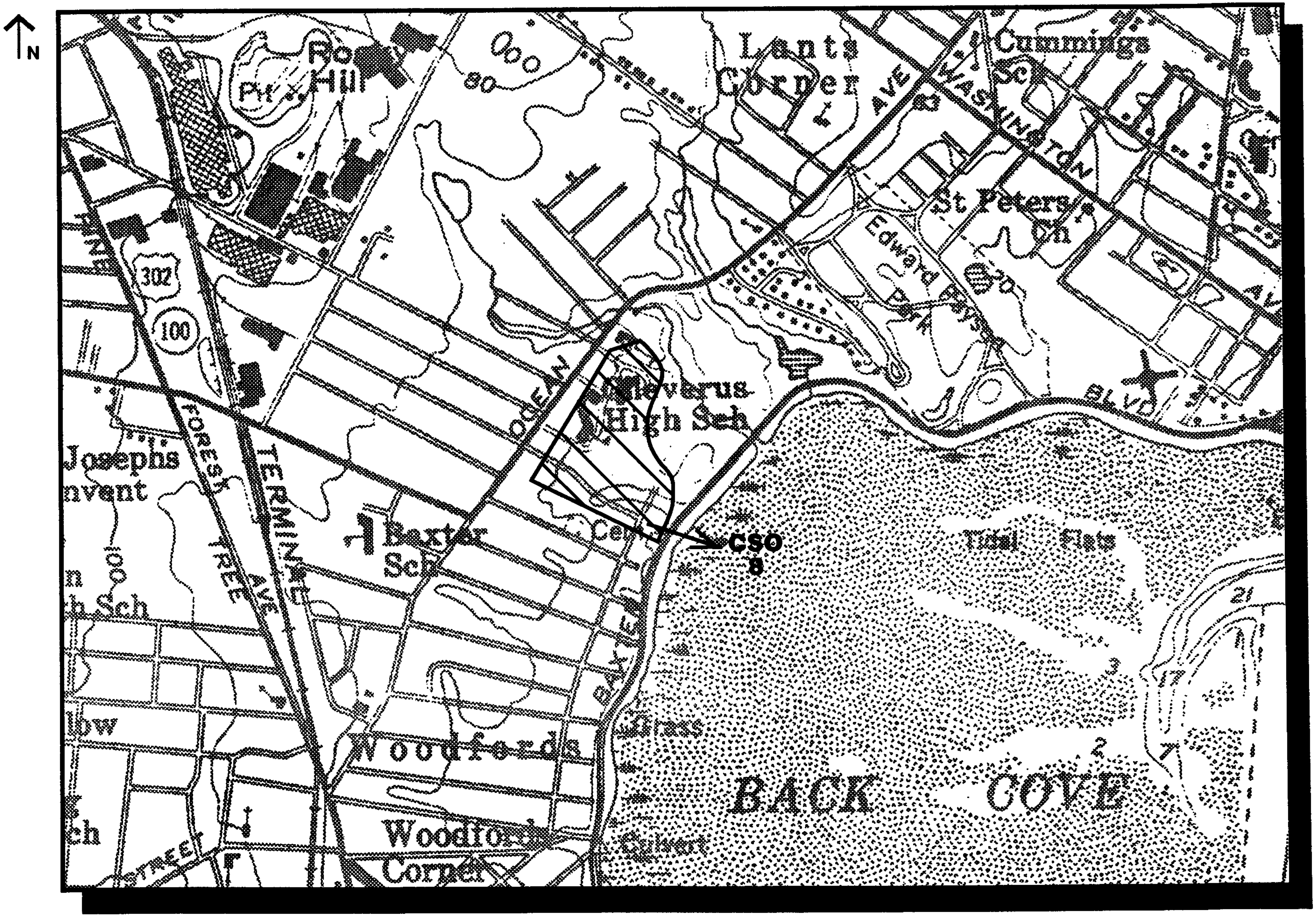
CSOs 8 and 9

The drainage area tributary to CSOs 8 (Clifton Street) and 9 (George Street) totals 18 and 6 acres, respectively. The area consists of medium-density residential neighborhoods. Annually, CSO 8 discharges 4 MG over 5 events. CSO 9 appears to be inactive. The drainage area tributary to CSO 8 has a limited number of catch basins that could be easily disconnected from the combined sewer and discharged to nearby drainage swales. It is recommended that the drainage area 8 be separated and that CSO 9 be evaluated for inactivation. Figure 5-7 identifies CSO 8 and the area proposed for separation.

CSOs 10-18 (Mackworth through Franklin Streets)

CSOs 10 through 18 extend from the western shore to the southern shore of Back Cove, covering a distance of approximately 8,000 feet. These 9 CSOs encompass drainage areas totalling approximately 1,200 acres. Numerous catch basins in drainage areas 10 through 16 have already been retrofitted with vortex valves to reduce the peak discharge rate to the sewer system. Because of the proximity of the CSO discharges to one another and the space along the banks of Back Cove adjacent to the existing sewer line, this area lends itself to the implementation of a storage conduit. The conduit would begin at CSO 10 and parallel the existing sanitary line, incorporating the flows from CSOs 10 through 18. During low flow periods in the Portland sewer system, the storage conduit can discharge by gravity to the Franklin Street Pump Station. A 10-foot-diameter conduit, 8,000 feet in length, consolidating CSOs 10-18 to a single relief at CSO 18, is recommended.

The Libbytown Sewer Separation Project was a two part emergency action and long-term planning study to evaluate alternatives for control of combined sewer surcharging and



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Portland CSO Abatement Study

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Figure 5-7
Location of CSO 8
Proposed Sewer Separation Area

surface flooding in the Libbytown section of Portland and particularly in the area around Hood Dairy. A recommended plan was developed to alleviate severe flooding in Libbytown and to provide some cost-effective CSO reduction. The Libbytown projects consist of the following:

- Sewer separation of upper Libbytown and the construction of a stormwater outfall tunnel under Douglass Street to a series of existing earthen basins which discharge through culverts to the Fore River

- Flow slippage of the Maine Medical Center area

- Flow slippage and construction of a 4,300 gpm stormwater pumping station at Hood Dairy

- Flow slippage of an area between Park Street, Cumberland Avenue, and Weymouth Street to Deering Oaks Pond with separation of the pond overflow from the combined sewer system

The greatest impact of the Libbytown projects on CSO reduction is at CSO 17.

The storage conduit located along Baxter Boulevard and north of Marginal Way and implementation of the Libbytown projects would reduce the overflow frequency of these 9 CSOs from 44 to 12 events and the volume from 210 to 70 MG. An overflow diversion structure for the storage conduit would include a baffle arrangement to limit solids and floatables from overflowing and enhance mixing for chlorination and dechlorination of the conduit overflow. This will substantially reduce the remaining CSO pollutant load to Back Cove. Sodium hypochlorite and a 30-minute detention time for average flow is proposed for chlorination; sodium bisulfate is proposed for dechlorination. Contact time is practically instantaneous for dechlorination. Chlorination and dechlorination chemical feeds would be housed in the FSPS. Variations of the length, diameter, and number of CSOs to be consolidated have been reviewed and debated. The actual configuration may not be finalized until design; however, an equivalent or greater level of control must be achieved in the receiving water. A location map and schematic layout of the conduit are presented on Figure 5-8.

CSO 19 (Diamond Street)

CSO 19 has a large drainage area (177 acres). However, it has limited CSO activity because of the hydraulics of the sewer system and its proximity to the NEPS. This CSO can be deactivated by increasing the NEPS pumping rate. Sewer system hydraulics and hydrology should be reviewed to confirm the feasibility of deactivating the outfall structure during normal precipitation events.

5.6 Portland Harbor

There are seven CSOs which discharge to Portland Harbor: CSOs 23 through 29 (India through West Commercial Streets). The drainage areas tributary to CSOs 23 through 29 are located in an area known as "The Peninsula," or "Old Port," section of Portland. The drainage areas total 451 acres. The peninsula is a developed and congested area with high volumes of commercial activity. Portland Harbor is lined with piers and supports several kinds of industrial and commercial activities.

Available land for construction of any kind of CSO control structure is limited. The surface elevation rises from Portland Harbor north to Congress Street and Cumberland Avenue, and then drops back down to Back Cove. It is recommended that the ISPS be utilized to its capacity and that the pumping rate at the ISPS be increased by 8 mgd to reduce overflows into the Harbor.

It is also recommended that flow slippage and in-system modifications be performed in this area to achieve a greater level of CSO control. Flow slippage appears feasible in

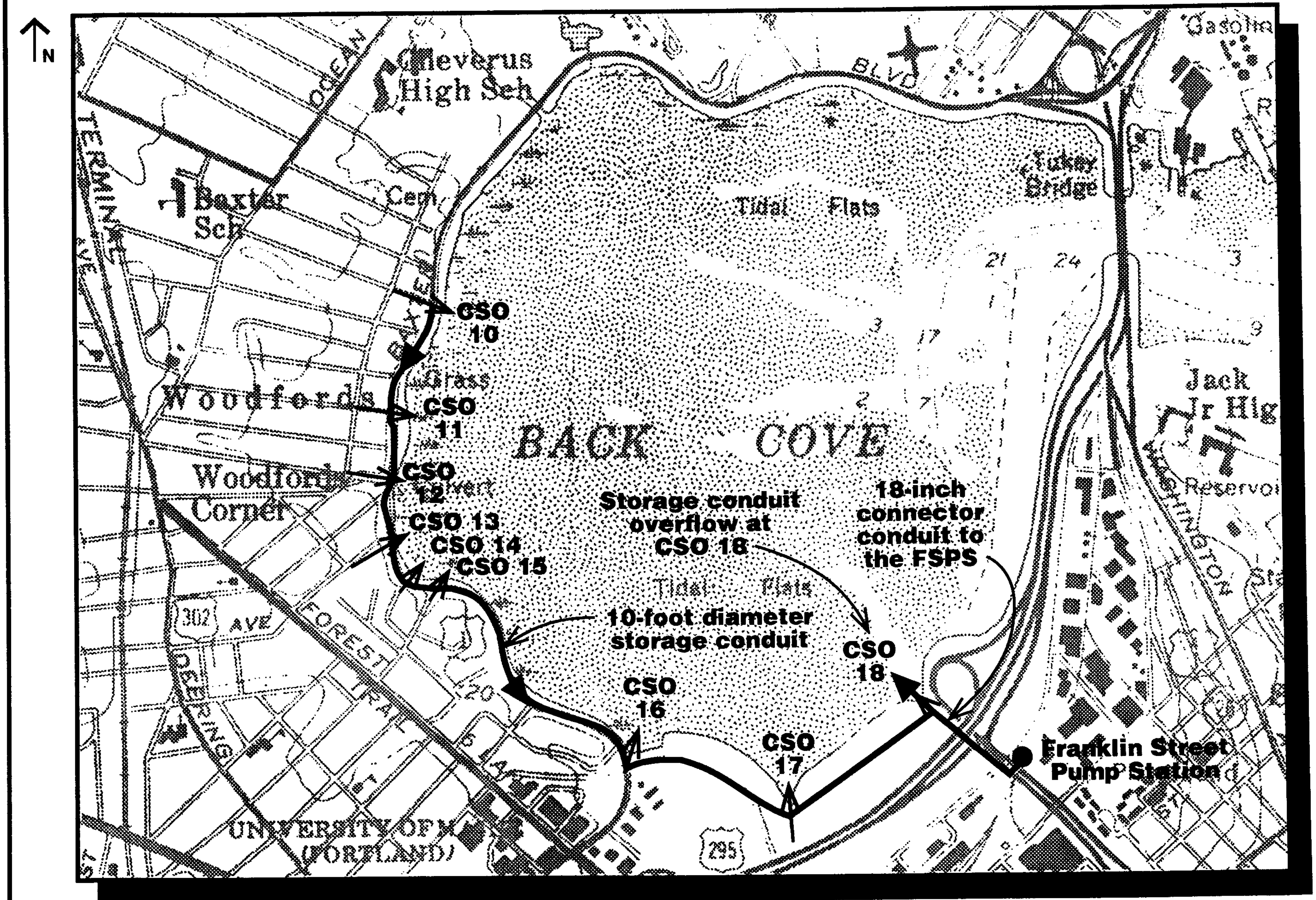

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Figure 5-8
Location of CSOs 10 Through 18 and the Proposed Storage Conduit

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drainage areas 23 through 29 in the area between Congress Street and Commercial Street and Western Promenade to Eastern Promenade. There is a separate storm sewer along Commercial Street to accept slipped flows. Some additional sewer separation in discrete locations may also be necessary to accept the large volume of slipped flows. Figure 5-9 shows the location of CSOs 23 through 29 and the proposed flow slippage area.

The City recently acquired land near the ISPS and south of the railroad tracks between the ISPS and Eastern Promenade. This land may provide potential for stormwater detention and pollutant load reduction prior to discharge to Portland Harbor.

5.7 Fore River

Eight CSOs discharge to the Fore River: 30 through 36 and 39. Their combined tributary area is 599 acres. Details of the proposed CSO controls are discussed in the following paragraphs.

CSO 30 (St. John Street)

Drainage area 30 totals 7 acres. Elimination of CSO 30 has been incorporated into the recommended plan for the Libbytown area of Portland. The Maine Medical Center area contributes large quantities of runoff to the Old Almshouse Sewer along Park Avenue in the center of Libbytown. This area will be separated as part of the Libbytown projects. Runoff from the hospital area will be collected and channeled to the Fore River with a conduit along St. John Street. Tieing additional storm laterals from CSO drainage area 30 into this conveyance line provides cost-effective elimination of CSO 30. Figure 5-10 shows CSO 30 and the proposed sewer separation area.

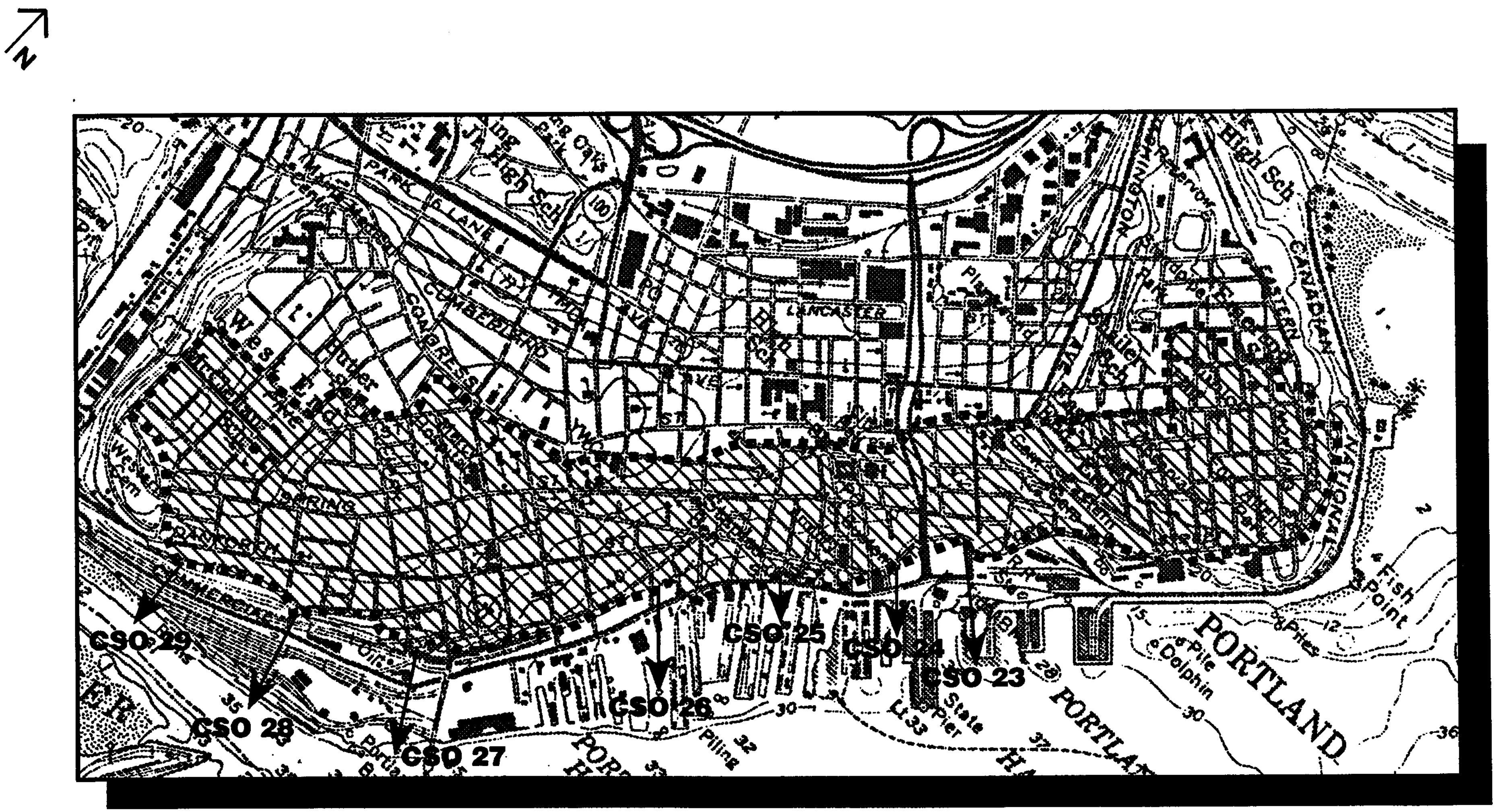

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Figure 5-9
Location of CSO's 23 Through 29 and Proposed Flow Slippage Area

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Bos31506 Fig 5-9

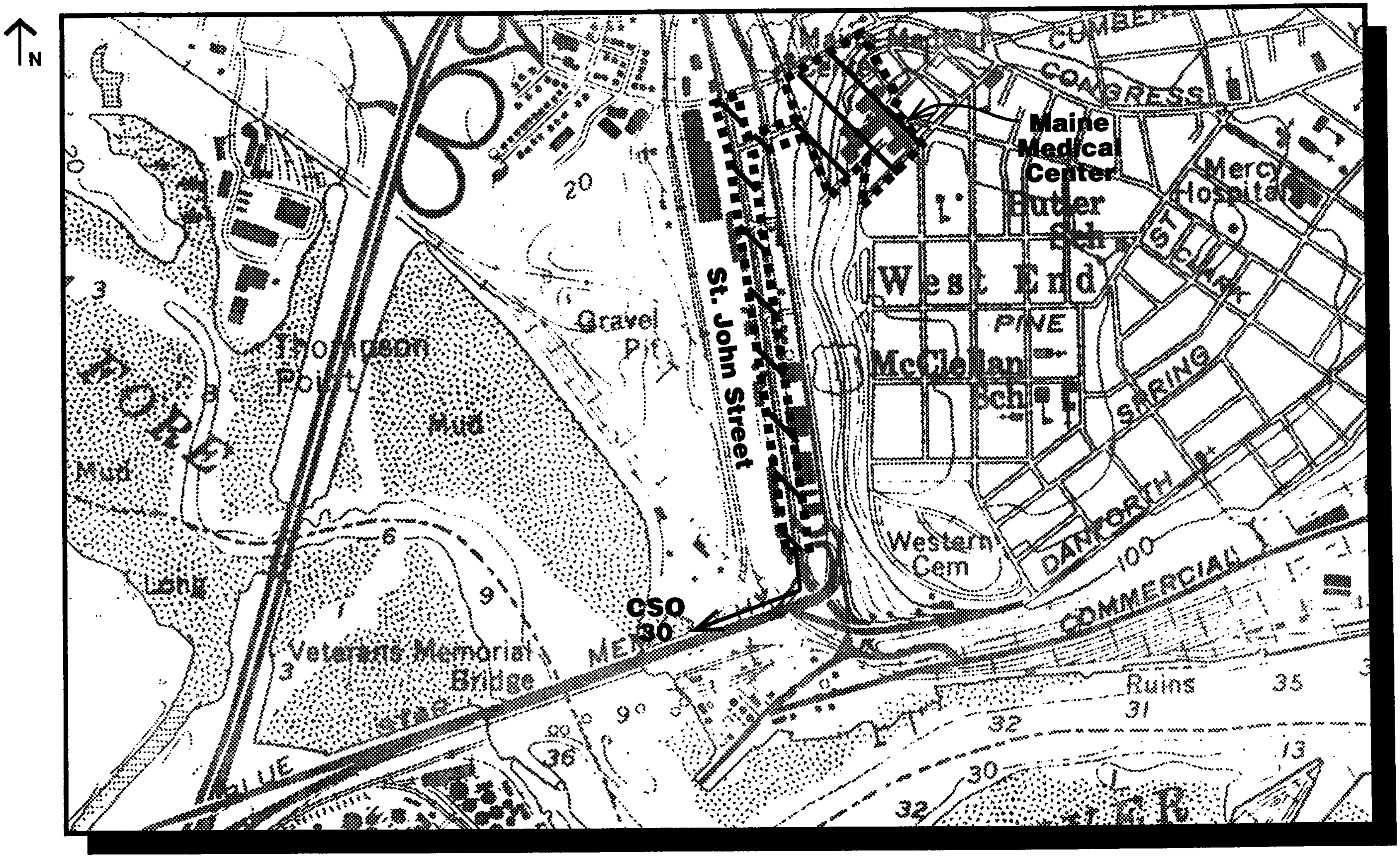

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Figure 5-10
Location of CSO 30 and Proposed Sewer Separation Area

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CSO 31 (Congress Street)

CSO 31 overflows to CSO 32 and is no longer an independent overflow.

CSO 32 (Thompson Point Pump Station)

Drainage area 32 totals 32 acres. The drainage area consists of medium-density residential areas mixed with some commercial and industrial areas. The industrial properties are adjacent to the Thompson Point Pump Station and the discharge location of CSO 32. CSO 32 is located on Figure 5-11.

Typical storm conditions indicate that CSO 32 has 14 overflows with a total volume of 0.8 MG. A cost-effective control alternative is to construct a 0.02 MG storage tank to capture CSO flows. Potential sites for this storage tank were examined, and the preferred location for the facility is near the Thompson Point Pump Station. A proposed layout of the storage facility is provided on Figure 5-12.

CSO 33 (Fore River Pump Station)

An area of 94 acres is tributary to CSO 33. The discharge location of CSO 33 is adjacent to the Fore River Pump Station. The area is predominantly residential with some commercial strips and some small industrial areas.

Typical storm conditions indicate that CSO 33 has two events with a total volume of 0.1 MG. Activity at CSO 33 is also impacted by flows from drainage areas upstream of the pump station; therefore, it is anticipated that actions taken to reduce CSOs upstream of CSO 33 will virtually eliminate overflows at CSO 33 as shown by the 100 percent reduction of CSO activity in Table 5-2. Sewer system hydraulics and hydrology should be reviewed to confirm the feasibility of deactivating the outfall structure during normal precipitation events.

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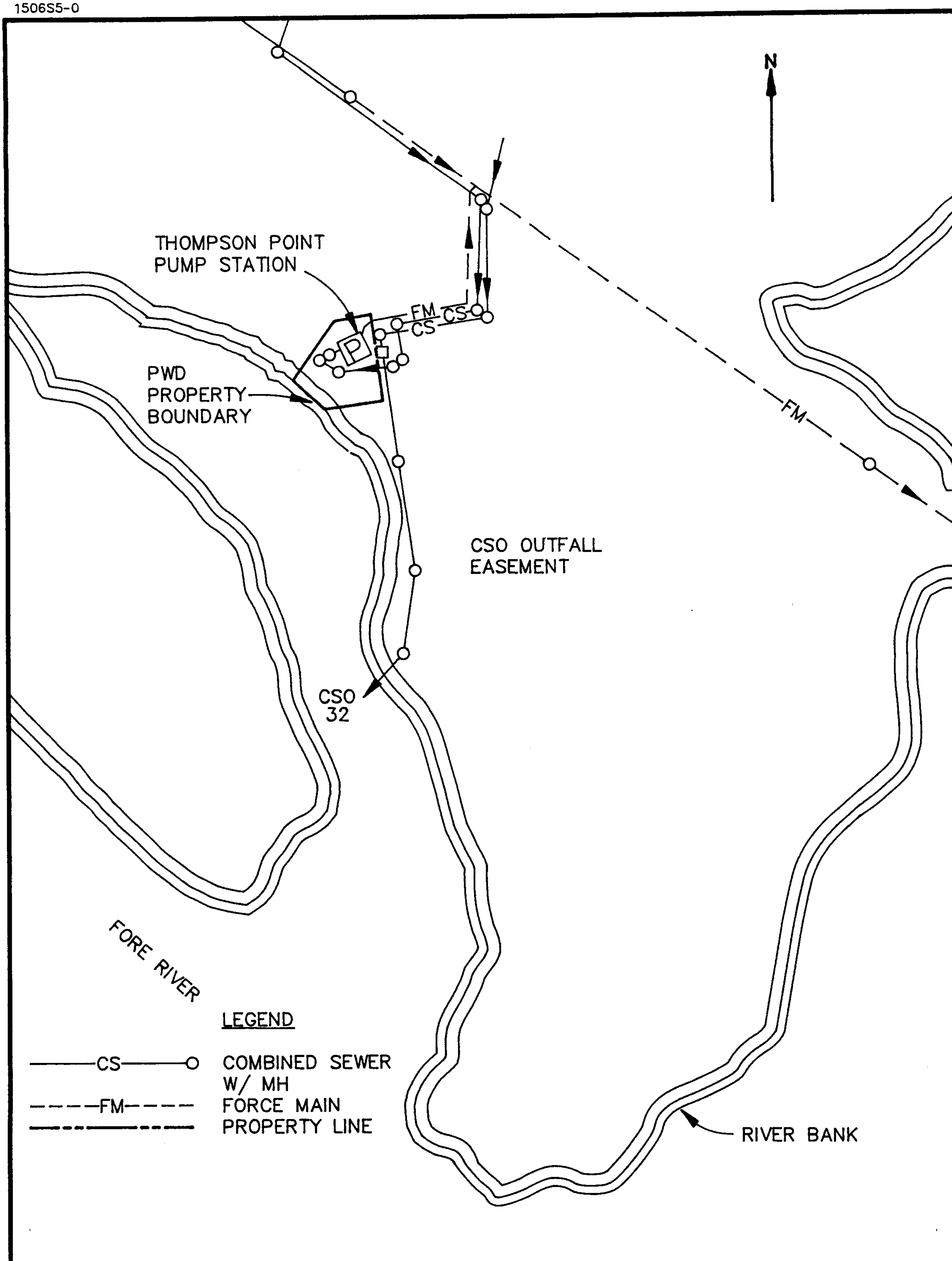

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Portland CSO Abatement Study

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Figure 5-11

Location of CSO 32

BOS31506 DATE: October 1992

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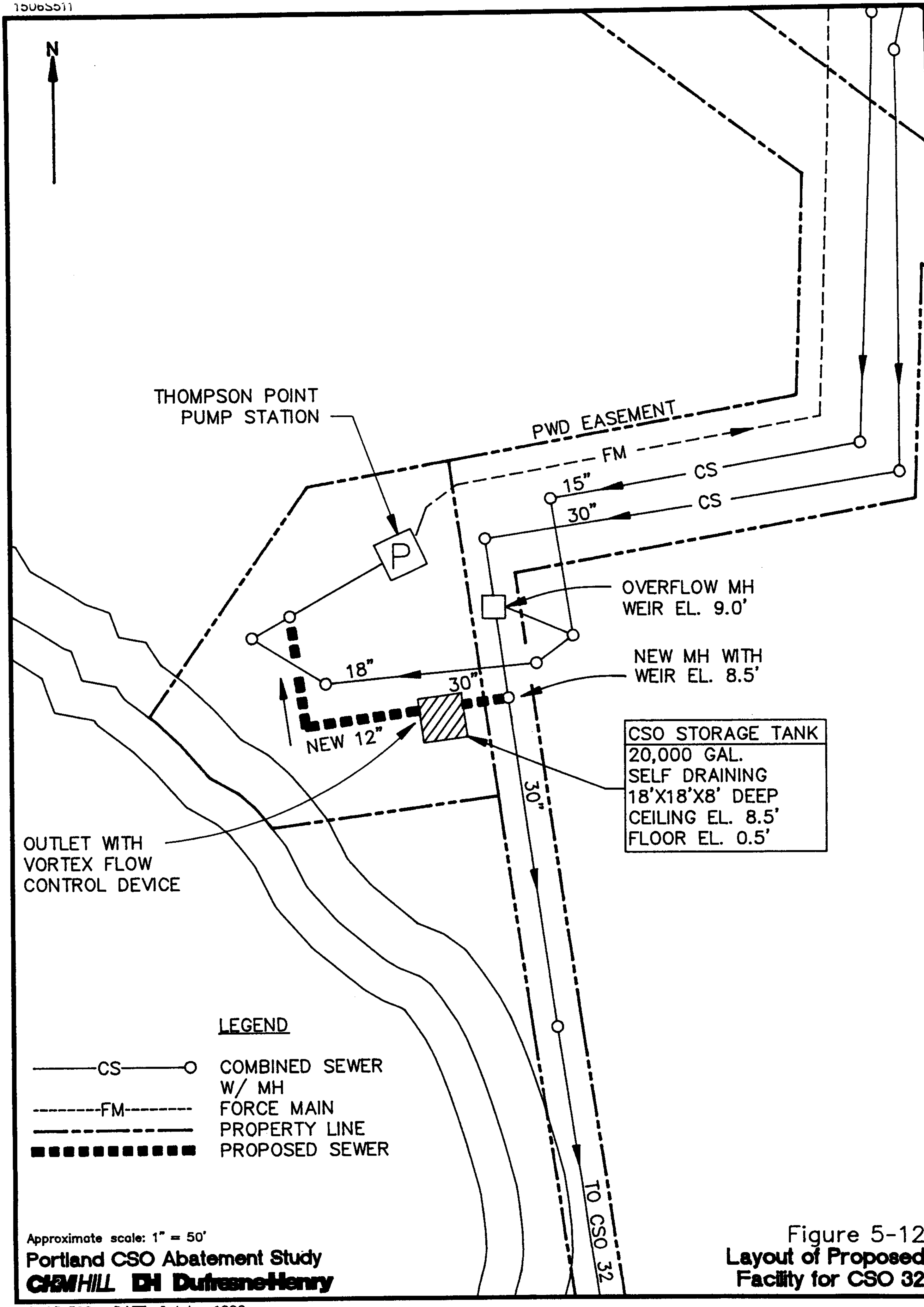

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Portland CSO Abatement Study

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Figure 5-12

Layout of Proposed Facility for CSO 32

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CSO 34 (Brewer Street)

Drainage area 34 consists of one residential street, Brewer Street. It drains an area totalling 3 acres. There are approximately 18 small overflow events annually with a total volume of 0.2 MG. Roof leaders can potentially be disconnected and rerouted to a drainage swale. The surrounding area has already been separated from the combined sewer system. It is recommended that Brewer Street be separated from the combined sewer system to eliminate CSO 34. Figure 5-13 depicts the drainage area.

CSO 35 (Stroudwater Road)

CSO 35 drains runoff from a small residential area totalling 11 acres. CSO 35 had an annual overflow volume of 0.2 MG from 10 CSO events. The area has a few catch basins connected to the combined sewer system, but no roof leader connections. The area is shown on Figure 5-14. The catch basins should be disconnected from the sewer system and rerouted to Capisic Brook and/or routed to a drainage swale.

CSO 36 (Capisic Pond Dam)

Drainage area 36 is one of the larger combined sewer areas; it totals 415 acres. The drainage area is predominantly residential and borders Capisic Brook and Capisic Pond. CSO 36 discharges downstream of Capisic Pond at the dam. The overflow combines with the pond overflow and discharges to the Fore River.

CSO 36 is a relatively large overflow. On the average, CSO 36 overflows 36 times annually with a total overflow volume of 68 MG. Land is limited in this area for the construction of a CSO storage facility. Construction of such a facility at the dam would involve costly modifications to the old dam structure, would most likely not be permitted by the U.S. Army Corps of Engineers, and would have negative environmental impacts.

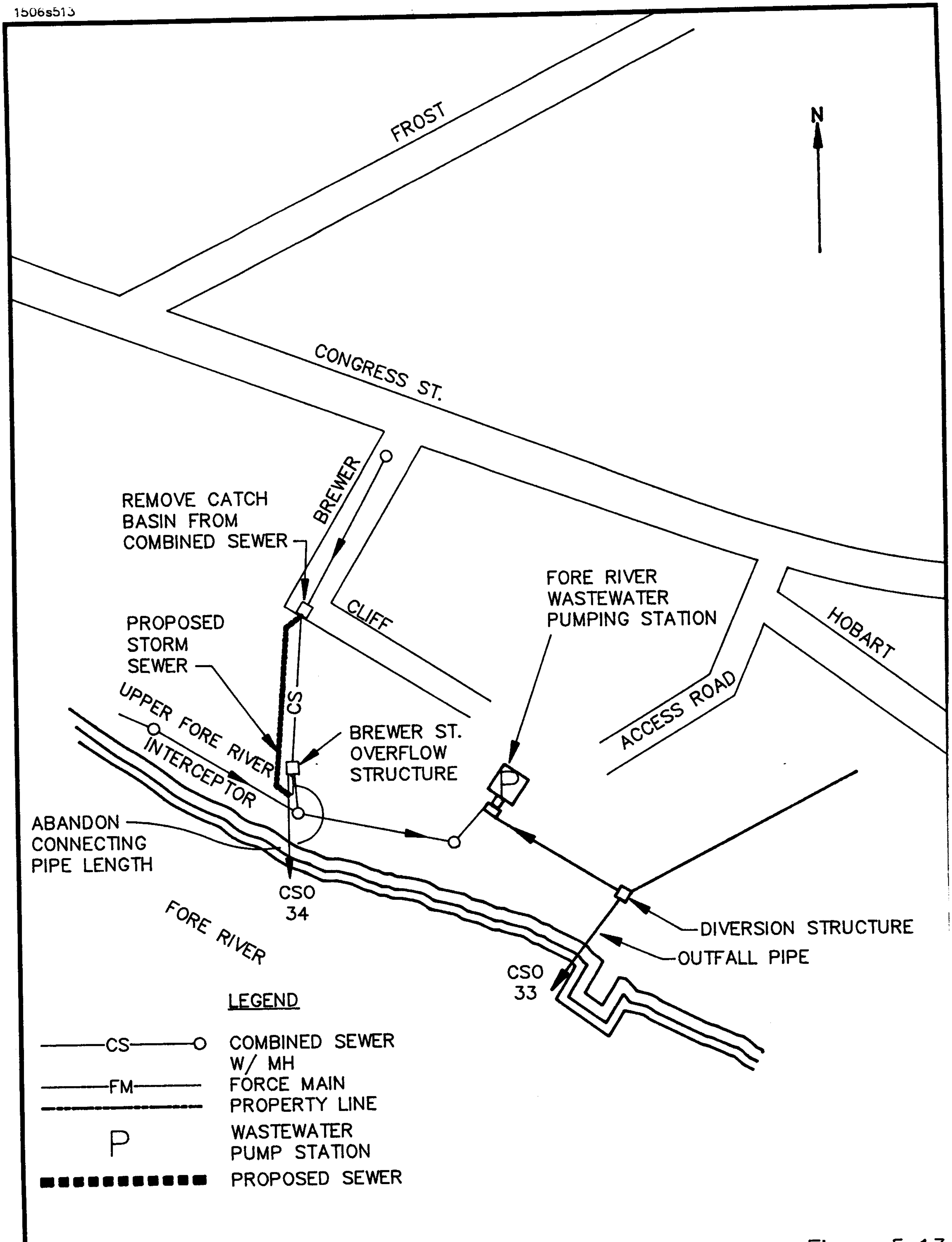

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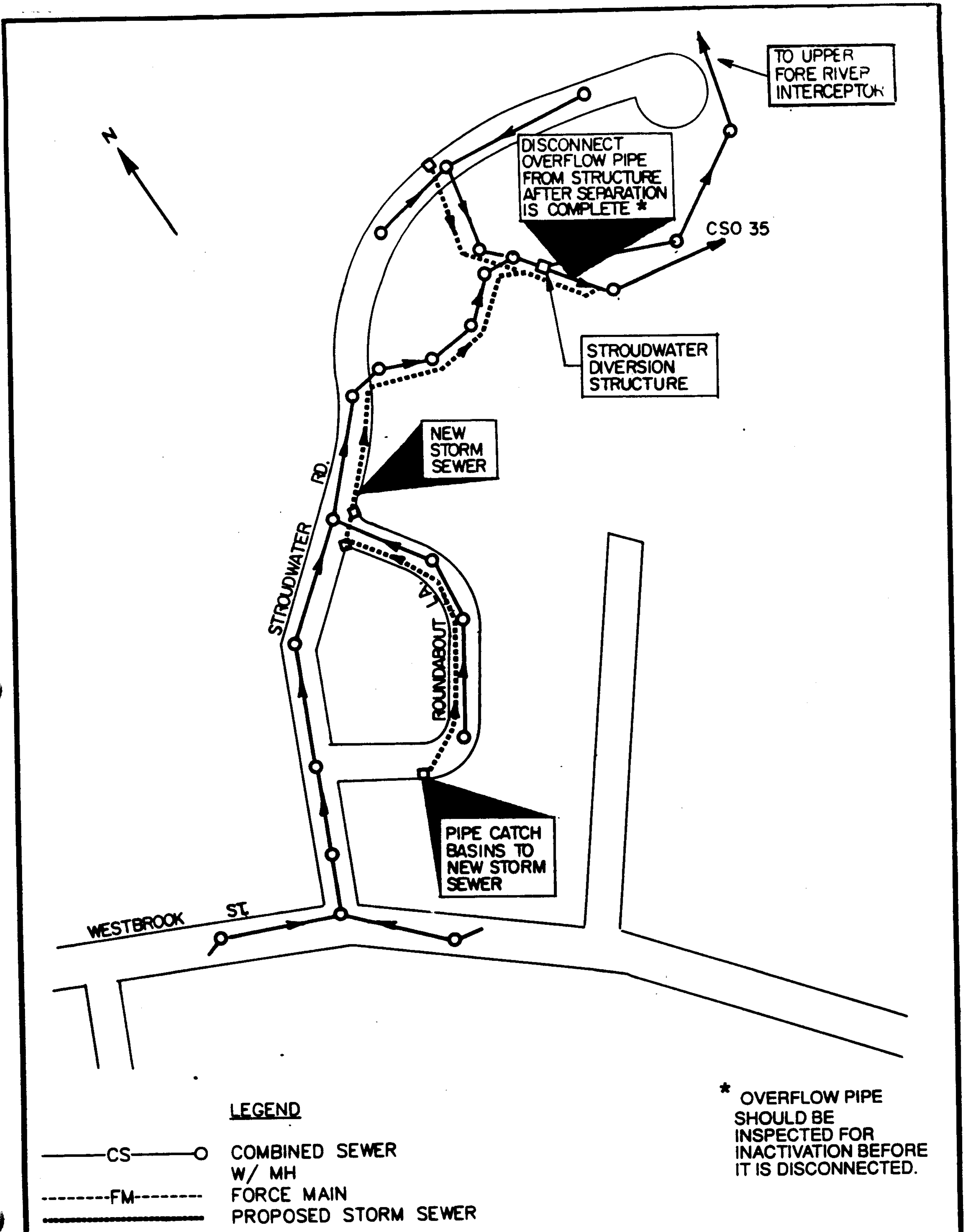
Figure 5-13
Location of CSO 34 and Proposed Sewer Separation Area



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Portland CSO Abatement Study

CH2MHILL Duffy&Henry (logo text partly illegible)

Figure 5-14
Location of CSO 35 and Proposed Sewer Separation Area

Bos31506 DATE: October 1992

Although CSO 36 discharges to the Fore River, CSO control alternatives recommended for this location apply to the whole Capisic Brook watershed. Therefore, CSO 36 will be discussed under Section 5.8 on the Capisic Brook.

CSO 39 (Rowe Street)

Drainage area 39 totals 37 acres. The overflow appears inactive. Sewer system hydraulics and hydrology should be reviewed to confirm the feasibility of deactivating the outfall structure during normal precipitation events.

5.8 Capisic Brook Watershed

Capisic Brook, which discharges to the Fore River just to the North of the Congress Street bridge, drains a total area of about 1700 acres. Of this area, approximately 826 acres is within the drainage area served by combined sewers. Sanitary and stormwater flow from the basin is conveyed by the Deering Center Combined Sewer and the West Side Interceptor, which join upstream of Capisic Pond to form the 10-foot-diameter West Side Combined Sewer. City Home Branch, which drains an area west of the Maine turnpike in Westbrook, and the Deering Branch, which drains the area west of the High School, are significant tributaries to Capisic Brook. Capisic Brook discharges to Capisic Pond just downstream of Brighton Avenue.

There are currently five overflows to Capisic Brook, CSOs 38-43. CSO 36 at Capisic Pond dam overflows downstream of the Pond and, therefore, primarily influences Fore River rather than Capisic Pond.

Land use in the watershed is primarily medium density residential, with some commercial development along Warren Avenue and an asphalt paving plant on Bishop Street. Evergreen Cemetery and a Central Maine Power power line corridor adjacent to the

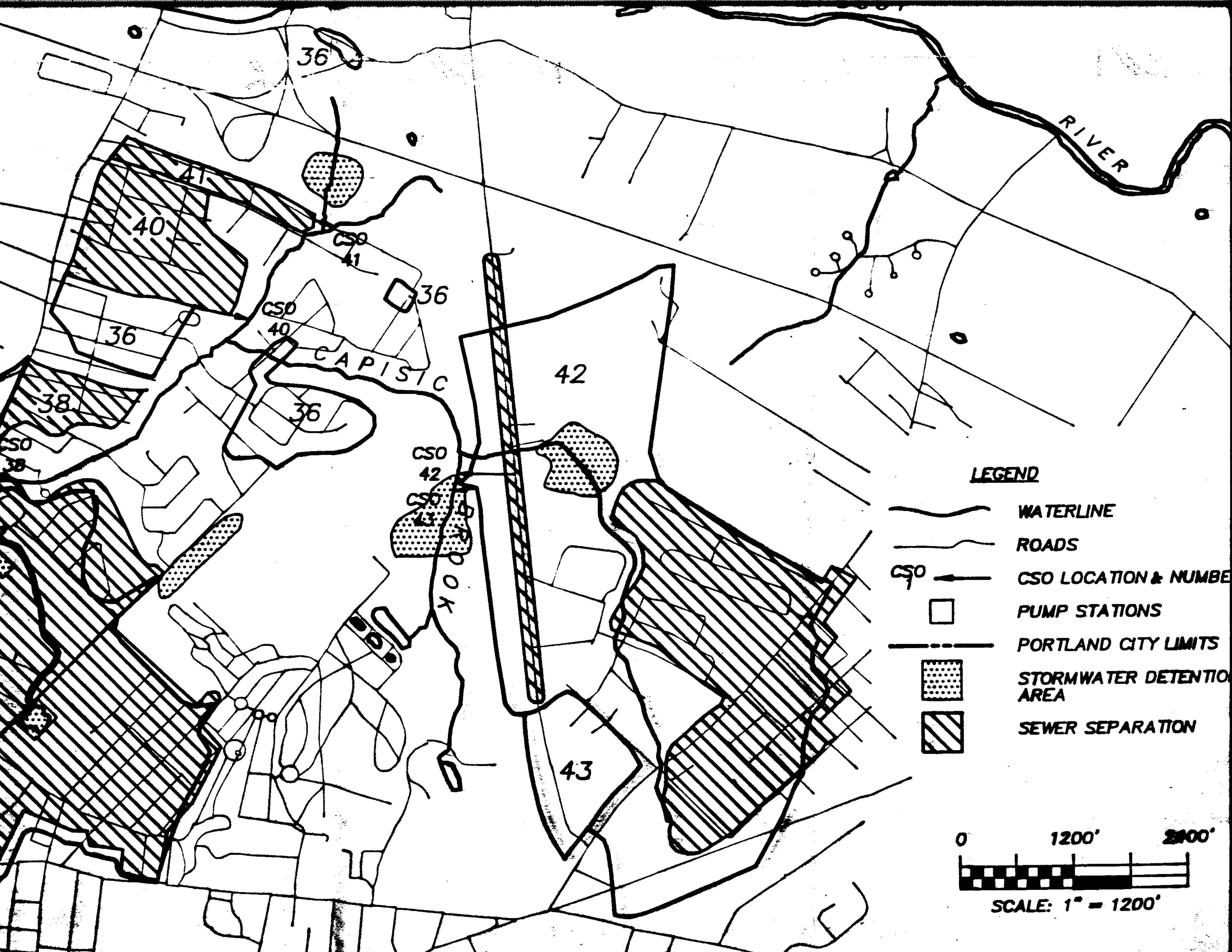
B&M Railroad embankment along Warren Avenue provide substantial open space in the upper watershed.

The City has several sewer separation projects in the watershed in various stages of progress towards completion, including the Sagamore Village area (completed), the Bishop Street area (underway), the Holm Street-Taft Street area (scheduled), the Avalon Road area (scheduled), the Deering Center area (planned), and the Colonial Road area (planned).

Definition of the Problem. CSOs along Capisic Brook are the result of the continuing development of the watershed with addition of increased stormwater runoff to the combined sewers to the point of exceeding capacity of the conduits. The rerouting of Brook flow into the interceptors also worsens the problem. Combined sewers appear to now be at capacity during wet weather, resulting not only in CSOs to the Brook but also in additional surcharging and flooding of residences in the Alden Circle, Wayside Road, Lucas Street, Violette Hill, and Dennett Street areas. CSO activity, in terms of frequency and volume of overflow, under existing conditions were shown on Table 5-2. In several locations, residential development has seriously encroached on the narrow Capisic Brook channel, resulting in street, yard, and some basement flooding.

Recommendations. The recommended plan for the Capisic Brook CSOs is implementation of a watershed management program, similar to that proposed for the Fall Brook watershed. Areas proposed for sewer separation are shown on Figure 5-15. Areas in which stormwater detention would be feasible are also shown on Figure 5-15. Other stormwater management practices that may be incorporated include wet and dry detention basins, infiltration trenches and swales, in-channel check dams, and use of constructed wetlands for storage and treatment. The plan include the following components:

1. Closure of **CSO 43** after completion of the Bishop Street and Warren Avenue separation projects (currently scheduled by the City).



RIVER
CAPISIC
BROOK
36
36
36
36
36
40
41
38
42
43
CSO 41
CSO 40
CSO 42
CSO 43
CSO 38
LEGEND
WATERLINE
ROADS
CSO LOCATION & NUMBE
PUMP STATIONS
PORTLAND CITY LIMITS
STORMWATER DETENTIO AREA
SEWER SEPARATION
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1200'
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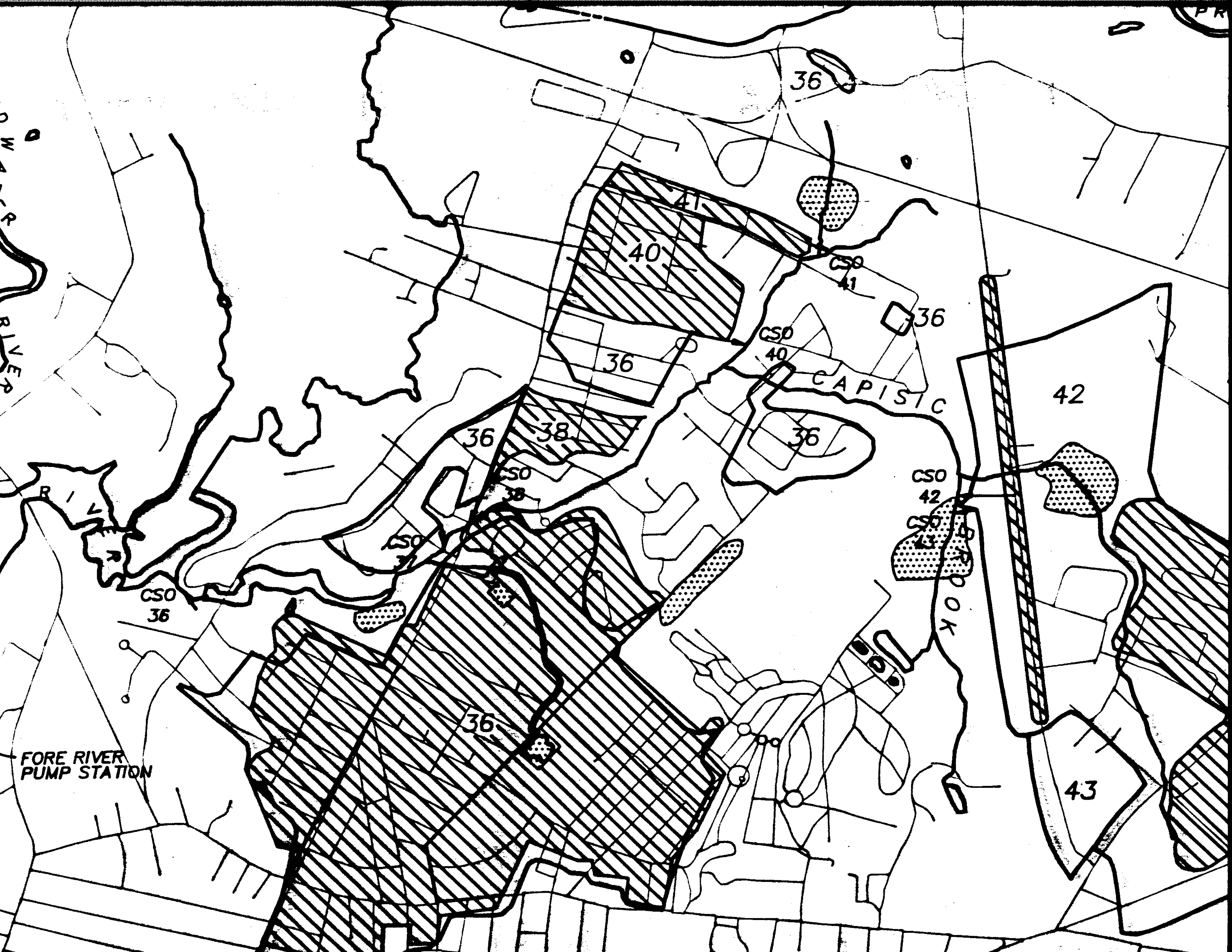
SCALE: 1" = 1200'



36
41
40
CSO 41
36
CSO 40
CAPISIC
42
36
36
38
36
CSO 42
CSO 43
BROOK
CSO 36
36
FORE RIVER PUMP STATION
43

2. Separation of Belfort Street-Commonwealth Drive area and elimination of the direct connection of the brook to the storm sewer adjacent to the tennis courts on Forest Avenue at Avalon Road. This will virtually eliminate overflows at **CSO 42** and allow for its closure.

3. Addition of stormwater management practices and BMPs to control the rate and quality of stormwater discharge from the upper reaches of the Warren Avenue branches of Capisic Brook.

4. Separation of the Brighton Avenue area from Kent to Dennett Streets allowing inactivation of **CSO 38** during normal precipitation events.

5. Separation of the Holm Avenue area, planned for the Spring of 1993, allowing inactivation of **CSO 41** during normal precipitation events.

6. Disconnection of Brook inflow to the West Side Combined Sewer and West Side Interceptor. Also, disconnection of the direct inflow of the Brook to the sewer system behind Mt. Sinai Cemetery.

7. Improvements to the Capisic Brook channel to increase its capacity to convey storm flows without flooding.

8. Construction of a stormwater detention facility and use of BMPs to control stormwater quality from the area west of I-95.

9. Construction of a new sanitary sewer parallel to the West Side Combined Sewer and/or use of the existing parallel 24-inch sanitary sewer to convey separated sanitary flow to the 30-inch sewer downstream of CSO 36.

10. Separation of the remaining combined sewer area tributary to CSO 36. This, in conjunction with No. 7 above, will allow use of the 10-foot West Side Combined Sewer as a storm sewer discharging at the existing location at Capisic Dam. **CSO 36** will thus be inactivated during normal precipitation events.

11. Implementation of BMPs (or modification of existing practices) and use of stormwater management practices (vegetative strips, etc.) to control stormwater quality from separated areas.

12. Use of the 10-foot West Side Combined Sewer for stormwater only would reduce the flow that the Brook channel would have to carry under the proposed plan.

The recommended plan is proposed with consideration of the long-term goals of the City for the Capisic Brook watershed. These goals include development of the natural trail system through the watershed, enhancement of the Capisic Pond, creation and protection of wetlands, protection of remaining open space, and remediation of the local flooding problems. Combined sewer overflows to the Brook and Pond are inconsistent with these high use, high visibility goals.

5.9 Key Issues of the Recommended Plan

Key issues to be considered as part of implementation of the recommended plan for the Fall Brook and Capisic Brook Watersheds include:

- Public acceptance and support of the Fall Brook Watershed plan, especially from those neighborhoods directly affected by channel improvements and construction

- Acquisition and use of land in the Fall Brook Watershed for public purposes rather than development, including the potential need to rezone to control the ultimate level of development

- City control of the Fall and Capisic Brook waterways, through easement, acquisition, or other means in order to develop and maintain the brook systems

- Legal issues related to safety and liability for ownership and management of brook systems that serve multiple public purposes

- Brook systems capable of handling increased stormwater flows without causing flooding of surrounding areas

- Combined sewer system hydraulics in drainage areas tributary to CSOs 42 and 43 capable of handling peak rainfall derived infiltration/inflow

Key issues to be considered as part of implementation of other aspects of the recommended plan include:

- CSO closure performed only after thorough investigation of sewer system hydraulics and hydrology is performed to verify inactivation during large storm events

- Future federal and state CSO, stormwater, and waste discharge (NPDES) regulations

5.10 Sewer System Optimization Plan Development

The 1992 Draft CSO Policy, summarized in Section 4, proposes that permit holders immediately implement nine minimum controls. To present progress towards this goal, a sewer system optimization plan was developed to demonstrate compliance of the nine minimum, technology-based controls previously presented. Information collected to date and recommendations for future actions are provided herein.

Measure 1: Proper operation and regular maintenance programs for the sewer system and the combined sewer overflow points

There are over 200 miles of sewers. Maintenance of the combined sewer system includes: clearing and dragging sewers prone to blockage and sedimentation buildup, combined sewer flushing, cleaning and rebuilding catch basins, and inspection of all CSO regulator and discharge points. Several sewers key to the operation of the system have been targeted for frequent inspection and cleaning.

Recommendation: Maintain procedures and documentation of activities performed for routine inspection and maintenance of the sewer system and the CSO structures.

Measure 2: Maximum use of the collection system for storage

The City currently maintains a sewer separation and rehabilitation program which includes infiltration/inflow (I/I) reduction, a roof leader and sump disconnection program, and pollutant control programs, as described in Section 1. These programs will provide the sewer system with increased capacity.

Recommendation: Consider expansion of existing programs or other programs where appropriate, such as installing or raising in-system weirs to create storage without creating sewer backups; some locations have already been identified in the Recommended Plan.

Measure 3: Review and modification of pretreatment programs to assure CSO impacts are minimized

The City has an Industrial Pretreatment Program to monitor commercial and industrial discharges to the combined sewer system. The program is highlighted in Section 1.

Measure 4: Maximization of flow to the WWTF for treatment

Modifications to the pump station and the WWTF to maximize flow through the plant during wet weather are included in the Recommended Plan.

Measure 5: Prohibition of CSO discharges during dry weather

Implementation of the City's routine inspection and maintenance of the sewer system and overflow structures is a preventive measure to ensure that CSO discharges do not occur during dry weather.

Measure 6: Control of solid and floatable materials in CSO discharges

Control of solid and floatable materials in CSO discharges is addressed in the Recommended Plan. In addition to recommended BMPs, storage facilities proposed in the Plan are to be designed to maximize retention of solids and floatables in the conveyance system for handling at the WWTF.

Measure 7: Pollution prevention programs that focus on containment reduction activities

The City of Portland has a variety of pollutant control programs as described in Section 1.

Recommendation: Maintain documentation on the programs in place and consider including activities such as pesticide and fertilizer use, proper disposal methods, and water conservation.

Measure 8: Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts

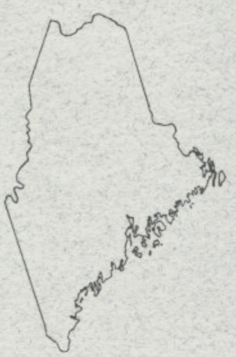
A public participation program has been included as part of this Study and will be continued through implementation of the Recommended Plan. The public participation program has educated the public on the impacts of CSOs and their controls.

Recommendation: In accordance with the requirements of the National Pollutant Discharge Elimination System (NPDES) Permit, signs should be posted at every CSO location to notify the public of the presence of a CSO discharge point. A notification plan should be developed to notify the public of a CSO occurrence and potential impacts such as beach closings (i.e., notification in daily paper or on local television).

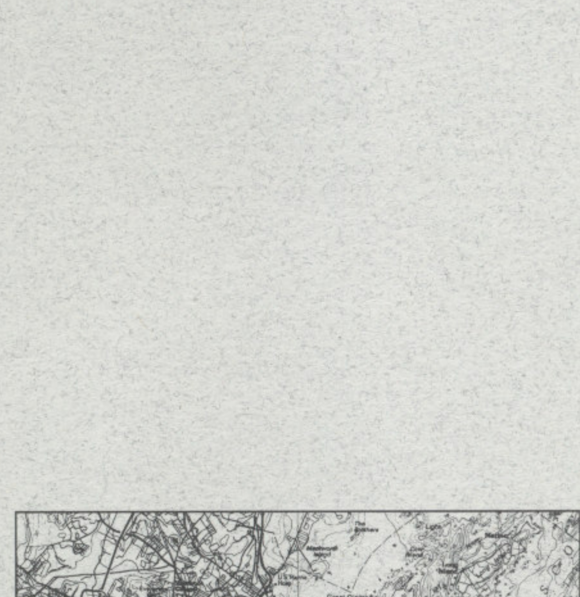
Measure 9: Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

A monitoring program was conducted for the CSO Abatement Study Plan and the 1983 I/I Study. A computer model has been developed for the sewer system, as discussed in Section 3, to characterize CSO activity for a variety of rainfall patterns and to estimate the reduction in CSO activity as improvements to the system are implemented.

Recommendation: Additional monitoring requirements to aid in implementation of the Recommended Plan are proposed in Section 8.



Cost Estimates



Section 6
Cost Estimates

Implementation of the recommended plan will require major financial commitments by the City and the Portland Water District. These include capital costs for design, construction, and land acquisition, and annual costs for operation, maintenance, and monitoring.

During the development of this Master Plan, cost estimates were prepared at several stages to define cost trade-offs for the screening, evaluation, and selection of alternatives. This section provides planning level cost estimates consistent with the data available and analyses performed during development of the recommended Master Plan. They are a refinement of the order-of-magnitude estimates presented in TM 6 and used in the analysis presented in Section 4. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scopes, implementation schedules, and other variable factors.

A summary of estimated construction, capital, and annual O&M costs for the recommended CSO Abatement Plan is included in Table 6-1. Construction costs are adjusted to an Engineering News Record (ENR) Construction Cost Index (CCI) of 5000. Construction costs should be updated periodically during Master Plan implementation. A 15 percent allowance for additional planning and design and a 20 percent allowance for contingency has been added to the construction costs to determine capital costs.

Estimates do not include costs for land acquisition, easements, and rights-of-way, or for legal services. The assumptions used to develop the construction cost estimates are explained in Section 6.1. Tables are provided giving a breakdown of cost estimates for projects that include several components. These tables also include present worth and annual cost calculations, which are discussed in Section 6.4. The financial impacts of

Table 6-1
Portland, Maine CSO Abatement Master Plan
Summary of Estimated Costs

Receiving Water and CSO Number	Project/Activity (Note 1)	Size/Length (Note 1)	Construction Cost	Capital Cost (Note 2)	Annual O&M Cost
Systemwide Projects					
	Portland WWTF Capacity Improvements		$284,000	$384,000	$6,700
	ISPS and NEPS Improvements		$185,000	$250,000	$7,200
	Benchmark and Compliance Monitoring		—	$16,000	$7,200
	Revision of Stormwater Management Regulations		$15,000	$20,000	$0
Subtotal			$484,000	$670,000	$21,100
Casco Bay					
CSO 1	Olympia Street Sewer Separation	350 LF	$44,000	$59,000	$700
CSO 3	Berwick Street Outfall Closure		$1,000	$1,000	$0
CSO 4	Tukey's Bridge Siphon Outfall Closure		$1,000	$1,000	$0
CSO 20	Northeast Pump Station Storage Facility	1 MG	$1,348,000	$1,819,000	$35,200
CSO 21	Quebec Street Flow Slippage		$269,000	$363,000	$4,000
Subtotal			$1,663,000	$2,243,000	$39,900
Presumpscot Estuary					
CSO 2	Arcadia Street Sewer Separation	2,100 LF	$210,000	$284,000	$3,200
Back Cove					
CSO 5	Randall St. Sewer Separation; Backflow Prevention	2,630 LF	$273,000	$369,000	$4,100
CSO 6	Johansen Street Sewer Separation	6,220 LF	$622,000	$840,000	$9,300
CSO 7	Fall Brook Projects		$8,450,000	$11,408,000	$237,400
CSO 8	Clifton/George Street Sewer Separation	950 LF	$95,000	$128,000	$1,400
CSO 9	George Street Outfall Closure		$1,000	$1,000	$0
CSO 10 - 18	Back Cove Storage Conduit	8,170 LF	$12,528,000	$16,912,000	$69,700
CSO 17	Libbytown Projects		$4,520,000	$6,100,000	$27,000
CSO 19	Diamond Street Outfall Closure		$1,000	$1,000	$0
Subtotal			$26,490,000	$35,759,000	$348,900
Portland Harbor					
CSO 23-29	Flow Slippage, Sewer Separation, and SWM		$1,920,000	$2,595,000	$30,100
Fore River					
CSO 30	St. John Street Sewer Separation (Note 3)		—	—	—
CSO 31	Eliminated		—	—	—
CSO 32	Thompson Point Storage Facility	0 MG	$183,000	$247,000	$4,800
CSO 33	Fore River Pump Station Outfall Closure		$1,000	$1,000	$0
CSO 34	Brewer Street Sewer Separation	240 LF	$12,000	$16,000	$200
CSO 35	Stroudwater Road Sewer Separation	1,350 LF	$135,000	$182,000	$2,000
CSO 36	West Side Sanitary Sewer	3,000 LF	$2,000,000	$2,700,000	$30,000
CSO 39	Rowe Street Outfall Closure		$1,000	$1,000	$0
Subtotal			$2,332,000	$3,147,000	$37,000
Capisic Brook					
CSO 36	Capisic Brook Sewer Separation and SWM		$2,609,000	$3,522,000	$46,800
CSO 37	Eliminated		$0	$0	$0
CSO 38	Brighton Avenue Sewer Separation	3,150 LF	$315,000	$425,000	$4,700
CSO 40	Sagamore Village Sewer Separation		$437,000	$590,000	$6,600
CSO 41	Holm Avenue Sewer Separation	2,300 LF	$230,000	$311,000	$3,500
CSO 42	Belfort/Commonwealth Dr. Sewer Separation and SWM	7,300 LF	$962,000	$1,299,000	$17,000
CSO 43	Bishop Street/Warren Ave. Sewer Separation and SWM		$864,000	$1,166,000	$16,000
Subtotal			$5,417,000	$7,313,000	$94,600
Total			$38,516,000	$52,011,000	$574,800

Notes:
(1) Abbreviations:
ISPS India Street Pump Station — NEPS Northeast Pump Station
LF linear feet — SWM stormwater management facility
MG million gallons — WWTF Portland Wastewater Treatment Facility
(2) Land acquisition costs are not included.
(3) Costs included under Libbytown Projects.

federal grant, state grant, or loan assistance for implementation of the Recommended Plan are discussed in Section 9.

6.1 Construction Costs

The assumptions made and methods used in estimating the construction costs for each type of project are discussed below.

Sewer Separation

In general, estimates for sewer separation projects include the reconnection of existing catch basins to a new storm drain system. Length of new storm sewer pipe was based on a preliminary layout of the new system, assuming reasonable allowances for flow slipping.

Bid tabulations from recent sewer projects in Portland were analyzed and used to develop approximate unit costs for sewer separation. Based on this analysis, sewer separation costs were generally estimated to be in the range of $80 to $100 per linear foot of new pipe. A cost of $100 per linear foot was assumed for this Master Plan, except where special conditions warranted using a different value:

- CSO 1—Increased unit cost to $125 per linear foot to cover cost of construction of new outfall and heavy traffic conditions.

- CSO 7—Read-Bay Area and CSOs 23-29—Portland Harbor Area—Increased unit cost to $150 per linear foot due to difficult installation conditions.

- CSO 34—Decreased unit cost to $50 per linear foot because of the relatively small size of the project and because the construction would be off the road, eliminating traffic considerations and simplifying surface restoration.

Costs for sewer separation for CSOs 40 and 43, currently in progress, were provided by the City of Portland.

Flow Slippage

Costs for flow slippage at CSOs 23-29 are based on the following assumptions:

- Catch basins connected to the combined sewer will be fitted with vortex flow control devices.

- Where two or more catch basins are located across the street from one another or in the same street intersection, pipe will be installed to connect the catch basins, and one catch basin, fitted with a vortex flow control device, will be connected to the combined sewer.

- The cost of installing a vortex flow control device on a single catch basin is approximately $750.

- The cost of installing connecting pipe and a vortex flow control device for a pair of catch basins is $2,500.

- The cost of installing connecting pipe and a vortex flow control device for several catch basins in an intersection is $4,500.

The number of each type of catch basin was estimated by examining the sewer maps and adding 25 percent to the number shown on the maps.

Storage Facilities

The proposed CSO storage facilities include storage tanks for CSOs 20 and 32 and a storage conduit for CSOs 10-18. Detailed breakdowns of the estimated costs for these projects are provided in Tables 6-2, 6-3, and 6-4, respectively. Quantities for excavation and other cost items were based on the layouts given in Section 5. Unit costs are based on recent construction experience in New England and on information given in Means Site Work and Landscape Cost Data 1992, 11th Annual Edition.

The storage facilities at CSOs 20 and 32 include the installation of cast-in-place, structurally reinforced concrete tanks. Associated with each storage tank is a diversion structure to be located on the CSO outfall pipe, downstream of the existing CSO structure. At both sites, the tanks drain by gravity back into the combined system for conveyance to the WWTF. A vortex flow control device and check valve are included to control the flowrate out of the tank. Facilities are included to provide for periodic washdown of the tanks.

Clearing and grubbing for construction is required only at the CSO 32 site. With limited soils information available, the volume of rock (ledge) to be excavated at the CSO 32 site is assumed to be a nominal 1 percent of the calculated total excavation quantities. At the CSO 20 site, a higher quantity of ledge excavation is expected. At both sites, the excavation is assumed to require sheet piling. Since the tank excavation will be a large, deep, open excavation in wet soils, a high unit cost of $30 per square foot was used for sheet piling. Dewatering costs are included in the excavation unit cost.

The proposed Back Cove storage conduit is a 10-foot-diameter storage conduit to collect overflows from CSOs 10 through 18. The conduit is assumed to be approximately 8,000

Table 6-2
Detailed Cost Estimate of CSO 20 Storage Tank

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST20.WK1

LIFE (yrs)	20
INTEREST RATE	8.50%
SITE WORK FACTOR	15.00%
ENGINEER/CONTINGENCIES FACTOR	35.00%
ENR	5000
O&M DEFAULT	3.00%

SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
10	0.1524	6.8790
20	0.1057	9.9026
30	0.0931	11.2399
40	0.0884	11.8314
50	0.0865	12.0930

COST ESTIMATE: CSO 20 Storage Tank 1.0 MG

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE			ESTIMATED O&M COST
					10	20	40	
MOBILIZATION	1	LS	$100,000.00	$100,000	$0	$0	$100,000	$3,000
EXCAVATION (GENERAL)	15,800	CY	$5.00	$79,000	$0	$0	$79,000	$2,370
EXCAVATION (LEDGE)	1,000	CY	$40.00	$40,000	$0	$0	$40,000	$1,200
SHEET PILING	18,600	SF	$10.00	$186,000	$0	$0	$186,000	$5,580
TANK CONCRETE	1,352	CY	$350.00	$473,200	$0	$0	$473,200	$14,196
GRAVITY PIPE - 18" RCP	140	LF	$125.00	$17,500	$0	$0	$17,500	$525
GRAVITY PIPE - 36" RCP	190	LF	$135.00	$25,650	$0	$0	$25,650	$770
BACKFILL/COMPACTION	9,600	CY	$14.00	$134,400	$0	$0	$134,400	$4,032
WASHDOWN FACILITIES	1	LS	$25,000.00	$25,000	$12,500	$6,250	$6,250	$750
DIVERSION STRUCTURE/PUMP STATION RETROFIT	1	EA	$50,000.00	$50,000	$0	$0	$50,000	$1,500
VALVE AND INSTRUMENTATION	1	LS	$20,000.00	$20,000	$10,000	$10,000	$20,000	$600
SURFACE RESTORATION	3,500	SY	$6.00	$21,000	$0	$0	$21,000	$630
SUBTOTAL				$1,171,750	$22,500	$16,250	$1,153,000	$35,153
GENERAL SITE WORK (15%)				$175,763	$3,375	$2,438	$172,950	
TOTAL CONSTRUCTION COST				$1,347,513	$25,875	$18,688	$1,325,950	
ENGINEER/CONTINGENCIES				$471,629	$9,056	$6,541	$464,083	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$1,819,142	$34,931	$25,228	$1,790,033	
* CRF					0.1524	0.1057	0.0884	
ANNUAL COST					$5,324	$2,666	$158,207	$35,153

	ENR = 5000
PRESENT WORTH COST	$1,990,000
TOTAL CONSTRUCTION COST	$1,348,000
TOTAL CAPITAL COST	$1,819,000
TOTAL ANNUAL COST	$201,000
TOTAL ANNUAL O&M COST	$35,000

** NOTE: SITE DEWATERING AND TRENCH BOX CONSTRUCTION ARE INCLUDED IN EXCAVATION COSTS

Table 6-3
Detailed Cost Estimate of CSO 32 Storage Tank

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST32.WK1

LIFE (yrs)	20	SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
INTEREST RATE	8.50%	10	0.1524	6.8790
SITE WORK FACTOR	15.00%	20	0.1057	9.9026
ENGINEER/CONTINGENCIES FACTOR	35.00%	30	0.0931	11.2399
ENR	5000	40	0.0884	11.8314
O&M DEFAULT	3.00%	50	0.0865	12.0930

COST ESTIMATE: CSO 32 Storage Tank 0.02 MG

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE 10	20	40	ESTIMATED O&M COST
MOBILIZATION	1	LS	$20,000.00	$20,000	$0	$0	$20,000	$600
CLEARING AND GRUBBING	0.25	AC	$4,000.00	$1,000	$0	$0	$1,000	$30
EXCAVATION (GENERAL)	600	CY	$5.00	$3,000	$0	$0	$3,000	$90
EXCAVATION (LEDGE)	6	CY	$100.00	$600	$0	$0	$600	$18
SHEET PILING	3,100	SF	$15.00	$46,500	$0	$0	$46,500	$1,395
TANK CONCRETE	70	CY	$350.00	$24,500	$0	$0	$24,500	$735
GRAVITY PIPE - 12" RCP	55	LF	$100.00	$5,500	$0	$0	$5,500	$165
GRAVITY PIPE - 30" RCP	20	LF	$130.00	$2,600	$0	$0	$2,600	$78
BACKFILL/COMPACTION	400	CY	$14.00	$5,600	$0	$0	$5,600	$168
WASHDOWN FACILITIES	1	LS	$25,000.00	$25,000	$0	$12,500	$12,500	$750
CONCRETE DIVERSION MANHOLE MODIFICATIONS	1	EA	$10,000.00	$10,000	$0	$0	$10,000	$300
ELECTRIC/CONTROLS	1	LS	$15,000.00	$15,000	$3,750	$7,500	$3,750	$450
SUBTOTAL				$159,300	$3,750	$20,000	$135,550	$4,779
GENERAL SITE WORK (15%)				$23,895	$0	$0	$23,895	
TOTAL CONSTRUCTION COST				$183,195	$3,750	$20,000	$159,445	
ENGINEER/CONTINGENCIES				$64,118	$1,313	$7,000	$55,806	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$247,313	$5,063	$27,000	$215,251	
* CRF					0.1524	0.1057	0.0884	
ANNUAL COST					$772	$2,853	$19,024	$4,779

	ENR = 5000
PRESENT WORTH COST	$267,000
TOTAL CONSTRUCTION COST	$183,000
TOTAL CAPITAL COST	$247,000
TOTAL ANNUAL COST	$27,000
TOTAL ANNUAL O&M COST	$5,000

** NOTE: SITE DEWATERING AND TRENCH BOX CONSTRUCTION COSTS ARE INCLUDED IN EXCAVATION COSTS

Table 6-4
Detailed Cost Estimate of CSO 10-18 Storage Conduit

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST1018.WK1

LIFE (yrs)	20
INTEREST RATE	8.50%
SITE WORK FACTOR (NOT USED)	15.00%
ENGINEER/CONTINGENCIES FACTOR	35.00%
ENR	5000
O&M DEFAULT	1.00%

SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
10	0.1524	6.8790
20	0.1057	9.9026
30	0.0931	11.2399
40	0.0884	11.8314
50	0.0865	12.0930

COST ESTIMATE: CSO 10 through 18 Back Cove Storage Conduit

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE 20	40	50	ESTIMATED O&M COST
STORAGE CONDUIT INSTALLATION:								
EXCAVATION AND BACKFILL	8,170	LF	$320.00	$2,614,400	$0	$0	$2,614,400	---
SHEET PILING	434,100	SF	$10.00	$4,341,000	$0	$0	$4,341,000	---
OSHA TRENCH SAFETY	8,170	LF	$5.00	$40,850	$0	$0	$40,850	---
GRAVITY PIPE - 120" RCP (INSTALLED)	8,170	LF	$420.00	$3,431,400	$0	$0	$3,431,400	---
MANHOLE STRUCTURES, 20' DEEP	16	EA	$10,000.00	$160,000	$0	$0	$160,000	---
SURFACE RESTORATION	8,170	LF	$61.00	$498,370	$0	$0	$498,370	---
DIVERSION STRUCTURES, INSTALLED	10	EA	$90,000.00	$900,000	$0	$0	$900,000	---
PUMP STATION CONNECTION:								
CONNECTING PIPE - 18" RCP	1,200	LF	$18.00	$21,600	$0	$0	$21,600	---
PIPE JACKING	1,200	LF	$400.00	$480,000	$0	$0	$480,000	---
PUMP STATION TIE-IN	1	LS	$40,000.00	$40,000	$0	40000	$0	
CHLORINATION-DECHLORINATION FEED SYSTEM	1	EA	$338,600.00	$338,600	$338,600	$0	$0	
SUBTOTAL				$12,527,620	$338,600	$40,000	$12,487,620	$69,700
TOTAL CONSTRUCTION COST				$12,527,620	$338,600	$40,000	$12,487,620	
ENGINEER/CONTINGENCIES				$4,384,667	$118,510	$14,000	$4,370,667	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$16,912,287	$457,110	$54,000	$16,858,287	
* CRF					0.1057	0.0884	0.0865	
ANNUAL COST					$48,303	$4,773	$1,457,624	$69,700

	ENR = 5000
PRESENT WORTH COST	$15,646,000
TOTAL CONSTRUCTION COST	$12,528,000
TOTAL CAPITAL COST	$16,912,000
TOTAL ANNUAL COST	$1,580,000
TOTAL ANNUAL O&M COST	$70,000

** NOTE: SITE DEWATERING AND TRENCH BOX CONSTRUCTION ARE INCLUDED IN EXCAVATION COSTS feet long and 20 feet deep. In addition to the estimate for the 10-foot conduit, costs are included for diversion structures at each of the nine outfall pipes, for an 18-inch gravity line connecting the storage conduit to the Franklin Street Pump Station, and for chlorination and dechlorination of the storage conduit overflow to Back Cove. A detailed breakdown of the estimated costs are provided in Table 6-4.

Pump Station and Wastewater Treatment Facility Improvements

A cost allowance is included for adding pumping capacity to the ISPS and NEPS. A detailed analysis of both pump stations should be made to verify the equipment and other modifications required to provide additional pumping capacity.

Costs to increase the maximum capacity at the WWTF from 60 mgd to 80 mgd were developed for the following components:

- Reconstruct one Parshall flume at the WWTF to increase its capacity from 25 mgd to 45 mgd

- Provide new instrumentation for both Parshall flumes

- Add two new grit cyclone/classifier mechanisms (pumps and piping already sized to handle the higher flows)

- Replace one manually-cleaned bar screen with a mechanically-cleaned screen

- Modify the primary effluent outfall, increasing the line size to handle the higher flows

A detailed breakdown of the estimated costs for the WWTF improvements is provided in Table 6-5. Costs for the equipment purchase and installation are based on estimates provided by equipment manufacturers' representatives.

Libbytown Projects

The intent of the Libbytown Projects is to reduce recurring combined sewer flooding problems in the Libbytown area and reduce overflow activity at CSO 17. An analysis and preliminary design of proposed alternatives is described in the June 1992 report Libbytown Sewer Separation Project: Preliminary Design Report prepared by CH2M HILL and Dufresne-Henry. Advanced planning and design of the projects described in the report has progressed, and various aspects of the projects have been modified. The recommended plan for Libbytown includes separation of sanitary flows and stormwater in Upper Libbytown and the area around Hood Dairy and inflow reduction in subcatchments tributary to CSO 17. The costs included on Table 6-1 for the Libbytown Projects are revised cost estimates reflecting changes to the program since the publication of the Preliminary Design Report.

Fall Brook and Capisic Brook

A variety of stormwater management and sewer separation projects are proposed for CSO control at Fall Brook and Capisic Brook. Table 6-6 presents a breakdown of the estimated costs for the Fall Brook (CSO 7) projects. The Capisic Brook projects include controls at CSO 36, CSO 42, and CSO 43; the estimated costs for these projects are presented in Tables 6-7, 6-8, and 6-9.

The stormwater management (SWM) facilities are permanent stormwater detention ponds. At each facility location, the approximate area suitable for detention was calculated. A percentage (generally 50 percent) of this area was assumed as the storage surface area, which was used, along with an assumed depth of 3 feet, to calculate storage volumes.

Table 6-5
Detailed Cost Estimate of Portland WWTF Capacity Improvements

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COSTWWTF.WK1

LIFE (yrs)	20
INTEREST RATE	8.50%
SITE WORK FACTOR (NOT USED)	15.00%
ENGINEER/CONTINGENCIES FACTOR	35.00%
ENR	5000
O&M DEFAULT (NOT USED)	3.00%

SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
10	0.1524	6.8790
20	0.1057	9.9026
30	0.0931	11.2399
40	0.0884	11.8314
50	0.0865	12.0930

COST ESTIMATE: Portland WWTF Capacity Improvements

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE			ESTIMATED O&M COST
					10	20	40	
Mobilization	1	LS	$25,000.00	$25,000	$0	$0	$25,000	---
Flow Measurement:								---
Demolish existing 25-mgd flume concrete	1	LS	$10,000.00	$10,000	$0	$0	$10,000	---
New 45-mgd fiberglass flume insert	1	EA	$5,600.00	$5,600	$0	$0	$5,600	---
New instrumentation	2	EA	$3,359.00	$6,718	$6,718	$0	$0	---
Equipment installation	1	LS	$7,000.00	$7,000	$3,500	$0	$3,500	---
Coarse Screening:								---
Climber-type mechanically-cleaned bar screen	1	EA	$90,000.00	$90,000	$0	$90,000	$0	---
Equipment installation	1	LS	$10,000.00	$10,000	$0	$10,000	$0	---
Grit Removal:								---
Grit cyclone and classifier	2	EA	$20,000.00	$40,000	$0	$40,000	$0	---
Equipment installation and miscellaneous items	1	LS	$20,000.00	$20,000	$0	$20,000	$0	---
Primary Effluent Outfall Modification	1	LS	$70,000.00	$70,000	$0	$0	$70,000	---
SUBTOTAL				$284,318	$10,218	$160,000	$114,100	$6,700
TOTAL CONSTRUCTION COST				$284,318	$10,218	$160,000	$114,100	
ENGINEER/CONTINGENCIES				$99,511	$3,576	$56,000	$39,935	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$383,829	$13,794	$216,000	$154,035	
* CRF					0.1524	0.1057	0.0884	
ANNUAL COST					$2,102	$22,825	$13,614	$6,700

	ENR = 5000
PRESENT WORTH COST	$446,000
TOTAL CONSTRUCTION COST	$284,000
TOTAL CAPITAL COST	$384,000
TOTAL ANNUAL COST	$45,000
TOTAL ANNUAL O&M COST	$7,000

Table 6-6
Detailed Cost Estimate of CSO 7 Projects

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST7.WK1

LIFE (yrs)	20
INTEREST RATE	8.50%
SITE WORK FACTOR (NOT USED)	15.00%
ENGINEER/CONTINGENCIES FACTOR	35.00%
ENR	5000
O&M DEFAULT	3.00%

SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
10	0.1524	6.8790
20	0.1057	9.9026
30	0.0931	11.2399
40	0.0884	11.8314
50	0.0865	12.0930

COST ESTIMATE: CSO 7 Fall Brook Stormwater Management and Sewer Separation Projects

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE			ESTIMATED O&M COST
					20	40	50	
Hydraulic Model of Fall Brook	1	LS	$150,000.00	$150,000	$150,000	$0	$0	$0
Fall Brook Channel Rehabilitation	60	ACRES	$16,500.00	$990,000	$0	$990,000	$0	$29,700
Modification of Roadway Culverts	6	EA	$200,000.00	$1,200,000	$0	$1,200,000	$0	$36,000
Torrey Street Detention Facility	1	LS	$110,700.00	$110,700	$0	$110,700	$0	$3,321
Canco Road Stormwater Management Facility	1	LS	$75,700.00	$75,700	$0	$75,700	$0	$2,271
Washington Avenue Stormwater Management Facility	1	LS	$150,700.00	$150,700	$0	$150,700	$0	$4,521
Milliken Brook Stormwater Management Facility	1	LS	$219,600.00	$219,600	$0	$219,600	$0	$6,588
Auburn Street Stormwater Management Facility	1	LS	$155,800.00	$155,800	$0	$155,800	$0	$4,674
Pheasant Hill Stormwater Management Facility	1	LS	$107,700.00	$107,700	$0	$107,700	$0	$3,231
Pennell Avenue Stormwater Management Facility	1	LS	$40,000.00	$40,000	$0	$40,000	$0	$1,200
Read/Bay Area Sewer Separation	12,200	LF	$150.00	$1,830,000	$0	$0	$1,830,000	$27,450
Cypress/Pennell Area Sewer Separation	7,600	LF	$100.00	$760,000	$0	$0	$760,000	$11,400
Princeton Street Area Sewer Separation	5,100	LF	$100.00	$510,000	$0	$0	$510,000	$7,650
Maine Avenue Area Sewer Separation	5,500	LF	$100.00	$550,000	$0	$0	$550,000	$8,250
Auburn Street Area Sewer Separation	11,300	LF	$100.00	$1,130,000	$0	$0	$1,130,000	$16,950
Miscellaneous Areas Sewer Separation	4,700	LF	$100.00	$470,000	$0	$0	$470,000	$7,050
Fall Brook Stormwater BMPs				$0.00	$0	$0	$0	$67,143
SUBTOTAL				$8,450,200	$150,000	$3,050,200	$5,250,000	$237,399
TOTAL CONSTRUCTION COST				$8,450,200	$150,000	$3,050,200	$5,250,000	
ENGINEER/CONTINGENCIES				$2,957,570	$52,500	$1,067,570	$1,837,500	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$11,407,770	$202,500	$4,117,770	$7,087,500	
* CRF					0.1057	0.0884	0.0865	
ANNUAL COST					$21,398	$363,937	$612,809	$237,399

	ENR = 5000
PRESENT WORTH COST	$12,240,000
TOTAL CONSTRUCTION COST	$8,450,000
TOTAL CAPITAL COST	$11,408,000
TOTAL ANNUAL COST	$1,236,000
TOTAL ANNUAL O&M COST	$237,000

Table 6-7
Detailed Cost Estimate of CSO 36 Projects

DATA: PORTLAND MAINE CSO ABATEMENT STUDY — FILENAME: COST36.WK1 — 17-Dec-93

		SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
LIFE (yrs)	20	10	0.1524	6.8790
INTEREST RATE	8.50%	20	0.1057	9.9026
SITE WORK FACTOR (NOT USED)	15.00%	30	0.0931	11.2399
ENGINEER/CONTINGENCIES FACTOR	35.00%	40	0.0884	11.8314
ENR	5000	50	0.0865	12.0930
O&M DEFAULT	3.00%			

COST ESTIMATE: CSO 36 Capisic Brook Stormwater Management and Sewer Separation Projects

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE 20	40	50	ESTIMATED O&M COST
Hydraulic Model of Capisic Brook	1	LS	$150,000.00	$150,000	$150,000	$0	$0	$0
West Side Sanitary Sewer:								
24" dia. pipe and manholes, installed	3,000	LF	$600.00	$1,800,000	$0	$0	$1,800,000	$27,000
Junction chambers	2	EA	$100,000.00	$200,000	$0	$0	$200,000	$3,000
Capisic Brook Channel Rehabilitation	1	LS	$300,000.00	$300,000	$0	$300,000	$0	$9,000
City Home Stormwater Management Facility	1	LS	$101,600.00	$101,600	$0	$101,600	$0	$3,048
Fuller Avenue Stormwater Management Facility	1	LS	$79,400.00	$79,400	$0	$79,400	$0	$2,382
Wayside Drive Stormwater Management Facility	1	LS	$43,300.00	$43,300	$0	$43,300	$0	$1,299
Ludlow Street Stormwater Management Facility	1	LS	$87,100.00	$87,100	$0	$87,100	$0	$2,613
Rockland Street Stormwater Management Facility	1	LS	$47,600.00	$47,600	$0	$47,600	$0	$1,428
Rockland Street Area Sewer Separation	14,200	LF	$100.00	$1,420,000	$0	$0	$1,420,000	$21,300
Deering Center Branch Sewer Separation	3,800	LF	$100.00	$380,000	$0	$0	$380,000	$5,700
SUBTOTAL				$4,609,000	$150,000	$659,000	$3,800,000	$76,770
TOTAL CONSTRUCTION COST				$4,609,000	$150,000	$659,000	$3,800,000	
ENGINEER/CONTINGENCIES				$1,613,150	$52,500	$230,650	$1,330,000	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$6,222,150	$202,500	$889,650	$5,130,000	
* CRF					0.1057	0.0884	0.0865	
ANNUAL COST					$21,398	$78,629	$443,557	$76,770
	ENR = 5000							

PRESENT WORTH COST	$6,140,000
TOTAL CONSTRUCTION COST	$4,609,000
TOTAL CAPITAL COST	$6,222,000
TOTAL ANNUAL COST	$620,000
TOTAL ANNUAL O&M COST	$77,000

Table 6-8
Detailed Cost Estimate of CSO 42 Projects

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST42.WK1

		SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
LIFE (yrs)	20	10	0.1524	6.8790
INTEREST RATE	8.50%	20	0.1057	9.9026
SITE WORK FACTOR (NOT USED)	15.00%	30	0.0931	11.2399
ENGINEER/CONTINGENCIES FACTOR	35.00%	40	0.0884	11.8314
ENR	5000	50	0.0865	12.0930
O&M DEFAULT	3.00%			

COST ESTIMATE: CSO 42 Belfort/Commonwealth Drive Stormwater Management and Sewer Separation Projects

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE 20	40	50	ESTIMATED O&M COST
Newcombe Avenue Stormwater Management Facility	1	LS	$175,000.00	$175,000	$0	$175,000	$0	$5,250
Belfort/Commonwealth Dr. Area Sewer Separation:								
Warren Ave. Stormwater Separation	100	LF	$250.00	$25,000	$0	$0	$25,000	$375
Disconnect Brook Inlets from Combined Sewer	2	EA	$1,000.00	$2,000	$0	$0	$2,000	$0
Forest Ave. and Comm. Dr. Area Sewer Separation	7,600	LF	$100.00	$760,000	$0	$0	$760,000	$11,400
SUBTOTAL				$962,000	$0	$175,000	$787,000	$17,025
TOTAL CONSTRUCTION COST				$962,000	$0	$175,000	$787,000	
ENGINEER/CONTINGENCIES				$336,700	$0	$61,250	$275,450	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$1,298,700	$0	$236,250	$1,062,450	
* CRF					0.1057	0.0884	0.0865	
ANNUAL COST					$0	$20,880	$91,863	$17,025

	ENR = 5000
PRESENT WORTH COST	$1,287,000
TOTAL CONSTRUCTION COST	$962,000
TOTAL CAPITAL COST	$1,299,000
TOTAL ANNUAL COST	$130,000
TOTAL ANNUAL O&M COST	$17,000

Table 6-9
Detailed Cost Estimate of CSO 43 Projects

17-Dec-93

DATA: PORTLAND MAINE CSO ABATEMENT STUDY FILENAME: COST43.WK1

LIFE (yrs)	20	SERVICE LIFE	CAPITAL RECOVERY FACTOR	PRESENT WORTH FACTOR
INTEREST RATE	8.50%	10	0.1524	6.8790
SITE WORK FACTOR (NOT USED)	15.00%	20	0.1057	9.9026
ENGINEER/CONTINGENCIES FACTOR	35.00%	30	0.0931	11.2399
ENR	5000	40	0.0884	11.8314
O&M DEFAULT	3.00%	50	0.0865	12.0930

COST ESTIMATE: CSO 43 Bishop St./Warren Ave. Stormwater Management and Sewer Separation Projects

MAJOR COMPONENTS	QUANTITY	UNIT	UNIT PRICE	ESTIMATED CONSTRUCTION COST	CONSTRUCTION COST BY SERVICE LIFE 20	40	50	ESTIMATED O&M COST
Warren Avenue Stormwater Management Facility	1	LS	$200,000.00	$200,000	$0	$200,000	$0	$6,000
Bishop Street Sewer Separation	1	LS	$350,000.00	$350,000	$0	$0	$350,000	$5,250
Warren Avenue Sewer Separation	1	LS	$314,000.00	$314,000	$0	$0	$314,000	$4,710
SUBTOTAL				$864,000	$0	$200,000	$664,000	$15,960
TOTAL CONSTRUCTION COST				$864,000	$0	$200,000	$664,000	
ENGINEER/CONTINGENCIES				$302,400	$0	$70,000	$232,400	
LAND ACQUISITION (NON-CITY OWNED)	0.0	AC	$87,120.00	$0	$0	$0	$0	$0
TOTAL CAPITAL COST				$1,166,400	$0	$270,000	$896,400	
* CRF					0.1057	0.0884	0.0865	
ANNUAL COST					$0	$23,863	$77,506	$15,960

	ENR = 5000
PRESENT WORTH COST	$1,159,000
TOTAL CONSTRUCTION COST	$864,000
TOTAL CAPITAL COST	$1,166,000
TOTAL ANNUAL COST	$117,000
TOTAL ANNUAL O&M COST	$16,000

The following formula, published in the document Controlling Urban Runoff: A Practice Manual for Planning and Designing Urban BMPs, by Thomas R. Schueler, was used to estimate SWM facility construction costs:

$$C = 10.71\ V_s^{0.69} \times \left(\frac{5000}{4195}\right)$$

where C	=	construction cost at ENR 5000
V_s	=	volume of storage in cubic feet
(5000/4195)	=	ENR adjustment

The West Side Sanitary Sewer is included in the CSO 36 Capisic Brook projects. The estimated cost for a new 24-inch sanitary sewer, including manholes and a junction chamber at each end of the new line, is shown in Table 6-7. Relatively high unit costs are used due to the congested installation conditions along the length of the new line.

Outfall Closures

Several existing CSO outfalls are designated for closure as part of the CSO Abatement Master Plan. A capital cost of $1,000 was included in Table 6-1 for each outfall closure. This cost allows for testing to insure outfall closure will not cause flooding or other problems, and for labor and materials to physically block the outfall.

6.2 Operation and Maintenance Costs

Preliminary estimates of O&M costs were made for the proposed CSO control projects. More detailed estimates should be made at later stages of the CSO program development when the projects and the associated O&M needs are more fully defined. The assumptions used for the estimated O&M costs presented in Table 6-1 are given below.

Sewer Separation and Flow Slippage

For areas in which sewer separation and flow slippage projects would be implemented, O&M costs reflect additional street sweeping and catch basin cleaning. It was assumed that a program of increased BMPs would be implemented in these areas, providing two additional street sweeping passes for every street and two additional cleanings of each catch basin. The annual cost of this program for each area was estimated at 1.5 percent of the total construction cost for the project in that area. This percentage was developed by analyzing three different sewer separation projects, and assigning a cost of $34 per catch basin for catch basin cleaning and $50 per curb mile for street sweeping. The catch basin estimate is an average of reported costs in the Boston area, and may be conservative for Portland. The unit cost for street sweeping is based on average literature values. For each of the three areas analyzed, the ratio of the estimated O&M cost to the estimated construction cost was taken and the average of the three ratios were determined; a contingency factor of 0.15 was added to the average ratio resulting in an estimated annual O&M cost of 1.5 percent of construction costs.

Storage Facilities

Estimated O&M costs for the storage tank facilities at CSOs 20 and 32 and for the storage conduit for CSOs 10-18 are based on guidelines in the document CSO Control Technologies Assessment, CH2M HILL, May 1991. For the storage tank facilities, the annual O&M costs are estimated at 3 percent of the facility construction cost. For the storage (consolidation) conduit, the annual O&M costs are estimated at 1.7 times the length of the sewer in feet (ENR=5000).

The SWM facility detention pond annual O&M costs were estimated at 3 percent of project construction costs, based on guidelines given in Controlling Urban Runoff: A Practical Manual for Planning and Assigning Urban BMPs.

Pump Station and Wastewater Treatment Facility Improvements

The estimated O&M costs associated with the ISPS, NEPS, and Portland WWTF improvements were calculated by estimating additional power costs and labor requirements, and adding an allowance for supplies.

The calculations were based on the following assumptions:

- Grit cyclone and classifier motors—1/2 hp each
- Mechanically cleaned bar screen motor—1 1/2 hp
- Power cost—$0.12 per kwhr
- Additional WWTF labor required—one person-day per month (96 hours per year)
- Additional PS labor required—two person-days per month
- Labor cost—$15 per hour
- Supplies—10 percent of labor and power costs
- NEPS operating at increased rate 185 hours per year
- ISPS operating at increased rate 196 hours per year
- Allowance for additional grit pumping and primary sludge handling—$5,000 per year

6.3 Land Acquisition Costs

Costs for land acquisition may be associated with channel rehabilitation in the Fall Brook and Capisic Brook watersheds. Land acquisition costs were not included in the total capital cost estimate for each respective CSO because of the variability of land prices and the uncertainty regarding actual requirements in each watershed. A discussion with the Portland City Assessor's Office indicated that the following issues would be involved in determination of land costs:

- Commercial versus residential zoning
- Independent appraisal value of property
- Total land area to remain under current ownership
- Hardship of property surrender to current owner

City average assessed value (1992 dollars) for residential property is approximately $3.25 per square foot, or $141,570 per acre. This unit cost is derived from an average $26,000 value for an 8,000 square foot residential lot. The current average value for commercial property is approximately $5.00 per square foot, or $217,800 per acre. These costs are average figures, and do not incorporate conditions specific to individual lots. For example, if an individual lot size exceeds the minimum required per zoning code, the additional portion of the lot will be assessed at a different unit cost. If that portion of the lot lay in designated floodplain, the unit cost may drop to as much as 10 percent of the average value. If that portion of a property to be acquired would cause the remaining lot area to fall beneath zoning requirements, the remaining lot would become less valuable for resale, and the cost for the acquired portion would rise, respectively, reflecting the loss of value to the current owner. These factors must be determined on an individual basis, during the preliminary design phases of projects. Additionally, the average residential and commercial values are subject to change as the assessment methods are being reevaluated.

For example, assuming that 15 percent of the total length of Fall Brook is commercial property, and the remaining 85 percent is residential property, land costs, using the average values above, could be in the order of $7.0 million. This assumes the purchase of a 20,000-foot length of brook, 100 feet wide.

Assuming that 100 percent of the total length of Capisic Brook lies within residentially zoned property, the cost of land would be about $1.5 million. This cost is based on a total length of 9,000 feet for a width of 50 feet across the entire length to be purchased.

These values are presented solely for general consideration. Actual costs would be determined by an independent appraiser who would assess the total value of the subject property.

6.4 Present Worth and Annual Costs

Project present worth values are useful in that they reflect not only the construction and O&M costs of the project, but also the residual value of the facilities at the end of the 20-year planning period, or, for facilities with service lives less than 20 years, the replacement cost to provide facilities for 20 years.

Present worth and equivalent annual costs were developed for each of the proposed projects. A summary of the present worth and annual costs is presented in Table 6-10. The detailed cost estimates presented in Section 6.2 (Tables 6-2 through 6-9) include present worth and annual cost calculations.

The service life of the project, or individual project components, was first determined to calculate the project annual cost. The guidelines used to determine service lives are described in Table 6-11. The total capital cost of each project component is multiplied by the capital recovery factor corresponding to the service life for that project

Table 6-10
Portland, Maine CSO Abatement Master Plan
Present Worth and Annual Cost

Receiving Water and CSO Number	Project/Activity (Note 1)	Capital Cost (Note 2)	Annual O&M Cost	Present Worth	Annual Cost	Service Life
Systemwide Projects						
	Portland WWTF Capacity Improvements	$384,000	$6,700	$446,000	$45,000	See Table 6-5
	ISPS and NEPS Improvements	$250,000	$7,200	$337,000	$34,000	20 years
	Benchmark and Compliance Monitoring	$16,000	$7,200	$99,000	$10,000	10 years
	Revision of Stormwater Management Regulations	$20,000	$0	$20,000	$2,000	20 years
Subtotal		$670,000	$21,100	$902,000	$91,000	
Casco Bay						
CSO 1	Olympia Street Sewer Separation	$59,000	$700	$59,000	$6,000	50 years
CSO 3	Berwick Street Outfall Closure	$1,000	$0	$1,000	$100	50 years
CSO 4	Tukey's Bridge Siphon Outfall Closure	$1,000	$0	$1,000	$100	50 years
CSO 20	Northeast Pump Station Storage Facility	$1,819,000	$35,200	$1,990,000	$201,000	See Table 6-2
CSO 21	Quebec Street Flow Slippage	$363,000	$4,000	$347,000	$35,000	50 years
Subtotal		$2,243,000	$39,900	$2,398,000	$242,200	
Presumpscot Estuary						
CSO 2	Arcadia Street Sewer Separation	$284,000	$3,200	$277,000	$28,000	50 years
Back Cove						
CSO 5	Randall St. Sewer Separation; Backflow Prevention	$369,000	$4,100	$357,000	$36,000	50 years
CSO 6	Johansen Street Sewer Separation	$840,000	$9,300	$812,000	$82,000	50 years
CSO 7	Fall Brook Projects	$11,408,000	$237,400	$12,240,000	$1,236,000	See Table 6-6
CSO 8	Clifton/George Street Sewer Separation	$128,000	$1,400	$119,000	$12,000	50 years
CSO 9	George Street Outfall Closure	$1,000	$0	$1,000	$100	50 years
CSO 10 - 18	Back Cove Storage Conduit	$16,912,000	$69,700	$15,646,000	$1,580,000	See Table 6-4
CSO 17	Libbytown Projects	$6,100,000	$27,000	$5,942,000	$528,000	50 years
CSO 19	Diamond Street Outfall Closure	$1,000	$0	$1,000	$100	50 years
Subtotal		$35,759,000	$348,900	$35,118,000	$3,474,200	
Portland Harbor						
CSO 23-29	Flow Slippage & SWM	$2,595,000	$30,100	$2,971,000	$225,000	50 years
Fore River						
CSO 30	St. John Street Sewer Separation (Note 3)	---	---	---	---	---
CSO 31	Eliminated	---	---	---	---	---
CSO 32	Thompson Point Storage Facility	$247,000	$4,800	$267,000	$27,000	See Table 6-3
CSO 33	Fore River Pump Station Outfall Closure	$1,000	$0	$1,000	$100	50 years
CSO 34	Brewer Street Sewer Separation	$16,000	$200	$20,000	$2,000	50 years
CSO 35	Stroudwater Road Sewer Separation	$182,000	$2,000	$178,000	$18,000	50 years
CSO 36	West Side Sanitary Sewer	$2,700,000	$30,000	$2,604,000	$263,000	50 years
CSO 39	Rowe Street Outfall Closure	$1,000	$0	$1,000	$100	50 years
Subtotal		$3,147,000	$37,000	$3,071,000	$310,200	
Capisic Brook						
CSO 36	Capisic Brook Sewer Separation and SWM	$3,522,000	$46,800	$3,535,000	$357,000	See Table 6-7
CSO 37	Eliminated	---	---	---	---	---
CSO 38	Brighton Avenue Sewer Separation	$425,000	$4,700	$406,000	$41,000	50 years
CSO 40	Sagamore Village Sewer Separation	$590,000	$6,600	$574,000	$58,000	50 years
CSO 41	Holm Avenue Sewer Separation	$311,000	$3,500	$297,000	$30,000	50 years
CSO 42	Belfort/Commonwealth Dr. Sewer Separation and SWM	$1,299,000	$17,000	$1,287,000	$130,000	See Table 6-8
CSO 43	Bishop Street/Warren Ave. Sewer Separation and SWM	$1,166,000	$16,000	$1,159,000	$117,000	See Table 6-9
Subtotal		$7,313,000	$94,600	$7,258,000	$733,000	
Total		**$52,011,000**	**$574,800**	**$51,995,000**	**$5,103,600**	

Notes:
(1) Abbreviations:
ISPS India Street Pump Station; NEPS Northeast Pump Station
LF linear feet; SWM stormwater management facility
MG million gallons; WWTF Portland Wastewater Treatment Facility
(2) Land acquisition costs are not included.
(3) Costs included under Libbytown Projects.

Table 6-11
Service Life for
Major CSO Control Components

Component Type	Service Life
Wastewater conveyance structures (including collection systems, outfall pipes, interceptors, force mains, drop shafts, tunnels)	50 years
Other structures (including plant buildings, concrete process tankage, basins, lift station structures, and site work)	40 years
Process equipment (including major process equipment such as clarifier mechanisms, vacuum filters, etc.; steel process tanks and chemical storage facilities; electrical generating facilities on standby service only)	20 years
Auxiliary equipment (including instruments and control facilities; sewage pumps and electrical motors; mechanical equipment such as compressors, aeration systems, centrifuges, chlorinators; electrical generating facilities on regular service)	10 years

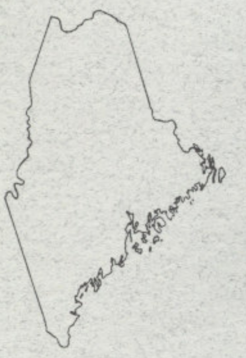
Source:

EPA Construction Grants, 1985; Municipal Wastewater Treatment, July 1984.

component, in order to get the annual cost of the project component. The sum of the project component annual costs and the project annual O&M cost is the annual cost for the entire project.

The project present worth is determined by multiplying the project annual cost by the present worth factor corresponding to the project life, or planning period. For the Portland CSO Abatement Master Plan the project life is assumed to be 20 years.

An annual interest rate of 8.5 percent was used in calculating the annual cost and present worth. Values of the capital recovery factor and present worth factor for various service lives are given on Tables 6-2 through 6-9.



Environmental Eval.

Section 7

Environmental Evaluation

This environmental evaluation reviews anticipated water quality improvement resulting from implementation of the recommended CSO abatement plan. Water quality improvement is inferred from the predicted reduction in the number of annual overflow events and water quality violations for designated uses of Portland's surface waters. Following the discussion of receiving water quality, an analysis of the environmental impacts associated with combined sewer separation and the CSO storage facilities is presented.

The environmental evaluation provides a description of the natural and built environment in and around sites and corridors selected for construction of CSO abatement facilities and identifies environmental issues that will be encountered in their construction and operation. Resources that may be impacted are discussed in the following categories under Siting Issues:

- Land use, access, and ownership
- Floodplains
- Wetlands
- Trees and landscaping
- Wildlife habitat
- Threatened and endangered species
- Cultural resources

The environmental evaluation also provides a description of potential CSO facility construction and operation impacts. Actions to mitigate the potential impacts are identified. The impacts are described in several categories under Construction and Operational Issues:

- Land use compatibility
- Excavated material disposal and erosion control
- Hazardous waste potential
- Floodplain encroachment
- Wetland encroachment
- Removal of trees and landscaping
- Loss of wildlife habitat
- Threatened and endangered species
- Cultural resources
- Recreational opportunities
- Traffic
- Air quality and odors
- Noise and vibration
- Coastal zone policies

Finally, a section entitled "Potential Environmental Concerns" summarizes the relative degree of impact of various activities. Section 5 presented the components of the recommended CSO control plan including figures showing the locations of the proposed storage facilities and the areas that are recommended for separation and stormwater management. Section 8.2, Permit Requirements, includes information on environmental permits and approvals required for the implementation of the recommended CSO controls.

7.1 Receiving Water Quality

Receiving water goals for the surface waters in the Portland area are established in accordance with the Maine Water Pollution Control Law and include uses such as habitat for fish and aquatic life, fishing, recreation in and on the water, and propagation and harvesting of shellfish. Uses for a specific water segment are determined by the established freshwater or marine water classification and also include all existing uses. Classified and existing uses of Portland's receiving waters include primary contact recreation such as swimming and windsurfing, secondary contact recreation such as wading (freshwater brooks), boating, and passive recreation. Protection of critical uses and sensitive areas, including adjacent shellfish waters, and aesthetics are also important considerations. Closure of beaches and shellfish areas, the threat to public health from poor water quality, and the aesthetic degradation of surface waters are examples of use impairments. These uses are all impaired or potentially impacted by CSO discharges.

There are many sources of water pollution which contribute to the degradation of surface waters in Portland and stand in the way of attaining of water quality goals for the City (discussed in Section 1). Reducing combined sewer overflows helps to achieve water quality goals by reducing the storm-related discharge of fecal and floatable material. Thus, the primary water quality goals of Portland's CSO control program should be to minimize CSO activity, violations in state bacteria standards, and impacts of floatable materials.

Water quality and hydraulic data were used in computer models to determine the average number of CSO overflow events that would occur on an annual basis as well as during the period from May 15 through September 30 when state bacteria standards are in effect. The analysis was performed for the existing CSO configuration and for the CSO configuration recommended in the master plan. An estimate was also made of the volume of CSO discharge during the overflow events and the total duration of the events over a year's time for both existing and recommended CSO management. The results predicted by computer modeling are presented in Table 7-1 by watershed.

Receiving Water	No. of CSOs	Annual			Summer[2]		
		No. of Events[3]	Vol. (MG)	Duration[4] (hours)	No. of Events[3]	Vol. (MG)	Duration[4] (hours)
Without CSO Abatement Plan							
Casco Bay	5	30	55	185	14	22	69
Presumpscot Estuary	1	13	2	50	6	1	20
Back Cove	15	44	416	357	19	157	96
Portland Harbor	7	43	145	202	19	62	99
Fore River	7	36	73	181	18	32	94
Capisic Brook	4	26	29	107	14	12	44
Areawide	39	NA	720	NA	NA	286	NA
With CSO Abatement Plan							
Casco Bay	1	0	0	0	0	0	0
Presumpscot Estuary	0	0	0	0	0	0	0
Back Cove	1	12	70	64	5	30	28
Portland Harbor	7	22	17	69	11	7	33
Fore River	1	0	0	0	0	0	0
Capisic Brook	0	0	0	0	0	0	0
Areawide	10	NA	87	NA	NA	37	NA

Table 7-1
Water Quality Impact Summary[1]

[1]Estimates of CSO activity were predicted by the recalibrated CSO Abatement Model and are based on the 1966 precipitation record.
[2]The summer season is defined by Maine's water quality regulations as May 15 to September 30.
[3]A receiving water CSO event is defined as one or more discharges to a receiving water resulting from a single precipitation event; it approximates the number of days a receiving water is impacted by CSOs.
[4]The duration is the accumulative length of overflow time.
NA - Not Applicable

An assessment of the expected improvements to water quality of Portland's receiving waters follows. The assessment does not consider impacts from pollutant sources other than Portland's CSO discharges, such as CSO discharges from South Portland or communities upstream from Portland along the Presumpscot and Stroudwater Rivers.

Casco Bay. By reducing the number of CSO from 5 to 1 and constructing a 1-MG storage tank, combined sewer impacts to Casco Bay, on average, can be eliminated.

A 1990 study entitled, <u>Assessment of Sediment Contamination in Casco Bay</u>, prepared for the Casco Bay Estuary Project concluded that:

- Metals concentrations in Casco Bay sediments are comparable to uncontaminated sediments

- Contaminants related to human activities are detectable throughout Casco Bay but in most cases are at exceedingly low concentrations

- Localized contamination by various chemicals is generally far below levels suspected of evoking toxic biological response

The study included both inner and outer Bay locations and evaluated pesticides, PCBs, polycyclic aromatic hydrocarbons, and selected trace metals.

Presumpscot Estuary. Elimination of the single CSO discharging to the Presumpscot Estuary would result in no CSO impacts from Portland to the Estuary.

Back Cove. The plan recommends sewer separation, combining many individual CSOs into a storage conduit, and implementing upland stormwater management in the Fall Brook watershed. The relief overflow of the storage conduit includes chlorination/dechlorination prior to discharge to Back Cove. The number of annual overflow events are estimated to be reduced from 44 to 12 and the volume discharged annually by 83 percent. During the summer months when water recreation is important in Back Cove, the duration of overflow events is reduced from 19 events over 96 hours to 5 events lasting a total of 28 hours. In addition, the design of the storage conduit relief overflow with disinfection will greatly reduce solids, floatables, and bacteria loads. These reductions in CSO discharges, in addition to quantity and quality control of stormwater discharges, should result in an improvement in the water quality in Back Cove and an increase in the use of its waters for critical uses, sensitive areas, and recreational purposes.

Portland Harbor. The CSO measures recommended for Portland Harbor will achieve a significant reduction in CSO discharges to the Harbor. Although the number of CSO locations remains the same and the number of annual overflow events decreases from 43 to 22, the annual volume of overflow would be reduced from 145 million gallons to 17 (88 percent reduction), and the duration would decrease from 202 hours to 33 hours (84 percent reduction).

Fore River. Under the CSO abatement plan, seven of the eight CSOs would be eliminated. This reduction and construction of a 0.02-MG storage tank are predicted to eliminate, on average, all CSO impacts to the Fore River.

Capisic Brook. All CSOs are eliminated under the plan, resulting in no CSO impacts under typical storm conditions. Sewer separation is recommended to eliminate the CSOs, and stormwater management measures are recommended to control the quantity and quality of separate stormwater.

A major feature of the recommended CSO control plan is the reduction of inflow to the combined sewer system, affecting primarily the Fall Brook and Capisic Brook Watersheds. This will eliminate CSO discharges to the freshwater brooks and will substantially reduce overflows throughout the Portland CSO system by decreasing interceptor flows. However, inflow reduction including disconnecting stream inflow, selective sewer separation, and flow slippage will increase stormwater discharges directly to the freshwater brooks and indirectly to marine waters.

Stormwater management is included in the recommended plan to provide control for stormwater from a quality and quantity basis. It is envisioned that the controls will include pollutant source control measures similar to those currently being implemented throughout the City. In addition, controls will include "active" stormwater management structures such as wet detention ponds, wetland systems, and infiltration basins as well as "passive" management features such as filters strips, vegetated buffers, and maintenance and/or rehabilitation of riparian areas. These controls will be prioritized for implementation to manage stormwater quality and quantity as a first priority through "active" structures, manage quantity only (also through structures) as a second priority, or provide "passive" controls as a third priority. Ideally, stormwater management controls will provide a mixture of control measures which will provide stormwater pollutant control, minimize the potential for flooding and provide aesthetically acceptable stream channels.

Pollutant removal associated with stormwater management has been assessed through a number of studies. The bacteria concentration in stormwater is about 40 to 90 percent less than that of CSO, depending on the type of bacteria. Table 7-2 provides some typical pollutant removals for the management practices which will be considered for implementation.

Table 7-2
Typical Urban Runoff Pollutant Reduction Efficiencies
For Selected Control Alternatives

Control Alternative	Removal Efficiency (percent)[3]				
	Suspended Solids	Total Phosphorus	Total Nitrogen	Metals	Fecal Coliform
Wet Ponds -- 0.5% Surface Area[1] -- 1.0% Surface Area[1]	 80-85 90-95	 50-55 60-65	 35-40 40-45	 35-40 40-45	 95 99
Dry Detention Ponds	60-70	10	20	30-35	90
Filter Strips	40	15	15	30	N/A
Grass Swales	40	15	15	30	N/A
Infiltration Devices[2]	50-95	75	50-75	50-95	75-95
Water Quality Inlets	20	negligible	negligible	negligible	negligible

[1]Surface area of pond as percentage of drainage area served.
[2]Infiltration devices include infiltration basins, infiltration trenches, and porous pavement. These devices effectively capture all surface runoff intercepted. A portion of the infiltrated surface runoff becomes interflow/baseflow.
[3]Optimal removal efficiency of controls if properly operated and maintained.

Source: *Mountain Island Lake Watershed Protection Plan* prepared for the Mecklenberg County (North Carolina) Department of Environmental Protection, CH2M HILL, May 1991.

In summary, the Recommended Plan recommends deactivation of 29 out of Portland's 39 CSOs and implementation of other CSO abatement measures including storage tanks and conduits, in-line flow adjustments, and upland runoff management. The estimated annual CSO reductions are substantial: the number of individual CSO events will be reduced by 85 percent; CSO volume will be reduced by 88 percent; and CSO duration will be reduced by 88 percent. Similar decreases are predicted during the summer months.

Applying the approaches identified in the 1992 Draft CSO Policy, we have developed a Recommended Plan that will provide the following:

- Control of 99% of all wastewater flows generated during wet weather
- Improve the quality of Portland's surface waters
- Provide, on average, 100% Portland CSO elimination in four out of six receiving waters
- Reduce significantly the CSO events, volume, and duration in waters with remaining CSOs
- Reduce significantly the number of violations of water quality standards for bacteria
- Improve habitats for critical uses and sensitive areas
- Expand the recreational potential of Portland's waters

The Recommended Plan will thereby move toward accomplishment of the state and federal water quality goals.

7.2 Construction Issues of Sewer Separation

Sewer separation consists of installing a new sewer line parallel to the combined sewer. Either the sanitary flow or the storm flow is connected to the new line.

Land Use Compatibility

Land uses in the areas recommended for sewer separation are primarily residential with some light commercial. Since the installation of separate sewers is typically along transportation rights-of-way and is below grade, there are no permanent impacts to land use or aesthetics. See the section on Traffic for the construction phase impacts of sewer separation.

Erosion Control

Excavation along roads to install a parallel network of new sanitary sewers will disturb approximately 76,000 linear feet (14 miles) of road right-of-way. Excavated soil will be placed next to the exposed trench.

Impacts. Soil erosion from stockpiled soil excavated from trenches and from the open faces of the trenches themselves can occur during storm events.

Mitigation. Compliance with SCS soil erosion and sediment control measures will be required by contract documents. Minimizing the length of trench opening at one time, minimizing the time trenches are opened, and resurfacing or reseeding filled trenches will reduce erosion potential from sewer installation. Careful installation, inspection, and maintenance of soil erosion control measures, such as silt fences and straw bales staked around stormwater inlets, will reduce sedimentation.

Floodplain Encroachment

Some of the sewer construction may occur in an existing floodplain. The construction and placement of the new sanitary sewers will not affect the flood storage capacity or the movement of flood waters because the sewers are placed below grade. If it is necessary for a new sewer to cross a streambed, steps should be taken to mitigate disturbance of the streambed and its aquatic habitat. Separation projects will increase the quantity of stormwater discharged to brooks and their tributaries.

In many instances in the Fall Brook watershed the stream channel must be maintained by clearing vegetation, debris, and sediment that would cause flooding. This must be accomplished before separation projects are completed.

In the Capisic Brook watershed several manmade and natural constructions to flow, which currently cause flooding and at which increased flow would exacerbate flooding, must be removed.

Wetlands

The sewer separation projects may encounter wet surface soil conditions. If wet soils are encountered during detailed sewer separation project design, these areas should be examined by a qualified wetlands specialist before completion of design to determine the extent of any wetlands. If wetlands areas are found in the project area, they should be avoided if possible. If significant areas of wetlands cannot be avoided, state and federal wetlands permits may be required and must be obtained prior to construction.

Wildlife Habitat

Installation of separate storm sewers generally is within the public rights-of-way. Therefore, there is no disturbance of wildlife habitat. In some locations, it may be necessary to cross land with wildlife habitat potential.

Impacts. There may be temporary disruption of wildlife habitat where storm sewer installation deviates from transportation corridors and crosses woodland or old fields.

Mitigation. Impacts on wildlife habitat caused by installation of sewers across woodland or old fields can be reduced by avoiding nesting periods; minimizing the construction period; caution in compacting soil, cutting trees, and damaging tree roots; and reseeding disturbed areas immediately after the trench is closed.

Cultural Resources

The historic value of structures or their historic contexts in areas where sewers are recommended for separation will not be affected by the installation of new sanitary or storm sewers under the streets on which they front. The Maine Historical Preservation Commission (MHPC) should be notified immediately if suspected archeological artifacts are encountered during excavation for sewer separation.

Recreational Opportunities

Some sanitary or storm sewer construction will occur in the more natural areas of stream valleys and parks. The construction may temporarily interfere with passive recreational activities in these areas. The installation of separate sanitary and storm sewers does not create any recreational opportunities.

Traffic and Access

Sewer lines generally run along streets and roads. Typically, combined sewer separation projects are broken into sections of several hundred feet. A new trench is excavated, usually in the road right-of-way. Construction generally occurs any time of year except during the coldest months. Traffic on a road segment may be disrupted for several weeks to several months.

Typically, four or fewer construction vehicles (backhoes, steam shovels, and pipe-laying vehicles) are active on a daily basis at the point of construction, and the site is visited by supply vehicles at a rate of less than 10 vehicles per week.

Impacts. Excavation of streets to install separated sewers will disrupt traffic. The inconvenience to motorists will depend on the availability of alternative routes. Residents and businesses most directly affected would be those on street and road segments where construction is taking place.

Traffic disruption will be more severe in denser areas, due to the narrower streets, the greater intensity of traffic, and the need to stockpile soil in the roadway or on nearby parking lots. Existing traffic will be burdened with additional movement of supply trucks and construction vehicles. Except for the disruption to traffic at the construction sites, the supply trucks will not significantly affect the flow of traffic.

Mitigation. Impacts to traffic will be minimized by giving prior notice to property owners, restricting trench excavation to short lengths at one time, and placing signage to indicate alternative routes. Soil will be stored off the shoulder of roads and away from driveway entrances wherever possible to minimize disruption of traffic and access to offstreet locations.

Air Quality and Odor

There will be a slight and temporary additional burden of air pollution from emissions of construction vehicles and supply trucks serving the construction sites. The emissions released will have an insignificant impact on the air quality of the Portland region. There should be no significant odors associated with the construction or operation of the separated storm sewers.

Noise and Vibration

Shallow bedrock occurs throughout the area where combined sewers are located. Blasting has been used to excavate the trench in previous sewer separation projects where bedrock is in the sewer alignment. Blasting will probably be necessary to excavate the trench in some areas.

Impacts. Blasting creates noise and may transmit shock waves along the bedrock to nearby structures. Typically, the blasting is confined in time and space so that the impacts on nearby sensitive receptors are temporary.

Mitigation. The impacts of blasting can be mitigated by using the smallest charge necessary, notifying neighbors when the blasting will occur, and by avoiding blasting where there is a reasonable possibility that shock waves could damage nearby structures.

7.3 CSO Facility Site Development and Operation

Construction of storage tanks, the storage conduit with chlorination and dechlorination, and sewer separation are all CSO strategies that require disturbance of the land. Storage facilities are typically large concrete tanks constructed below grade near a CSO discharge point or somewhere upstream along the combined sewer. When CSO discharge points are closely spaced, combined sewage can be stored in a large conduit that cuts across and connects them. Table 7-3 lists the CSOs that will be reduced by the construction of a storage tank or conduit.

Table 7-3
Proposed CSO Storage Treatment Facilities

Receiving Water	CSO	Facility
Casco Bay	20	Storage tank, 1 million gallons
Back Cove	10-18	Storage conduit intercepting overflows, 4.4 million gallons, delivering flow to the FSPS with relief overflow near CSO 18 receiving chlorination (sodium hypochlorite) and dechlorination (sodium bisulfate)
Fore River	32	Storage tank, 0.2 million gallons

Siting Issues

Land Use, Access, and Ownership

CSOs 10-18. These nine CSOs discharge to Back Cove around its western and southern edge. The recommended solution for these CSOs is to consolidate their flow in a 10-foot-diameter storage conduit starting with CSO 10, around to CSO 18, and discharging to the FSPS. The recommended storage conduit would be constructed under Baxter Boulevard and the park area adjacent to the I-295 embankment along Marginal Way. This strip separates residential neighborhoods and institutional uses from recreational uses along the shore of Back Cove. Figure 5-8 shows the location of the storage conduit that connects CSOs 10-18. Chlorination and dechlorination equipment for the storage conduit overflow would be housed at the FSPS. This would not have any land use impacts because the activity is compatible with the surrounding land use of the FSPS.

The City has a 100-foot right-of-way centered on Baxter Boulevard which expands to a 175-foot right-of-way along Preble Street. The City has an easement between I-295 and Back Cove.

CSO 20. CSO 20 discharges to Casco Bay at the NEPS immediately to the east of Tukey's Bridge. The plan recommends a storage tank south of the access road to the Portland WWTF, immediately east of the NEPS. The storage tank would occupy an area of 8,400 square feet. Both sites are on property owned by the PWD. The site is in an industrial area dominated by the I-295 overpass and the Portland WWTF. The site is isolated from residential land uses. Figure 5-3 shows the proposed location for the CSO 20 storage tank.

CSO 32. CSO 32 discharges to the Fore River. The recommended solution for CSO 32 is to construct a storage tank just to the southeast of the pumping station on land owned by the PWD. The tank would occupy an area of 324 square feet.

The location of the storage tank site is shown in Figure 5-12. Access to the pumping station site is south along Sewall Street, across the Portland Terminal Railroad and along a gravel driveway over the sewer right-of-way. The site is located in the midst of an industrial zone.

Floodplains

The sites proposed for CSO storage facilities are not in the FEMA 100-year floodplain. The site for the recommended storage facility for CSO 20 is close to the floodplain.

Wetlands

The storage conduit for CSOs 10-18 under Baxter Boulevard and the park area paralleling Marginal Way will not impact wetlands. Part of the storage tank site for CSO 20 contains a narrow band (<35 feet) of emergent and scrub/shrub wetlands at the base of the hill south of the Northeast Pumping Station. The construction of a storage tank for CSO 32 should not impact wetlands. Tidal wetlands are located at the bottom of an adjacent steep slope at the site for CSO 32.

Trees and Landscaping

The site for the CSOs 10-18 storage conduit connection to the FSPS is a grassed area. The site for the proposed tank at CSO 20 is predominantly grassed but includes some shrubs along its southern edge. Several trees planted to landscape the Thompson's Point Pumping Station are on the site for the storage tank at CSO 32. There are many mature street trees lining both sides of Baxter Boulevard between CSOs 10 and 16.

Wildlife Habitat

The area proposed for the conduit between CSOs 16 and 18 is covered with turfgrass and does not provide cover for wildlife. This is also true for the FSPS area. The CSO 32 location is landscaped immediately adjacent to a tidal marsh. Baxter Boulevard and its shoulders, the site of the storage conduit for CSOs 10-16, do not provide food or cover for wildlife. Most of the site for CSO 20 storage tank is turfgrass and offers little habitat. However, the arboreal species on the southern edge of the site have some habitat value.

The Department of Inland Fisheries and Wildlife has no record of mapped essential or significant wildlife habitats associated with any of the proposed locations for storage tanks. However, the agency indicates that Back Cove has been identified as an important coastal concentration for aquatic birds; the Stroudwater River estuary in Portland is also identified as a concentration area.

Back Cove provides habitat year round or seasonally to a number of marine wildlife, according to the *Casco Bay Coastal Resources Inventory* (State of Maine, Department of Inland Fisheries and Wildlife, 1981). Back Cove, the recipient of CSOs 5-19, has a high priority rating for aquatic wildlife habitat for the fall (September 1 to November 30) and spring (February 16 to April 30) seasons, and medium high for nesting (May 1 to June 30) and postnesting (July 1 to August 31) periods. The inventory shows that there are 14 species or types of aquatic birds that are expected to occur in the cove. The black duck, herring gull, and other gulls are expected year round. Cormorant, snowy egret, various shorebirds black-beaked gull and other gulls are expected to nest in Back Cove. The cove has other birds that are expected to use the cove for habitat at other seasons of the year including: great blue heron, scaup, goldeneye, bufflehead, old squaw, merganser, and various terns.

Threatened and Endangered Species

According to the Maine Department of Economic and Community Development, the Maine Natural Heritage Program has no record of any animals, plants, or natural communities that are endangered, threatened, or considered rare in Maine. However, agency records indicate that none of the areas proposed for CSO storage tanks have been inspected for rare or unusual plants, animals, or natural communities. A field trip by a qualified biologist did not reveal the presence of rare or unusual species or natural communities at any of the CSO sites.

Cultural Resources

According to MHPC, storage structures for CSOs 20 and 32 pose no threat to either historic or prehistoric resources. However, MHPC is concerned about the potential visual impact that any entrances to the storage conduit for CSOs 10-18 may have on the park along Baxter Boulevard and Back Cove.

Summary of Siting Issues

The brief description of the sites and alignments proposed for construction of CSO storage and transmission facilities identifies constraints to their development and operation. Table 7-4 summarizes the potential environmental constraints of each site or alignment.

Table 7-4
Environmental Constraints on Candidate Sites for CSO Facilities

Constraint	FSPS[2]	10-18	20	32
Adjacent land use (1)	-	+	-	-
Private ownership	-	-	-	-
Poor road access (1)	-	-	-	-
Hazardous waste potential	-	-	-	-
Steep slopes at edge (1)	-	-	-	+
Floodplain	-	-	-	-
Wetlands	-	-	+	-
Large trees	-	+	-	+
Wildlife habitat	-	+	+	+
T & E species	-	-	-	-
Cultural resources	-	+	-	-

Key: + site constraint
- no site constraint
(1) Constraint during construction phase only.
(2) Site of chlorination/dechlorination equipment for CSO 10-18 storage conduit.

Construction and Operational Issues

Land Use Compatibility

The storage tanks and storage conduits are located below ground. After each major storm, City workers will enter the storage facilities to wash them down.

Impacts. The storage tank site and any associated entrance structure for CSOs 20 and 32 are in areas that are surrounded by industrial uses or transportation corridors. There are no land use or aesthetic impacts from the construction and operation of CSO storage tanks at these sites. An entrance structure to the storage conduit for CSOs 10-18 may have a negative aesthetic impact along Baxter Boulevard. If a structure is necessary, then it should be placed to minimize visual impact and be screened by vegetation. Proposed chlorination/dechlorination operations at the FSPS site are compatible with existing uses.

Excavated Material Disposal and Erosion Control

Construction of all CSO storage facilities requires disturbance and stockpiling of soils and the disposal of excess excavated material.

Impacts. Earth disturbance at all sites has the potential for erosion and sedimentation. Erosion is of particular concern at the site for CSO 32 due to the steep slopes and the proximity of wetlands to the site.

Mitigation. Erosion control measures should be installed and maintained at all CSO storage facility construction sites in accordance with Soil Conservation Service recommended practices. Disturbed areas should be backfilled and seeded, or paved, in the case of Baxter Boulevard, as soon as possible after construction. The banks at CSO 32 should be stabilized with sheet piling prior to excavation to prevent soil and fill material from washing or collapsing into wetlands and surface waters. Suitable sites for disposal of excavated material must be identified.

Hazardous Waste Potential

There is no known hazardous waste potential at any of the sites.

Floodplain Encroachment

Since the proposed storage tanks are not in the floodplain, there are no impacts on the floodplain.

Wetlands Encroachment

Construction of the proposed storage conduit for CSOs 10-18 and a storage tank at CSO 32 can avoid disturbance to wetlands. However, the storage tank at CSO 32 is adjacent to tidal wetlands. The storage tank at CSO 20 will encroach on a small wetland area.

Impacts. Impacts at the site for the CSO 20 storage tank may include clearing of a small area of wetland vegetation and removal of hydric soils.

Mitigation. Where wetlands cannot be completely avoided, impacts at the CSO 20 site can be mitigated by stockpiling and replacing hydric soils over the tank and returning the site to its original grade where it has encroached on wetlands. The Maine Department of Environmental Enforcement should be notified if wetlands are encountered at the CSO 20 storage tank site. Construction of the storage tank at CSO 32 should protect the bank of the tidal marsh by sheet piling along the top of the bank.

Removal of Trees and Landscaping

Sites vary in the amount of vegetation from none to old field and wetland edge.

Impacts. Turfgrass maintained as lawn would be disturbed to construct a storage tank for CSO 20 and to connect the storage conduit for CSOs 10-18 to the FSPS.

Although the trees lining Baxter Boulevard would not be removed by the construction of the storage conduit between CSOs 10 and 16, there is the possibility that some could be damaged directly by heavy construction equipment or indirectly by disruption of the root zone, lowering of the water table by open trench construction, or by compaction of the ground over the root zone.

Mitigation. Trees, bushes, and ground cover lost to construction for CSO 32 should be replaced close by. Grassed areas disturbed will be reseeded or resodded. The street trees in the construction zone along Baxter Boulevard will be protected by wrapping trunks against scarring, staking out an equipment off-limits zone around trees, avoiding excavation too close to trees, and scheduling excavation during the colder months of the year, if possible.

Loss of Wildlife Habitat

There is no significant wildlife habitat at the storage facilities for CSOs 10-18 and 20.

Impacts. Wildlife habitat at the tidal wetland edge and in the landscaped area of CSO site 32 may be temporarily disturbed during tank construction.

Mitigation. Impacts to wildlife habitat at CSO 32 can be minimized by scheduling construction for the fall and early winter. In all cases where habitat may be disturbed, there is similar habitat in adjacent areas for any species displaced.

Threatened and Endangered Species

There are no known occurrences of rare or unusual plants, animals, or natural communities at any of the proposed storage tank or conduit sites. All of the proposed sites are significantly altered from a natural condition and provide little habitat.

Cultural Resources

There will be no impact on either historic or prehistoric resources due to the construction or operation of the storage tanks at CSOs 20 and 32.

Impacts. The MHPC is concerned about potential visual impacts from any entrance structure to the storage conduit for CSOs 10-18 in the park setting of Baxter Boulevard and Back Cove.

Mitigation. The location and design of any access structure to the conduit for CSO 10-18 should be forwarded to the MHPC and to Portland's Friends of the Park Committee for review of potential visual impacts prior to final design and construction.

Recreational Opportunities

Storage facility sites at CSOs 20 and 32 are in industrial settings and provide no recreational opportunities. The storage conduit proposed for CSOs 10 through 18 would be along Baxter Boulevard and the I-295 embankment. These areas provide recreational opportunities.

Impacts. Use of the jogging path along Baxter Boulevard between CSOs 10-18 and the soccer fields next to Preble Street may be disrupted for installation of the CSO storage conduit but not impaired over the longer term. The temporary disruption will detract from the beauty of the Back Cove setting and may also interrupt the continuity of the path around the cove during the construction period.

Mitigation. Installation of the storage conduit under Baxter Boulevard should disrupt jogging and other recreational uses of the Back Cove path minimally by limiting the period of construction, scheduling construction during colder weather, and assuring continuity of the path around the active construction areas. In addition, disruption to recreational use of the Back Cove path can be reduced by scheduling work by road segment and completing one segment before opening the next.

Traffic

During the construction period, about five trucks per day will enter and leave the sites where storage tanks will be built to haul away excavated material. Trucks serving CSO 32 must travel about 1,000 feet along Sewall Street, a street of mixed uses, some of which are residential.

Trucks serving construction at CSO 20 pass through a nonresidential area before reaching arterials. The storage conduit for CSOs 10-18 will be constructed under Baxter Boulevard and the park area between Back Cove and the I-295 embankment. Access to the connection from the CSOs 10-18 storage conduit to the FSPS would be from Preble Street at the foot of the I-295 embankment.

Impacts. Residents along Sewall Street will be impacted by truck traffic serving the construction of the facility at CSO 32. These impacts are temporary and minor.

Construction of the storage conduit for CSOs 10-18 will require the closing of sequential sections of Baxter Boulevard, each for a 4-6 month period. Traffic normally using the closed segment would be rerouted, with potential congestion on the temporary routes. Baxter Boulevard residents depending on this street to enter their driveways would be inconvenienced during the period that construction occurs on their section, but would benefit from no traffic outside of working hours. Construction at the FSPS site will not generate significant traffic or interfere with existing traffic patterns.

Mitigation. The impact of truck traffic in neighborhoods near CSO 32 can be minimized by completing the excavation and construction in as short a time as possible.

Baxter Boulevard residents with driveways onto the Boulevard would have to use the same temporary surface as construction trucks to reach connecting roads away from the area.

It is possible, depending on cost and geotechnical factors, that the storage conduit under Baxter Boulevard could be installed by tunnelling. In this case there would be minimal interruption of access to and travel on Baxter Boulevard, except at tunnel staging points where machinery and trucks would be active and excavated material brought to the surface for removal.

Air Quality and Odors

Impacts. There will be a slight and temporary increase in air pollution. Construction vehicles, supply trucks, and excavation haul trucks serving the construction sites will release exhaust emissions. The amount released will have an insignificant impact on the air quality of the Portland region.

Normal operation and cleanout of the storage treatment facilities should eliminate the release of objectionable odors. The stored flow is very dilute wastewater. Disinfection operations will be contained and not generate odors or affect air quality.

Mitigation. Stored overflow from the combined sewers would be pumped or drained out within 24 hours of a storm event, allowing insufficient time for odor-producing anaerobic conditions to develop in the tanks. Tank vents could be equipped with activated carbon filters, if odor problems occur. Any accumulation of sediment in the tanks will be scoured and removed periodically.

Noise and Vibration

Shallow bedrock may be encountered during excavation for the storage tanks and conduits. If so, blasting would be used to loosen the rock for removal. There will be noise from construction equipment and vehicle traffic.

Impacts. Blasting creates noise and may transmit shock waves along the bedrock to nearby structures. Typically, the blasting is confined in time and space so that the noise impacts on nearby sensitive receptors are temporary.

Noise from construction equipment and traffic may impact residential areas and marine bird nesting sites adjacent to Baxter Boulevard where the storage conduit for CSO 10-18 will be installed.

Mitigation. The impacts of blasting can be mitigated by using the smallest charge necessary, notifying residents and other property owners particularly near CSOs 10-16, and 32 when the blasting will occur, and by avoiding blasting where there is a reasonable possibility that shock waves transmitted through the bedrock could damage nearby structures. Blasting should not occur during the nesting season of the aquatic birds expected to nest in Back Cove (May 1 to June 30).

Noise impacts on residential areas from construction equipment and traffic associated with the installation of the storage conduit for CSOs 10-18 can be partly mitigated by restricting the time of construction activity from 8 a.m. to 6 p.m. Construction should be scheduled for CSOs 10-18 to avoid the spring nesting season of the aquatic birds expected to nest in Back Cove (May 1 to June 30).

Coastal Zone Policies

The recommended plan to store combined sewer overflow for subsequent treatment provides significant positive benefits to Maine's Coastal Zone by responding to many of the nine Coastal Management Policies. The recommended actions will improve water quality and are compatible with recreational use of and public access to the waterfront.

Potential Environmental Concerns

The construction of CSO storage facilities will have certain impacts on the natural and built environments in and around the construction sites. Nearly all of these impacts are associated with the construction phase and most of these can be mitigated to some degree. Some impacts however, are more permanent and should be mitigated to the extent they can by sensitive location of the facilities where flexibility exists.

Table 7-5 summarizes the impacts that are likely to result from the construction and operation of the CSO storage facilities. The estimation of impacts assumes that all steps to mitigate impacts discussed in this section have been taken. Table 7-5 indicates that there are only two significant adverse impacts remaining after mitigation:

- **Land Use Conflicts.** Construction of the storage conduit for CSOs 10-18 under Baxter Boulevard will adversely affect adjacent residential and recreational activity on the path around Back Cove. The impacts on recreation are minimized if construction is scheduled during colder months when use of the path is low.

- **Traffic.** Installation of the storage conduit for CSOs 10-18 under Baxter Boulevard will adversely affect motor vehicle circulation on the Boulevard and adjacent residential streets. Construction activity will interfere with access to residential driveways off Baxter Boulevard.

These impacts will be temporary and end at the completion of construction. The significant adverse impacts on recreation and residential uses and on traffic circulation by construction of the storage conduit for CSOs 10-18 can be reduced to minimal adverse impacts if tunneling construction methods are feasible.

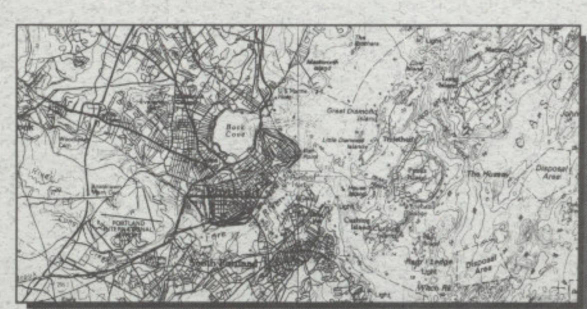
Table 7-5
Environmental Impacts of CSO Storage/Treatment Facilities

Environmental Impacts	CSO Control Facilities		
	10-18	**20**	**32**
Water quality	++	+	+
Land use conflict including noise (1)	--	o	o
Erosion of steep slopes (1)	o	o	o
Encroachment on floodplain	o	o	o
Encroachment on wetlands	o	-	o
Removal of significant wildlife habitat	o	o	o
Disturbance of aquatic bird nesting (1)	-	o	-
Disturbance of threatened and endangered species	o	o	o
Conflict with cultural resources	-	o	o
Recreational use short-term (1)	-	o	o
Recreational use long-term	++	o	o
Traffic (1)	--	o	o

Key:
++ = significant beneficial impact
\+ = minimal beneficial impact
o = no impact
\- = minimal adverse impact
-- = significant adverse impact

(1) Impact during construction phase only.

Implementation



Section 8
Implementation of the Recommended Plan

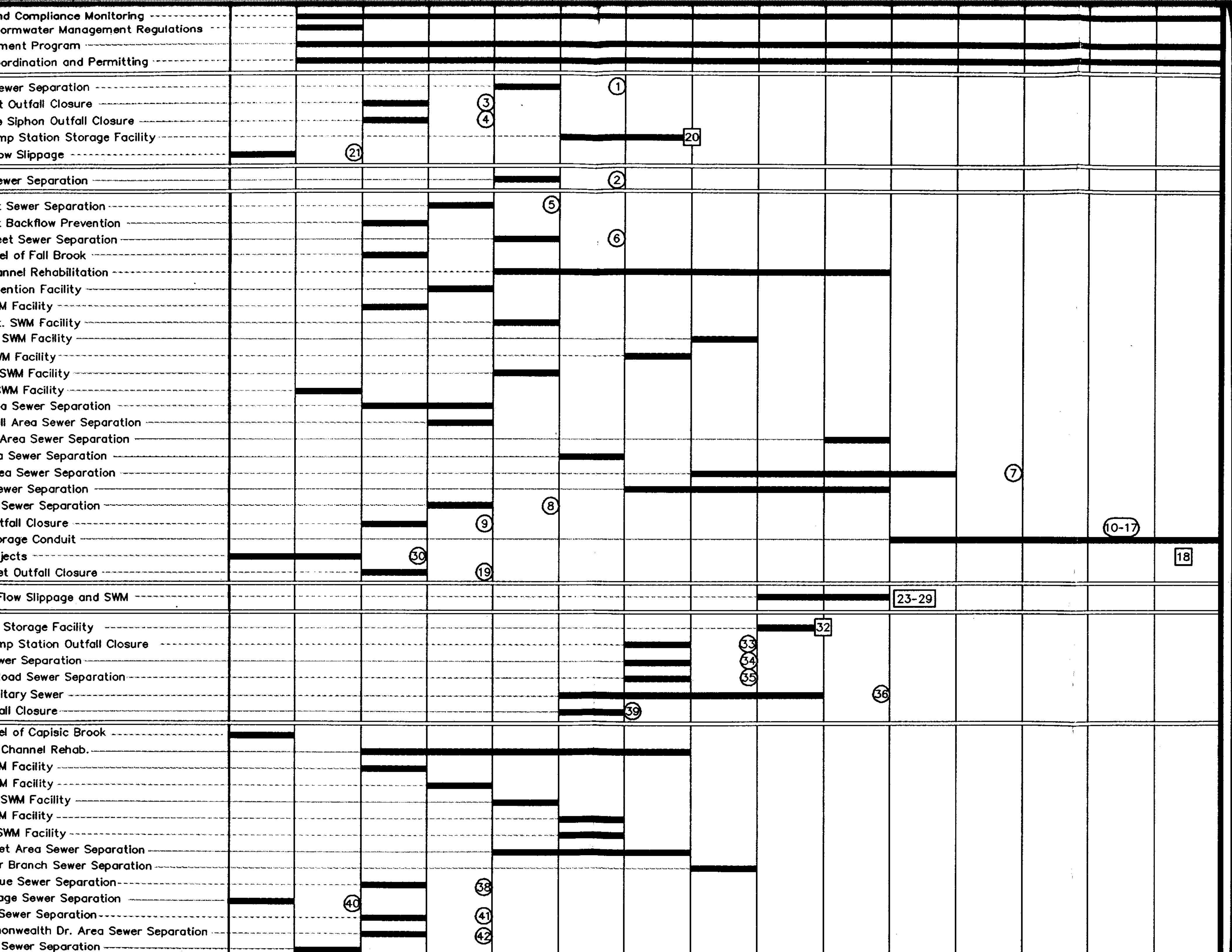
This section presents a proposed schedule for implementation of the recommended plan, requirements for permits that will govern the implementation process, and the compliance monitoring plan that will track achievement of goals of the plan.

8.1 Implementation Schedule

A proposed implementation schedule for the components of the CSO Abatement Master Plan, as described in Section 5, is shown on Figure 8-1. This schedule lays out a 15-year program, beginning in 1994, that will virtually eliminate 29 of Portland's 39 remaining CSOs. A tabulation of the capital expenditure for each year is also shown on Figure 8-1. Project cost estimates are provided in Section 6.

The proposed implementation plan is intended to accomplish the following objectives:

- Phase improvements to achieve the water quality based CSO control objectives defined in Section 4.
- Balance and regulate annual capital investment by the City.
- Include components that address the flooding and stormwater management needs integrally linked to the CSO problems.
- Provide for early completion of low cost components that yield the greatest reduction in CSO frequency and volume.



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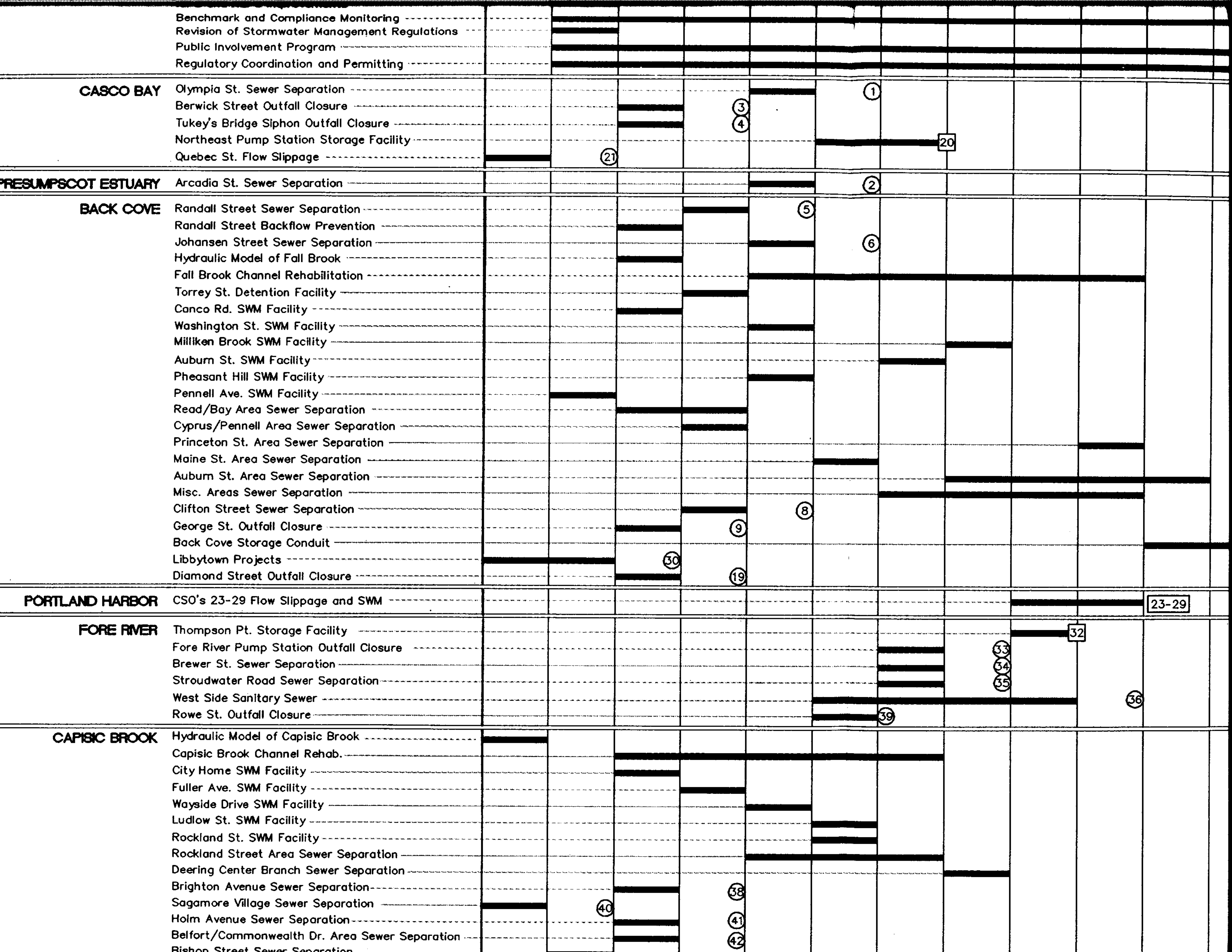

Benchmark and Compliance Monitoring
Revision of Stormwater Management Regulations
Public Involvement Program
Regulatory Coordination and Permitting
CASCO BAY
Olympia St. Sewer Separation
Berwick Street Outfall Closure
Tukey's Bridge Siphon Outfall Closure
Northeast Pump Station Storage Facility
Quebec St. Flow Slippage
PRESUMPSCOT ESTUARY
Arcadia St. Sewer Separation
BACK COVE
Randall Street Sewer Separation
Randall Street Backflow Prevention
Johansen Street Sewer Separation
Hydraulic Model of Fall Brook
Fall Brook Channel Rehabilitation
Torrey St. Detention Facility
Canco Rd. SWM Facility
Washington St. SWM Facility
Milliken Brook SWM Facility
Auburn St. SWM Facility
Pheasant Hill SWM Facility
Pennell Ave. SWM Facility
Read/Bay Area Sewer Separation
Cyprus/Pennell Area Sewer Separation
Princeton St. Area Sewer Separation
Maine St. Area Sewer Separation
Auburn St. Area Sewer Separation
Misc. Areas Sewer Separation
Clifton Street Sewer Separation
George St. Outfall Closure
Back Cove Storage Conduit
Libbytown Projects
Diamond Street Outfall Closure
PORTLAND HARBOR
CSO's 23-29 Flow Slippage and SWM
FORE RIVER
Thompson Pt. Storage Facility
Fore River Pump Station Outfall Closure
Brewer St. Sewer Separation
Stroudwater Road Sewer Separation
West Side Sanitary Sewer
Rowe St. Outfall Closure
CAPISIC BROOK
Hydraulic Model of Capisic Brook
Capisic Brook Channel Rehab.
City Home SWM Facility
Fuller Ave. SWM Facility
Wayside Drive SWM Facility
Ludlow St. SWM Facility
Rockland St. SWM Facility
Rockland Street Area Sewer Separation
Deering Center Branch Sewer Separation
Brighton Avenue Sewer Separation
Sagamore Village Sewer Separation
Holm Avenue Sewer Separation
Belfort/Commonwealth Dr. Area Sewer Separation
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- Phase improvements, especially high cost controls, to allow for program modifications based on results from the on-going flow monitoring work and actual performance of controls already completed.

- Include a public involvement program to coordinate work with community groups.

In the Fall Brook and Capisic Brook watersheds, for which comprehensive watershed management programs are recommended, the intent is to address areas with a history of flooding and sewer back-ups first. Such areas include the Bay-Read Street area, the Cyprus-Pennell Street area, and several areas along Capisic Brook. In several cases, sewer surcharging, flooding, and CSOs will be alleviated by reductions in flows in the interceptor downstream. In general, work should proceed in the upstream direction with the most downstream projects first, e.g., the WWTF and pump station capacity increases. Brook capacity to convey increased flow must be provided for Fall Brook and Capisic Brook before substantial additional separation is completed.

Several projects now under construction or in design are included in the schedule for completeness. Such projects include the Quebec Street flow slippage project, the Libbytown projects, and the Holm Avenue and Warren Avenue separation projects.

Each component on Figure 8-1 includes the planning, design and construction phases of the project. The actual durations are approximate. The schedule is intended to reflect only the relative order and timing of each project. The actual schedule must be modified, as the program proceeds, to reflect numerous, unpredictable issues that arise during permitting and implementation. The financial analysis, the results of which are covered in Section 9, is based on the proposed implementation schedule.

8.2 Permit Requirements

Several permits, licenses, and approvals are required for the construction and operation of the proposed facilities. Permits, licenses, and approvals should coincide with the phased implementation of the plan. The agencies issuing these requirements include:

- Federal
  - U.S. Army Corps of Engineers (ACE)
  - U.S. Environmental Protection Agency (EPA)

- State
  - Maine Department of Environmental Protection (DEP)
  - Maine Department of Transportation (DOT)
  - Conservation Department

- Municipal
  - City of Portland Department of Parks and Public Works
  - City of Portland Planning Department

Table 8-1 provides a summary of permit requirements. This list is not all-inclusive; other requirements may be necessary. A brief description of the permits and licenses follows.

Federal Permits

U. S. Army Corps of Engineers

Permits must be obtained from ACE for construction of a discharge structure in navigable waters (Rivers and Harbor Act, Section 10), and for work in wetlands (Section 404 of the U. S. Clean Water Act). There are three types of permits that the ACE may grant for

Table 8-1
Summary of Permit Requirements

Permits and Licenses	Modify WWTF	Controls for CSO																
		1	2	5	6	7	8	10-18	20	23-29	30	32	34	35	36	38	41	42-43
ACE Nationwide and General Permit	–	○	○	○	○	●	○	–	–	–	○	–	○	○	●	○	○	●
ACE Individual Permit	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
EPA NPDES and Stormwater Discharges	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DEP (NRPA) Permit/Coastal Zone Mgmt.	–	○	○	○	○	○	○	○	○	–	○	○	○	○	○	–	–	–
Waste Discharge License	+	*	*	*	*	*	*	○	○	–	*	○	*	*	*	*	*	*
State Conservation Department Lease Agreement	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
DOT Utility Location Permit	–	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
DOT Opening Permit	–	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
City Street Opening Permit	–	●	●	●	●	●	●	●	–	●	●	–	●	●	●	●	●	●
City Site Plan Approval	–	○	○	○	○	●	○	●	○	○	○	○	○	○	●	○	○	●
City Shoreland Zoning Ordinance	–	●	●	●	●	○	●	●	●	●	●	●	●	●	○	○	○	○

● A permit/formal proceedings will be required.
○ A permit/formal proceedings may be required upon further determination of the agency.
* Modify existing permit when the CSO is deactivated [The existing permit should also be modified to remove other CSOs not in this table which are deactivated (i.e., CSOs 3, 4, 9, 19, 21, 31, 33, 37, 39, and 40)]
+ Modify existing permit
– A permit/formal proceedings will most likely not be required.

<u>Summary of Projects</u>
Sewer Separation: CSOs 1, 2, 5, 6, 7, 8, 30, 34, 35, 36, 38, 41, 42-43
Storm Water Management: CSOs 7, 36, 42-43
Storage Conduit with chlorination and dechlorination: CSOs 10-18
Storage Tanks: CSOs 20 and 32

wetlands work depending on the complexity and nature of the projects: nationwide, general, and individual permits.

Nationwide and General Permits. Nationwide and general permit applications are designed to provide cursory review of projects that are anticipated to have minimal impact of jurisdictional wetlands. The Code of Federal Register 33 CFR Part 330, November 22, 1991, lists the most recent types of nationwide permits that may be granted. General permits are required under conditions similar to those that warrant nationwide permits. They are reviewed and granted on a case-by-case basis.

Individual Permits. Individual permit applications require extensive review, including comments generated from other federal and state agencies such as the Department of Inland Fisheries and Wildlife, Department of Marine Resources, and the Maine DEP. An individual permit must be obtained when more than 25 cubic yards of fill is proposed below the normal high tide of the coastal wetland. If an individual permit application is required, the applicant must demonstrate two points:

1. An alternatives analysis must be performed to show that both the no-build alternative and all other alternatives are not feasible.

2. A mitigation design must be proposed for the enhancement, reparation or replacement of wetlands disturbed.

General Guidelines. Although the ACE has guidelines for assessing which of the three types of permits may be required, applicants are encouraged to request predetermination of jurisdiction and exact permitting requirements before spending time and money developing the application. For any proposed construction location, a wetland delineation must be made to determine whether or not the proposed structure lies within jurisdictional wetlands. If the structure and related construction activities are located in upland areas and do not effect wetlands, the ACE has no jurisdiction and no permit is required. If the activity is located within a wetland, it may be permitted under the nationwide permit process provided it meets the specific criteria. These can only be determined after preliminary design and exact construction locations are determined.

U.S. Environmental Protection Agency (EPA)

Under the National Pollutant Discharge Elimination System (NPDES), EPA issues WWTF discharge limitations permits and reviews new stormwater discharges. EPA has recently enacted preliminary stages of review for stormwater outfall permitting. It is anticipated that water quality analysis of storm drain outfalls will be required in the future to determine the extent of their impact on receiving water quality. Current requirements apply to municipalities with population greater than 100,000. Portland does not meet this guideline and should not be required to apply for permit for a new stormwater outfall.

State Permits

Maine Department of Environmental Protection (DEP)

Natural Resources Protection Act (NRPA) Permit. The Land Bureau of DEP monitors work in jurisdictional wetlands. A wetlands delineation accepted by the Army Corps of Engineers is accepted by the DEP. Wetlands alteration is reviewed and permitted under the State's Natural Resources Protection Act. Anyone proposing the construction of a structure within 100 feet of a tidal shoreline must apply for a Natural Resource Protection Act Permit from the Land Quality Control Bureau of DEP. A Permit-by-Rule may be obtained if the proposed construction is set back at least 25 feet from the shoreline on land with a minimal slope. Setback distances increase as the intervening slope increases. The DEP may grant Permit-by-Rule under cursory review and certain guidelines for anticipated minimal impacts. The placement of outfall pipes including ditches and drain tile and placement of riprap may be eligible under Permit-by-Rule. A full permit is required if the proposed construction is within 25 feet of the shoreline or within 100 feet of the shoreline if Permit-by-Rule criteria cannot be met.

The State of Maine initiated a coastal zone management program in 1978 in accordance with the United States Coastal Zone Management Act of 1972. Through the program, the state reviews proposed activities in areas such as port and harbor development, marine resources management, and shoreline management and access. The program is administered through the State Planning Office in conjunction with the DEP and the Maine Department of Conservation. No separate permitting process exists for coastal zone activity outside of the regulations and requirements already set forth under the Natural Resources Protection Act. The Maine DEP concurrently reviews any and all NRPA projects, including permit-by-rule applications, for conformity with coastal zone management principles.

Utility lines may be installed across coastal and freshwater wetlands. Proposed isolated storm drain outfalls may be exempt if their locations are above the delineated wetlands, or located in uplands.

Waste Discharge License. The Water Quality Bureau issues waste discharge licenses. A Waste Discharge License is required to discharge effluent from CSO facilities to surface waters must be obtained from the Department of Environmental Protection, Water Quality Control Bureau, License and Enforcement Division. A license to discharge may be required for CSO locations that are modified as a result of the construction of CSO storage facilities. No waste discharge licenses are required for separated storm drain outfalls.

Modification to the Waste Discharge License (both state and federal) for the WWTF is required for the proposed increase of flows. Specific modifications include:

- Allowance for additional flow
- Reduced primary treatment effluent limitations during peak wet weather events

State Conservation Department

In addition to permits, a Lease Agreement must be requested from the State Conservation Department, Public Lands Bureau, if new outfall structures from CSO facilities are placed on the bottom of tidal waters.

Maine Department of Transportation (DOT)

The DOT issues two types of permits applicable to the proposed CSO controls: a utility location permit and an opening permit.

Utility Location Permit. A utility location permit allows any entity to locate utilities within the DOT right-of-way. This permit would allow a storm drain crossing, a storm drain outfall, storage of stormwater, and the storage of CSO.

Opening Permit. The second permit typically required is an opening permit allowing construction within the DOT right-of-way. This permit requirement is waived, however, when the right-of-way is otherwise maintained by the municipality.

Municipal Permits

City of Portland

Street Opening Permit. The City of Portland Department of Parks and Public Works requires any contractor proposing construction within a City right-of-way to also acquire a street opening permit. An exception is granted where the property is not owned in fee, but where an easement exists for such work.

Minor Site Plan Approval. The City of Portland Planning Department reviews proposed construction that includes the alteration of a watercourse drain or swale under the Minor Site Plan review process. Minor proposals generally require only staff review, or no formal Planning Board review process. The Portland Planning Board does have jurisdiction over buildings and other structures which would be included in any CSO control. The nature of their review and possible zoning conflicts could not be determined until preliminary designs are completed.

City of Portland Shoreland Zoning Ordinance. The City of Portland has adopted standards for construction within those areas designated as Shoreland and Resource Protection zones. Municipalities are required to comply, at a minimum, with the Mandatory Shoreland Zoning guidelines as adopted by the State of Maine and administered by the DEP. The City of Portland has adopted Shoreland Zoning guidelines for the following:

> "...all land areas, uses, structures and land use activities within two hundred fifty (250) feet, horizontal distance, of the normal high water line of any river of saltwater body; within two hundred fifty (250) feet, horizontal distance, of the upland edge of a coastal or freshwater wetland; and within seventy-five (75) feet, horizontal distance, of the normal high water line of a stream"

Two regulated activities within the Shoreland Zone include clearing of vegetation and erosion/sedimentation control. Within resource protection zones, clearing is allowed but limited to that which is "necessary for uses expressly authorized in that zone." In all other areas, a buffer strip of seventy-five (75) feet in horizontal distance from the edge of the resource is required with strict guidelines for maximum clearing amounts. An erosion and sedimentation control plan in accordance with the Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices, published by the Cumberland County Soil and Water Conservation District and the Maine Department of Environmental Protection.

Two recent amendments to the state's Shoreland Zoning laws include the determination that forested wetlands are not defined as "Freshwater Wetlands" under the Shoreland

Zoning Act, and the allowance for municipalities to reduce the Shoreland Zone abutting freshwater wetlands to 75 feet from 250 feet if the wetland is not rated as moderate or high value by the Inland Fisheries and Wildlife Department, and if stream protection zone requirements are applied to any outlet streams from the wetland. At present, the City of Portland Shoreland Zone still extends 250 feet from the edge of designated freshwater wetlands.

Although no specific permit is issued for construction within the Shoreland Zone, conformity of a proposed activity with ordinance guidelines are reviewed during the City of Portland's Site Plan review process.

Stormwater Management and Erosion Control Design. Although not specifically required to execute a drainage maintenance agreement under its own stormwater management and erosion control design standards, the city and its contractors should abide by the requirements of those standards in implementation of the recommended plan.

8.3 Benchmark and Compliance Monitoring

Pursuant to the Consent Agreement, the City of Portland and the Portland Water District will implement a compliance monitoring plan that tracks the progress in achieving the receiving water quality goals of the CSO Abatement Master Plan. The compliance monitoring plan will commence upon acceptance of the Master Plan by the DEP and will continue during the implementation and on-going operation periods of the plan.

Purposes of the Monitoring

The overall purpose of the program is to monitor CSO discharges and receiving water quality in order to evaluate the achievement of CSO control and water quality goals established in the CSO Master Plan. Goals established in the Master Plan set forth targets for:

- Consolidation and/or elimination of CSOs
- Reduction of overflow frequency and/or volume at remaining CSOs
- Increased pumpage and flow to the WWTF during wet weather
- Elimination of street and basement flooding due to combined sewer surcharging
- Increased use of natural channels for conveyance of stormwater
- Control of quality of new stormwater discharges

Because the implementation of the plan will occur over a period of years, a second major purpose of the monitoring program is to provide feedback regarding the success of certain components of the plan in achieving CSO control and water quality goals. This will allow adjustment of the plan based on actual implementation experience. The plan should be reviewed on an annual basis, using monitoring and cost data for the previous years to revise the type, priority, and design of projects comprising the plan. This annual review will also provide for on-going public input to the implementation process, which will be important, especially in the Capisic and Fall Brook watersheds.

Components of the plan include:

- Benchmarking existing conditions
- Short term monitoring
- Long term compliance monitoring
- Use of the sewer system simulation model

- Compliance reporting
- Data base management

A preliminary monitoring plan is presented in Table 8-2.

Benchmarking Existing Conditions

Benchmarking existing conditions will be important in measuring progress of the plan. Most of the information necessary for establishing existing conditions is available with respect to CSO location, frequency, and volume. Additional flow data is needed for design of the storage facilities for CSOs 10-18 and 20. Flow characteristics at CSO 32 are understood well enough to negate the need for benchmark monitoring. Unfortunately, structural constraints make flow monitoring difficult at several of the sites in the CSO 10-18 group. CSOs 10, 13 and 16 are recommended as benchmark flow monitoring locations for the design of the storage facilities.

Also, increased pumping to the WWTF at the Northeast and India Street pump stations will change the overflow conditions at CSO 20 at the NEPS and CSOs 23-29 along Portland Harbor. Although these overflows should be monitored to calibrate the system for the increased treatment plant rate, most of the locations are not amenable to flow monitoring. Recommended benchmark flow monitoring sites are CSOs 20, 23, and 28.

Revised estimates of existing conditions, annual frequency, and volume of CSO at several key overflows could result from the benchmark flow monitoring. Benchmark flow monitoring will be performed until sufficient data is collected to confirm the need for, and the required sizing of, facilities.

Table 8-2 Preliminary Monitoring Plan		
Location	**Parameters**	**Frequency**
Benchmarking Existing Conditions		
CSOs 10, 13, 16, 20, 23, and 28	Flow monitoring[1]	Continuous
Short Term Monitoring		
CSOs 5, 6, 7, 36, and 42	Flow monitoring[1]	Continuous
CSOs 3, 4, 9, 19, 33, and 39	Block testing	Continuous
Long Term Compliance Monitoring		
CSOs 18, 20, and 23	Flow monitoring[1]	Continuous
	Enterococcus, fecal coliform, temperature, and pH	Every other year
CSOs 24, 26, 27, 28, 29, and 32	Block testing	Continuous
Receiving Waters: Back Cove, Fore River, and Capisic Brook	Quality[2], temperature, and conductivity	Every other year during dry and wet weather between May 15 and September 30
Street and basement flooding	Field surveys/interviews	After significant storm events

[1]Continuous depth recorders are preferred; however, some locations may not be amenable to their use. The specific method of flow monitoring will be determined prior to inception of the program.

[2]Quality parameters include: E coli. for freshwaters; Enterococcus and fecal coliform for marine waters.

Short Term Monitoring

The proposed closure of several large CSOs will require implementation of several separation and stormwater management projects over a period of years. These overflows are:

CSO	5	Randall Street
CSO	6	Johansen Street
CSO	7	Ocean Avenue
CSO	36	Capisic Pond Dam
CSO	42	Warren Avenue

Flow monitoring of these CSOs will be required to track the success of each project in reduction of CSO frequency and volume.

Block testing will be performed at CSO locations recommended for closure. Those overflows which demonstrate inactivity for local large precipitation events will be permanently closed.

Long Term Compliance Monitoring

The long term compliance monitoring program incorporates several objectives including monitoring CSO activity and quality, receiving water quality, and field surveys of areas prone to flooding.

CSOs. Ten CSOs will remain open after implementation of the plan: CSOs 18, 20, 23-29, and 32. Flow at CSOs 18, 20, and 23 will be monitored continuously. Block testing will be performed at seven out of the remaining eight CSO locations. The configuration of the CSO 25 regulator structure is not amenable to either flow monitoring or block testing.

Every other year, water quality samples will be collected from the storage facilities when they are discharging CSO. The samples will be analyzed for a limited list of parameters to estimate the pollutant concentrations of overflows from the facilities. Measurement of first flush pollutant concentrations would not provide meaningful data at storage facilities. Actual overflows from the facilities are not required to obtain a reasonable estimate; a sampler can be located at the influent location but activated by a sensor at the overflow location.

Receiving Waters. Receiving water samples will be collected every other year for a limited list of parameters during both dry and wet weather periods. Dry weather samples will be collected to help define ambient conditions. Wet weather samples will be collected after a large storm event that triggers a CSO at storage facilities. Sampling results will reflect the impact of all wet weather sources and not differentiate the impact of Portland's CSOs on receiving water quality. The purpose will be to assess overall receiving water response rather than the effect of a given CSO at a particular location.

Receiving waters recommended for sampling include Back Cove, Fore River, and Capisic Brook. Receiving water data in Casco Bay at East End Beach is routinely collected by the PWD and intermittently by DEP. Portland Harbor is not recommended for receiving water monitoring due to the various pollutant sources which impact its quality. Specific locations within each receiving water may vary every other year depending on the progress of implementation of CSO controls. Specific locations will be determined prior to inception of the program.

Street and Basement Flooding. Resolving street and basement flooding is a key goal of the plan. Surveys of residents in flood prone areas will be conducted after significant storm events to track the effects of improvements and set priorities for future work.

Use of the Sewer System Simulation Model

At present the CSO Abatement Model for the Portland system is suitable for planning level and preliminary design decisions related to CSO and stormwater management. As the sewer flow data base is expanded, model calibration should continue to be refined. Sections of the model can be and have been separated from the system model and expanded to include greater detail and additional subareas, (i.e., the Libbytown Model). This enhances its usefulness in watershed management. The goal of providing data to improve the calibration of SWMM has been considered in the layout of the preliminary compliance monitoring program.

Continuous improvement will allow the model to be used as part of the ongoing compliance monitoring program. Annual frequency and volume of CSO can best be estimated with the model. The model can also be used to reevaluate priority of future improvements based on hydraulic analysis using the latest information.

Compliance Reporting

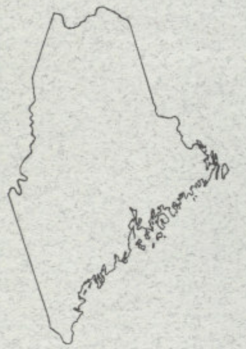
Each year, a summary of the accomplishments of the Master Plan will be prepared. It will include:

- Elements of the plan completed during the year
- Improvement in CSO control in terms of overflow frequency, volume, CSO deactivation, and elimination of street flooding
- Results of flow and water quality monitoring
- Proposed revisions to the remaining plan components, based on results to date

- Proposed revisions to the compliance monitoring program

Data Base Management

Data collected during the monitoring program must be organized, stored, and documented to assure its continuing value. Experience indicates that commonly used spreadsheet programs are the most successful tools for managing water resources monitoring program data. These employ adequate graphic capabilities, are well supported and documented, are commonly used in the industry, are compatible with other data base management systems, are less expensive than more complex tools, and are generally easier to use. The EXCEL and LOTUS spreadsheet packages have been used successfully for similar data bases and would be candidates for the Portland program. It is important that the data base program selected be acceptable to the person responsible for use of the data.



Financial Evaluation

Section 9
Financial Evaluation

This section presents a financial evaluation of the project and assesses the impact of costs on households in the City of Portland. The area's ability to finance recommendations depends on a number of factors, including the economic and financial characteristics of the study area, the financial and revenue generation tools available to the City, policy decisions regarding the distribution of costs, the customer base over which the program's costs will be spread, and the potential for grant or loan assistance from federal or state agencies.

The following information is included in this section:

- Demographic/financial characteristics of the study area
- Description of CSO program parameters and costs
- Financing options available to the City of Portland
- Project financing assumptions
- Household financial results

Information related to formation of a CSO/stormwater utility and sources for the financial analysis are included as Appendix C.

9.1 Demographic/Financial Characteristics of the Study Area

According to the 1990 Census of Population and Housing, the population of the City of Portland is 64,358, residing in 28,230 households, approximately 2.3 persons per household. The 1989 median household income for the City of Portland, as reported in the 1990 Census, was $26,576. The City has approximately 14,900 residential and commercial customer accounts for sewerage purposes; in addition, there are approximately 40 regulated industries and 50 small unregulated industries.

Sewerage service rates are based on water usage and the current rate for service is $2.93 per hundred cubic feet (CCF). The minimum charge is based on two 100 cubic feet units of usage per month, which would result in annual charges of approximately $70 per year. The typical residential unit, based on average household size and consumption patterns, consumes approximately 69 CCF units of water per year; at current rates, the typical residential unit incurs approximately $200 per year for the sewerage service.

The City's population is expected to grow at a small rate. During the period from 1980 to 1990, the population grew by only 5 percent, from 61,572 to 64,358. Two percent growth in annual use of the sewer system is assumed in this analysis based on projections developed by the City. This growth rate is assumed to result from additional use from in-fill residential development and additional use by existing and new commercial and industrial customers.

9.2 Description of CSO Program Parameters and Costs

In order to assess the impact of financing the proposed CSO facilities, facility-planning-level cost estimates have been developed for recommendations in this plan. This analysis forecasts financial results of the recommended CSO alternative.

The estimated total capital construction cost for the recommended plan is approximately $52 million (expressed in 1992 dollars). Annual operation and maintenance (O&M) costs have been estimated at $575,000 per year (expressed in 1992 dollars). O&M costs will be phased into effect during the first 8 years of the program.

The financial impact of implementing the recommended facilities over 10- and 15-year implementation periods is evaluated here.

9.3 Financing Options Available to the City of Portland

User fees are currently used to pay for operation and maintenance of facilities and for capital outlays. Residential and commercial customers pay a flat rate of $2.93 per CCF of water consumption. Regulated industrial customers pay the following surcharges:

- $0.0857 per CCF
- $0.1633 per lb. of BOD over 250 mg/l
- $0.0817 per lb. of TSS over 300 mg/l

The financing mechanisms available to the City to pay for the proposed construction include:

- Sewer user fees
- General obligation (GO) bonds repaid by sewer user fees
- Special assessments (including possibility of stormwater/CSO utility)
- Grants
- Loans (e.g., State revolving loan program)

The City will explore opportunities for grant and loan funding assistance. Based on policy direction from the City, it is assumed that the local share of the project's capital cost will be financed with the 20-year General Obligation (GO) bonds; the debt service on the bonds is assumed to be repaid through sewer user fees.

The City is also interested in considering the establishment of a CSO/stormwater utility, which could result in fees based on impervious area. Appendix C outlines the steps that the City could follow in implementing a stormwater utility.

9.4 Project Financing Assumptions

Based on the policy direction from the City described above, it is assumed for the following financial analysis that funding for the capital costs required to implement the recommended program will be secured through the issuance of GO bonds with a 20-year term.

It is also assumed that the amount for each year's capital expenditures will be included in an annual GO bond issue by the City. Debt service for the portion of the bonds used for the CSO program will be repaid through user charges collected from sewerage system users. The bonds used to finance the CSO improvements would therefore be secured by the full faith and credit of the City plus the revenue-generating capability of the City's sewerage utility. It is assumed for the purpose of this analysis that these bonds will have an interest rate of 8 percent. The City issued GO bonds in July of 1992; these had an average interest rate of approximately 5.7 percent. The bonds received a rating of Aa1 from Moody's rating agency and a rating of AA from Standard and Poor's. The 8 percent interest rate is considered conservative and reflects the uncertainty of financial markets over the 10- to 15-year timeframe during which the CSO program will be implemented.

In addition to paying the debt service required for the recommended facilities, the financial analysis assumes that user charges will also continue to be used for:

- Debt service for previously issued bonds that have been used to fund sewerage facilities

- Operation and maintenance
  - Sewer maintenance
  - Emergency repairs

- Administration

- Labor costs, including fringe benefits

- Engineering and related studies

- Payments to the Portland Water District for collection and treatment services provided

- Future non-CSO capital improvement plan expenditures

It is also assumed that the distribution of charges among types of customers will not change significantly from the current rate structure. A detailed cost-of-service and rate study could result in changes to this assumption in the future. It is therefore assumed that the City will continue to generate revenues at approximately current levels from industrial surcharge and other miscellaneous revenue sources.

9.5 Household Financial Results

The financial impact results presented below are for a 20-year study period, which represents the traditional study period for facility planning evaluations. Capital and operating cost estimates are presented in non-inflated (i.e., 1992) dollars, so that the resulting financial impacts can be compared by review agencies and the public with recent household income figures.

15-Year Implementation Option

Table 9-1 shows the financial results for 10- and 15-year CSO program implementation options. For the 15-year scenario, the estimated annual cost to households would increase from approximately $200 today to approximately $250 during the average year and approximately $325 during the peak year of the study period. Because of the uncertainties in predicting the timing of both CSO and non-CSO expenditures over a 20-year period, the peak year charges shown in Table 9-1 reflect the peak estimated charges for each of the three elements that comprise the user charges (prior commitments, future CIP projects, and future CSO program costs). The current user charges represent approximately 0.75 percent household income for the median income household in Portland.

During the average year, implementation of the recommended plan is estimated to result in sewerage charges that would represent approximately 0.94 percent of median income; the average year charge for this scenario would be approximately 26 percent higher than current charges. During the peak year of program costs, user charges are estimated to represent approximately 1.22 percent of household income for a household with median income.

If the City experiences no growth in consumption rather than the 2 percent annual growth assumed in the base case analysis, the average year charge for a typical household is estimated to be approximately $305, which would represent approximately 1.15 percent of median household income; the estimated peak year charge of $379 would represent approximately 1.42 percent of median household income.

10-Year Implementation Option

For the 10-year scenario, the estimated annual cost to households would increase from approximately $200 today to approximately $262 during the average year and

Table 9-1
Projected Household Financial Impact
10-Year and 15-Year Implementation Options

	Baseline Sewer Charges			Future CSO Program Costs ($)	Baseline, CIP Plus Future CSO Projects ($)	Estimated 1992 Median Household Income ($)	Average Year Charge: Estimated Future Charge as a Percent of Median Income	
	Prior Commitments ($)	Future CIP Projects ($)	Total Baseline Charges ($)				Future CSO Program Costs (%)	Baseline, CIP Plus Future CSO Projects (%)
I. Current (1992) Charges	198	NA	198	NA	198	26,576	NA	0.75
I. CSO Program Implementation - 15-Year Option								
Average Year	180	10	190	60	250	26,576	0.23	0.94
Peak Year	214	18	232	94	325	26,576	0.35	1.22
II. CSO Program Implementation - 10-Year Option								
Average Year	180	10	190	72	262	26,576	0.27	0.99
Peak Year	214	18	232	103	335	26,576	0.39	1.26

NA = Not Available

Sources:

Current rates are based on data supplied by the City of Portland. Future rates have been estimated based on program cost estimates developed by the project staff and financing assumptions provided by the City. All cost estimates are represented in 1992 dollars.

Median household income estimates are based on 1990 census figures.

Peak year charges reflect the peak charges for each component of user charges (prior commitments, future CIP projects, and future CSO program costs).

Assumptions for this Run:

CSO Program Capital Cost $52,011,000

Bond Interest Rate: 8.00%
Bond Term (in Years) 20

approximately $335 during the peak year of the study period. During the average year, implementation of the recommended plan is estimated to result in sewerage charges that would represent approximately 0.99 percent of median income; the average year charge for this scenario would be approximately 32 percent higher than current sewer charges. During the peak year of program costs, user charges are estimated to represent approximately 1.26 percent of household income for a household with median income.

If the City experiences no growth in consumption rather than the 2 percent annual growth assumed in the base case, the average year charge for a typical household is estimated to be approximately $319, which would represent approximately 1.20 percent of median household income; the estimated peak year charge of $379 would represent approximately 1.42 percent of median household income.

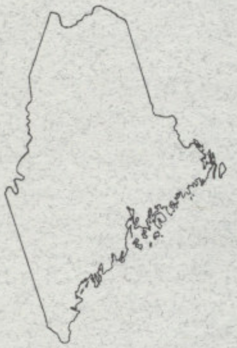
Affordability Considerations

Guidance documents published by the U.S. EPA have suggested that when a community's total sewerage charges exceed 2 percent of annual income for the median income household, a sewerage program may be considered to impose financial hardship on the community. As shown in Table 9-1 and the discussion above, the projected sewerage rates for implementing the recommended CSO facilities fall within the recommended guidelines.

The analysis presented here assumes that the City will fund the entire project locally. Diligent efforts on the part of the City to control project costs during the design and project delivery phases could lower the costs of the project and resulting user fees to sewer system customers.

The City may qualify for grants or low-interest loans to fund a portion of the projects which could result in a reduction of the percent of household income needed for sewerage system costs. Under current conditions, however, the City would be unlikely to qualify for grant funding for the CSO program. Grant funds at the state level are very limited, and only certain types of CSO-related facilities would qualify for grants. Also, according to rules currently used to distribute grants by the State of Maine, projected sewerage charges for the median income household must exceed 2 percent in order for the City's CSO program to qualify for a grant.

There is a better chance that the City's CSO program could qualify for a low-interest loan from the state revolving loan fund. The loans offered through this fund are offered at terms of up to 20 years, and offer interest rates approximately 2 percent below market rates. This could reduce the annual charge to homeowners by approximately $9 per year during the average year. For example, for the 15-year implementation plan, Table 9-1 shows that the average year cost to a typical household would be approximately $250. With a 2 percent reduction in interest rates, the typical charge would drop to about $241. The peak year charge for this alternative would drop from about $325 to about $311 with a 2 percent interest rate reduction. Other federal grant funding could potentially be available from the Federal Emergency Management Agency (FEMA) or from EPA.



Public Participation

Section 10

Public Participation Plan

The two primary objectives of the public participation plan are:

- To further improve the recommended plan and make it more responsive to the desires and concerns of the affected communities

- To encourage and provide a basis for continuing public involvement that works in partnership with the City and mobilizes the resources and talents of the community in the management of the watersheds

To accomplish these objectives, the public participation plan consists of several components:

- Monthly Progress Review Meetings
- Public comment meetings
- City Council presentation
- Technical Workshop with regulatory groups
- Environmental Resources Workshop
- Continuing public participation

The CSO Abatement Master Plan is the result of a planning process that began three years ago. Considerable guidance during this process has been provided by City staff, the PWD staff, regulatory agencies, environmental groups, and others. The continuing public participation plan conducted over the past year has provided a forum for generating comments, suggestions, and feedback from those interested in and impacted by the recommended CSO Abatement Master Plan.

To be successful, the CSO Abatement Master Plan must not only satisfy the requirements of the Consent Order with the DEP, but must also address the priorities and goals of the communities that will be affected by the recommended improvements. During the development of the recommended plan, emphasis has been placed on alternatives that not only solve the CSO problem, but also address associated problems with aged sewer facilities, combined sewer surcharging, street flooding, basement flooding, stream channel degradation, and the need for open space and recreational facilities.

To achieve these latter goals, in conjunction with CSO control, input to the plan is needed from community and neighborhood groups that presently experience these problems and will be impacted by the proposed CSO improvements. Support from the communities is also critical during implementation of the plan over the coming years and in the future management of the watersheds to achieve proposed recreational and water quality goals. The following paragraphs summarize the public participation activities.

10.1 Monthly Progress Review Meetings

During 1991 and 1992, monthly workshop meetings were held to inform interested groups and to generate comments and input to the planning process for CSO abatement. Presentations were made at these workshops on subjects such as infiltration/inflow, computer modeling of the sewer system, development of CSO control alternatives, program costs, and water quality studies.

Attendees at the monthly progress meetings included the City's Public Works Director, City engineering and sewer maintenance staff, PWD staff, local and state Department of Environmental Protection representatives, Casco Bay Estuary Project, Friends of Casco Bay, Bay Keeper, South Portland's CSO Coordinator, and the engineering consultant team. Typically, 10-15 individuals attended these meetings. Written and verbal comments were exchanged at these monthly meetings. The variety of participants' backgrounds resulted in a wide range of input and the development of a balanced plan.

Also, technical memoranda (TM) summarizing the results of important studies supporting decisions of the plan were distributed throughout the process to involved parties for review. These TMs and their key conclusions are summarized in Appendix B of this report.

10.2 Public Comment Meetings

The Draft CSO Master Plan was submitted to the DEP on December 1, 1992. Two public information meetings were held in May 1993 to present the plan, address questions, and solicit input in tailoring the plan to achieve CSO control and address neighborhood concerns.

The specific goals of the public comment meetings were to:

- Explain the impact of existing combined sewer overflows
- Provide an overview of the proposed control alternatives
- Discuss how the proposals will address the concerns of the neighborhoods
- Review implementation schedules and the costs to residents
- Receive comments that will be used to fine-tune the Master Plan recommendations

The meetings were held in specific sections of the City:

- Capisic Brook and Fall Brook watershed neighborhood
- Back Cove, Portland Harbor, and Casco Bay neighborhood

The City and consulting staff have also used other opportunities (i.e., presentations for related project work, presentations to specialty groups, etc.) over the past year to provide exposure of the plan and to address public comments that arise. Questions have been answered; however, no formal comments on the plan have been received from the public. To date, the public has been supportive of the controls selected.

10.3 City Council Presentation

The City Council has ultimate responsibility to respond to the needs and concerns of the community. It also oversees City finances and directs tax revenues and state/federal grants to projects that satisfy regulatory requirements and benefit the community. The general public makes its wishes known to the Council through district council members, and these councilors respond by supporting programs which benefit their constituents and the community at large.

The Draft CSO Master Plan was presented to a joint meeting of the City Council, the Planning Board, and the PWD trustees on May 27, 1993. This presentation provided an overview of the existing CSO impacts on Portland's streams and marine waters and the Recommended Plan to abate these impacts, along with proposed planning costs, and the financial impact to the community. No formal comments on the Draft Plan were received; however, support of the plan was expressed by several attendees.

10.4 Technical Workshop with Regulatory Groups

The public involvement plan must include many groups with differing concerns and understanding of the CSO issues and proposed control measures. A detailed review and discussion of regulatory and engineering issues was held on November 17, 1992, for the attendees of the monthly progress review meetings, other regulatory agencies, and an expanded City staff.

Since CSO controls will affect nearly every department of city government, the City Manager, planning, code enforcement, legal, recreation, and financial departments were invited to attend the technical briefing. Representatives of the U.S. EPA, Maine DEP, U.S. Fish and Wildlife, Friends of Casco Bay, and Portland Water District also participated. The details of the proposed Master Plan were presented for review and comment. Minutes of the meeting are in Appendix E.

10.5 Environmental Resources Workshop

While virtually every person is concerned with the environment in which they live, several local and national groups serve a leadership role for environmental causes. These groups are concerned with the present impacts of CSO and the effects any proposed controls will have on water quality.

A presentation was held on December 3, 1992 to focus on the environmental benefits and impacts associated with the proposed CSO control measures. Groups invited to this workshop included the Audubon Society, Friends of Casco Bay, the Island Institute, Natural Resource Council of Maine, Portland Trails, Conservation Law Foundation, Soil Conservation Service, and Friends of Capisic Pond. City staff involved in CSO control implementation also attended.

The concepts of watershed management as part of the plan for CSO control are of primary interest to these groups. Since approximately 90 percent of combined sewer overflow volume is stormwater, the importance of stormwater management, especially in the less developed Capisic and Fall Brook watersheds, becomes evident. Control of stormwater quantity and quality is a critical issue in the control of CSOs, as is the control of pollutants at their source rather than at their entry to the receiving waters. The methods, benefits, and problems associated with minimization of stormwater flow to the combined system was a key issue at this meeting. Minutes of the meeting are in Appendix E.

10.6 Continuing Public Participation

In some areas of the City, the Master Plan calls for CSO storage and pumping facilities or for flow slippage and sewer separation work, both of which would be constructed and maintained by City and PWD staff. In other areas, such as in the Capisic and Fall Brook watersheds, recommendations call for enhancement of natural stormwater management systems, development of open space and wetland systems, and revitalization of the natural stream channels in the watersheds. These approaches to CSO and stormwater management in the Capisic and Fall Brook watersheds involve land use decisions and management programs that require the active participation of community groups and individual citizens. The City has excellent working relationships with numerous citizen and environmental groups which have resulted in a partnership focused on improving quality of life as well as satisfying regulatory requirements. The City is eager to maintain and develop these partnerships to ensure that water quality and flood control programs meet the priorities of the citizens of the watersheds.

The public participation plan will not end with acceptance of the Master Plan. Community and environmental groups will continue to be involved in programs such as the following:

- Citizen water quality monitoring programs
- "Adopt-a-Brook" stream channel maintenance and enhancement programs
- Project review groups
- Environmental education programs
- Trail and open space planning teams
- Assistance with newsletters and information materials

Many of these activities are already in progress. The City has been working with the Casco Bay Estuary Project providing public education and participation opportunities. As components of the Recommended Plan are implemented, public participation efforts will be broadened. The City will continue to offer its assistance and resources to organize additional support.

This Final Master Plan is a reflection of the input from those who participated in the workshops and meetings. We believe and intend that the plan provides the most reasonable and cost-effective CSO control and also complements the efforts of the City to provide recreational and other community benefits that improve the quality of life in the City of Portland.

Appendix A

Consent Order

BOARD ORDER

IN THE MATTER OF

THE CITY OF PORTLAND AND PORTLAND WATER DISTRICT PORTLAND, MAINE	)))	ADMINISTRATIVE CONSENT AGREEMENT AND ENFORCEMENT ORDER

This Agreement by and among The City of Portland and Portland Water District, ("Portland" and "PWD" respectively), the Maine Board of Environmental Protection, (the "Board"), and the State of Maine Attorney General is entered into pursuant to 38 M.R.S.A., Section 347-A(1) and in accordance with the Department of Environmental Protection's (the "Department") Consent Agreement Policy, as amended.

The parties agree as follows:

1. Portland is a municipal corporation which is organized and exists under the laws of Maine, and which operates a wastewater collection system in Portland, Maine.

2. PWD is a quasi-municipal corporation which is organized and exists under the laws of Maine, and which operates a wastewater conveyance and treatment system in Portland, Maine.

3. The Board has regulatory authority over the activities described hereafter.

4. PWD has a Waste Discharge License issued by the Board for the discharge of treated municipal wastewater and combined sewer overflow to the Portland Harbor, Class SC. The license was issued on August 20, 1984.

5. Portland maintains sixteen combined sewer overflow discharge points which periodically discharge pollutants to Portland Harbor. Portland does not have a current Waste Discharge License. For the purposes of this action only, Portland agrees that such discharges are in violation of 38 M.R.S.A., §413.

6. PWD's Waste Discharge License requires that a plan to monitor combined sewer overflows be submitted to the Department within twelve months of issuance of the license. Portland in cooperation with PWD, has agreed to conduct a stormwater overflow monitoring program.

7. Portland and PWD expressly waive:

   a. notice of and opportunity for hearing;

   b. any and all further procedural steps before the Board;

   c. the making of any findings of fact by the Board or its presiding officer; and

   d. its right to appeal any provision of this Administrative Consent Agreement and Enforcement Order.

8. This Agreement shall not become part of the official record unless and until it is accepted by the Board.

9. To resolve the violations referred to in paragraph 5 above, Portland and PWD agree to:

(A) Portland and PWD shall develop and implement a prioritized, long-term program for evaluation and abatement of Combined Sewer Overflow ("CSO") discharges from their sewerage systems. The program shall include evaluations of CSO discharge points, characterization of their activity under various conditions, study of water quality impacts, evaluation of the sewer system and development of a Master Plan for future steps to control CSO discharges. In the interim, appropriate best management practices for reducing CSO discharges shall be implemented. The Master Plan shall provide a report of evaluations and studies and shall examine a full range of alternatives for CSO abatement. In developing the Master Plan, consideration shall be given to pollutant loadings and management of urban runoff and separate storm sewers.

1. Scope of Work. On or before March 1, 1991, Portland and PWD shall submit to the Department for review and approval a Scope of Work for the development of a CSO Master Plan consistent with the requirements of this agreement. The Scope of Work shall contain a critical path of tasks to be performed along with milestones, including dates for submitting an interim report on the CSO Master Plan.

2. CSO Assessment. As part of the Interim Report, Portland and PWD shall complete an assessment of the sewer system. The assessment shall be based upon or include:

   (a) Up-to-date plans or drawings of the as-built sewerage system, including currently proposed modifications;

   (b) The locations of all significant and relevant sources of wastewater or stormwater discharges including CSO structures, stormwater outfalls, as well as known industrial discharges, and discharges from neighboring communities. Separate stormwater outfalls less than 8 inches in diameter need not be included;

(c) A description of the drainage area of each CSO, including the size of the drainage area, topography, population and residential density, average daily volume of water use and/or average daily sewage flow, and all significant industrial, commercial, and other land uses that are likely to affect runoff or wastewater quality;

(d) A description and map of receiving waters, showing existing and designated uses, wildlife habitat, and commercial uses of such receiving waters under State water quality standards; and

(e) A characterization of known historic water use impairments if any.

3. CSO Monitoring Plan. On or before March 1, 1991 and July 1, 1991, respectively, Portland and PWD shall prepare preliminary and final plans for monitoring to supplement existing data as necessary, to allow estimation of the frequency, volume, pollutant loads, and impacts of their CSO discharges. The final CSO Monitoring Plan shall describe monitoring of the CSO discharge volumes and durations; monitoring of the pollutant loads in CSO discharges; and receiving water monitoring. If fewer than all CSOs are to be sampled, the plans shall include a demonstration that the program will adequately supplement existing data to allow characterization of the overall sewer system during both dry (summer) and wet seasons. The completed data base shall be adequate to evaluate storm events of a sufficient range of intensities and durations to characterize CSO discharges in all forseeable conditions.

(a) For the monitoring of CSO discharge volumes and durations the Monitoring Plan shall specify the measurement points and sampling protocol. The program shall be designed to fill data needs to establish the relationship between various environmental conditions such as land use; rainfall amounts; intensity and duration; surface runoff conditions; groundwater levels; and tidal influences. Particular attention shall be given to assure that data necessary to determine the relationship between various CSO discharge points and to identify those which function most frequently or are indicative of how other points function under given conditions, is collected.

(b) For the monitoring of pollutant loads the CSO Monitoring Plan shall specify the measurement points and sampling protocol (including the parameters for which samples are to be analyzed) to provide a basis for defining the pollutant loads from CSOs during varying rainfall conditions. This monitoring program shall also conform to the following:

i. Sampling shall be performed during dry periods and during storm events of a sufficient range of intensities and durations to characterize CSO discharges events;

ii. In each storm event selected for sampling, sampling will be based upon flow-proportioned composite samples which identify and include the "first flush", if any;

iii. Priority should be given to sampling those CSOs that function first during storm events, that frequently discharge high volumes, or that are believed to impair or threaten impairment of water uses; and

iv. Observations of the water near the sampling location for floatables, debris, scum, oil and grease, odor, etc. shall be made at the time of sampling.

v. The program shall include testing for the following constituents unless testing and land use pattens in drainage areas of the system demonstrate that they are not present: suspended solids, biochemical oxygen demand, pH, lead, zinc, chromium, copper, cadmium, mercury, iron, arsenic, silver, total kjeldahl nitrogen, total ammonia, nitrate/nitrite nitrogen, total phosphorus, petroleum hydrocarbons, polyaromatic hydrocarbons, PCB's, and herbicides (2,4-D, dicamba and MCPP).

(c) For the monitoring of receiving waters, the CSO Monitoring Plan shall specify the measurement points and sampling protocol (including the parameters for which samples are to be analyzed) to define the impacts of CSOs on ambient water quality and uses and to provide a basis for predicting the effects of sewer rehabilitation and separation projects on CSO discharges and on the receiving waters. Sediments in Casco Bay shall also be sampled to evaluate the accumulation of pollutants from CSO discharges and other sources.

Selection of monitoring locations will be based on consideration of location of overflows, wastewater characteristics and physical conditions in the receiving water such as uses (especially swimming), current, depth, other possible sources of pollutants and tidal influences. The monitoring locations and the rationale for their selection shall be submitted to the Department for review and approval. All water samples collected shall be tested for enterococcus bacteria and fecal coliform bacteria for marine waters and <u>E. coli</u> bacteria for freshwaters.

Ambient water samples will be collected at times of high tide, low tide and half tide (incoming and outgoing), and will be limited to the locations which best reflect the Portland and PWD CSO discharge after the opportunity for initial mixing with the receiving water.

(d) CSO Monitoring Report. As part of the Interim Report and Master Plan, Portland and PWD shall submit reports of the results of CSO monitoring to the Department for review and approval. Monitoring Reports shall include summaries of all sampling data and a discussion of any deviations from the approved monitoring plans.

4. **Sewer System Evaluation.** Concurrently with the CSO monitoring referred to above, Portland shall conduct a study of its sewer system in order to evaluate volumes and sources of groundwater and surface runoff entering the system. The sewer system study shall be conducted in accordance with a plan of study submitted to the Department for review and approval. Monitoring points shall be established within the sewer system in order to measure the flows contributed from various drainage areas. The impact of flows from each area or sub-drainage system of discharges from CSO points shall be evaluated through use of a sewer system model or other means of predictive analysis. In conducting the study, significant sources of extraneous water entering the sewer system shall be described and if practical, identified and prioritized according to their contribution to CSO discharges and feasibility of corrective actions to abate them. A report of the study shall be submitted to the Department as part the Interim Report and the Master Plan.

5. **Sewer System Master Plan.** Portland and PWD shall develop a Master Plan describing steps and timetables for abatement of CSO discharges. Control or abatement of CSO discharges will not be technologically more stringent than that required to meet water quality standrds or other applicable technology-based requirements. Nothing in this Agreement shall prevent Portland and PWD from seeking a modification of water quality standards in accordance with applicable federal and State law where appropriate. The plan will include the findings of the studies and evaluations referred to above and methods to be used in rehabilitating or improving the sewer system as necessary. Prioritized implementation schedules for this work shall be provided.

   Prior to December 1, 1992, Portland and PWD shall submit the Master Plan to the Department for review and approval. The Master Plan submitted shall be complete except for revision in response to review comments provided by the Department. Appropriate revisions to the Master Plan will be completed within 3 months of receipt of the Department's review comments, if any, and the finalized copy will be provided to the Department. The Master Plan shall include: an evaluation of the effectiveness of the Best Management Practices, pretreatment program, and secondary treatment plant, and an assessment of alternative measures to abate CSO discharges or to apply treatment technology to improve the quality of such discharges, selection of abatement strategies for individual or groups of CSOs, and a timetable for completing CSO abatement projects. In developing an implementation schedule, consideration shall be given to water quality impacts, abatement alternatives selected and Portland's capacity to finance such measures.

   (a) Portland and PWD must assess a full range of possible alternatives, including reasonable combinations of elimination, reduction in discharge frequency or discharge volumes, relocations, and storage and treatment. In assessing each alternative Portland and PWD shall consider:

i. The minimum size and intensity storm required to activate each overflow, volume discharged from each overflow for various size storms, and volume discharged and number of overflow events per year based on historic rainfall data;

ii. The existing and designated uses of receiving waters under the State water quality standards in the area affected by each CSO discharge;

iii. The alternative's expected effects on in-stream water quality and uses;

iv. The effects of the best management practices to be implemented under paragraph 6, below, as well as the pretreatment program and the improvements of the secondary treatment plant;

v. The estimated cost and construction dates for implementing the CSO control strategies;

vi. A comparative analysis of the costs of each control strategy for each CSO or group of CSOs with the overall benefits to the in-stream water quality and uses within the study area of the CSO Master Plan derived from each such strategy; and

vii. A sewer rate analysis, including but not limited to an examination of grant funding, phasing of projects, and rate stabilization.

(b) In selecting and scheduling CSO abatement projects, Portland and PWD shall give priority to abating CSO discharges in the following order:

i. Those which are due primarily to infiltration of water into the sewer system during dry weather periods;

ii. Those which may impair water contact recreation uses or create public health concerns in the receiving waters;

iii. Those which discharge into areas determined to have shellfish resources;

iv. Those which contain significant industrial or high strength wastes;

v. Those which function during the months of June through September; and

vi. Those which cause localized nuisance conditions.

Additionally, high priority should be given to abating all CSO discharges which occur during the so-called "first flush" of suspended sediments from the sewer system at the beginning of a storm event.

(c) The CSO Master Plan shall also include a Compliance Monitoring Plan for the regular monitoring of the CSO discharges which may remain during and after implementation of the CSO Master Plan and the waters receiving those discharges.

(d) Portland and PWD shall provide periodic reviews of the Master Plan in order to evaluate the effectiveness of abatement projects. These reviews shall serve to supplement and/or amend the Master Plan as may be appropriate, taking into consideration projects completed, Compliance Monitoring Plan results or changes in the assumptions upon which the Master Plan was approved. Amendments to the Master Plan shall be approved by the Department. Reviews shall be made in accordance with a schedule provided in the Master Plan, but at least every two years.

6. Best Management Practices. During the time that studies, evaluations, and sewer system improvements are being completed and until modified through implementation of the approved Master Plan, Portland and PWD shall immediately take steps to minimize the discharge of pollutants from CSO points. These steps shall include but not be limited to the following:

(a) Adopt and or maintain an ordinance or rule prohibiting the introduction of uncontaminated water into the sewer system (such as roof or cellar drains, surface drainage, and non-contact cooling water) from private sources;

(b) Development and implemention where feasible of a plan for the removal of existing direct sources of water into the sewer system from private sources such as roof or cellar drains, surface drainage, and non-contact cooling water;

(c) Formal plans for regular cleaning of sewer lines, especially in those sections where the deposition of solids may restrict flow and cause surcharges which result in overflows;

(d) Development and implementation of a high flow management plan designed to optimize the use and overall effectiveness of the treatment system during high flows;

(e) Formal plans for maintaining overflow control structures, pumping stations, tide control gates and other structures in the sewer system in good working condition to minimize CSO discharges;

(f) Addition of septic tank wastes only to the treatment plant during times when all flows being received are given full secondary treatment;

(g) Special efforts to assure that industrial high strength wastewater and other non-"conventional" pollutants (such as hospital wastes) do not overflow and that such wastewater receives full treatment;

(h) Regulating the addition of new or increased volumes of industrial process or high-strength wastewaters into the sewer system under circumstances in which they could be discharged through a CSO point;

(i) Conducting periodic surveys all municipal discharges (CSO and stormwater) during dry weather to verify that no dry weather sanitary discharge exists;

(j) Effective street sweeping and catch basin cleaning; and

(k) Allowing the introduction of additional sanitary wastewater into the system only upon the removal of five gallons of uncontaminated water for each gallon of sanitary wastewater added. Sewer additions shall be based on the State Plumbing Code and calculated at the time building and plumbing permits are issued. Additions will be credited against sewer rehabilitation work completed within the preceeding two years or which will be done in the following year. Preference shall be given to CSO abatement in the area of the proposed addition, but sewer system-wide credits may be used. The effectiveness of rehabilitation projects shall be evaluated using inflow from a three-month storm, observed infiltration rates and engineering estimates of the proposed projects.

7. Sewer System Rehabilitation and Improvements.

(a) Short-term Projects. During the period until 1993, Portland and PWD shall complete sewer system improvement projects in order to eliminate or abate CSO discharges. These projects shall be, to the extent possible, consistent with the priorities outlined in paragraph 9(A)(5), above. At a minumum, they shall include elimination of the Quebec Street CSO discharge, elimination of a CSO discharge in Sagamore Village and sewer separation work in the Libbytown area. Periodic reports of proposed projects and work completed shall be made to the Department.

(b) Long-term Projects. Beginning in 1993, and in each year thereafter, Portland and PWD shall complete CSO abatement projects described in the approved Sewer System Master plan referred to in paragraph (A)(5), above.

(B) prior to March 1, 1991, Portland shall submit to the Department a complete application for a Waste Discharge License for all combined sewer overflows maintained by the City;

paragraph shall be inoperative unless Portland and/or PWD notifies the Commissioner of the Department of Environmental Protection in writing as set forth above. Failure to agree under this paragraph shall trigger the dispute resolution provisions of Paragraph 10 hereof. During the negotiations under this paragraph or the proceeding paragraph providing for dispute resolution and any litigation thereunder, stipulated penalties shall not accrue and shall not be payable if the position of Portland and/or PWD prevails.

12. The Board and the State of Maine Attorney General grant Portland and PWD a release of their causes of action against Portland and PWD for the specific violations listed in paragraph 5 on the express condition that all actions called for in paragraph 9 above are completed in accordance with the express terms and conditions of this Agreement. The release shall not become effective unless and until the above condition is satisfied.

ORDER

Pursuant to 38 M.R.S.A., §347-A(1) and the Department's Consent Agreement Policy, as amended and based on the Agreement set forth above, the Board ORDERS Portland and PWD to:

(A) Portland and PWD shall develop and implement a prioritized, long-term program for evaluation and abatement of Combined Sewer Overflow ("CSO") discharges from their sewerage systems. The program shall include evaluations of CSO discharge points, characterization of their activity under various conditions, study of water quality impacts, evaluation of the sewer system and development of a Master Plan for future steps to control CSO discharges. In the interim, appropriate best management practices for reducing CSO discharges shall be implemented. The Master Plan shall provide a report of evaluations and studies and shall examine a full range of alternatives for CSO abatement. In developing the Master Plan, consideration shall be given to pollutant loadings and management of urban runoff and separate storm sewers.

1. Scope of Work. On or before March 1, 1991, Portland and PWD shall submit to the Department for review and approval a Scope of Work for the development of a CSO Master Plan consistent with the requirements of this agreement. The Scope of Work shall contain a critical path of tasks to be performed along with milestones, including dates for submitting an interim report on the CSO Master Plan.

2. CSO Assessment. As part of the Interim Report, Portland and PWD shall complete an assessment of the sewer system. The assessment shall be based upon or include:

(a) Up-to-date plans or drawings of the as-built sewerage system, including currently proposed modifications;

(b) The locations of all significant and relevant sources of wastewater or stormwater discharges including CSO structures, stormwater outfalls, as well as known industrial discharges, and discharges from neighboring communities. Separate stormwater outfalls less than 8 inches in diameter need not be included;

(c) A description of the drainage area of each CSO, including the size of the drainage area, topography, population and residential density, average daily volume of water use and/or average daily sewage flow, and all significant industrial, commercial, and other land uses that are likely to affect runoff or wastewater quality;

(d) A description and map of receiving waters, showing existing and designated uses, wildlife habitat, and commercial uses of such receiving waters under State water quality standards; and

(e) A characterization of known historic water use impairments if any.

3. CSO Monitoring Plan. On or before March 1, 1991 and July 1, 1991, respectively, Portland and PWD shall prepare preliminary and final plans for monitoring to supplement existing data as necessary, to allow estimation of the frequency, volume, pollutant loads, and impacts of their CSO discharges. The final CSO Monitoring Plan shall describe monitoring of the CSO discharge volumes and durations; monitoring of the pollutant loads in CSO discharges; and receiving water monitoring. If fewer than all CSOs are to be sampled, the plans shall include a demonstration that the program will adequately supplement existing data to allow characterization of the overall sewer system during both dry (summer) and wet seasons. The completed data base shall be adequate to evaluate storm events of a sufficient range of intensities and durations to characterize CSO discharges in all forseeable conditions.

(a) For the monitoring of CSO discharge volumes and durations the Monitoring Plan shall specify the measurement points and sampling protocol. The program shall be designed to fill data needs to establish the relationship between various environmental conditions such as land use; rainfall amounts; intensity and duration; surface runoff conditions; groundwater levels; and tidal influences. Particular attention shall be given to assure that data necessary to determine the relationship between various CSO discharge points and to identify those which function most frequently or are indicative of how other points function under given conditions, is collected.

(b) For the monitoring of pollutant loads the CSO Monitoring Plan shall specify the measurement points and sampling protocol (including the parameters for which samples are to be analyzed) to provide a basis for defining the pollutant loads from CSOs during varying rainfall conditions. This monitoring program shall also conform to the following:

i. Sampling shall be performed during dry periods and during storm events of a sufficient range of intensities and durations to characterize CSO discharges events;

ii. In each storm event selected for sampling, sampling will be based upon flow-proportioned composite samples which identify and include the "first flush", if any;

iii. Priority should be given to sampling those CSOs that function first during storm events, that frequently discharge high volumes, or that are believed to impair or threaten impairment of water uses; and

iv. Observations of the water near the sampling location for floatables, debris, scum, oil and grease, odor, etc. shall be made at the time of sampling.

v. The program shall include testing for the following constituents unless testing and land use pattens in drainage areas of the system demonstrate that they are not present: suspended solids, biochemical oxygen demand, pH, lead, zinc, chromium, copper, cadmium, mercury, iron, arsenic, silver, total kjeldahl nitrogen, total ammonia, nitrate/nitrite nitrogen, total phosphorus, petroleum hydrocarbons, polyaromatic hydrocarbons, PCB's, and herbicides (2,4-D, dicamba and MCPP).

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Ambient water samples will be collected at times of high tide, low tide and half tide (incoming and outgoing), and will be limited to the locations which best reflect the Portland and PWD's CSO discharge after the opportunity for initial mixing with the receiving water.

(d) CSO Monitoring Report. As part of the Interim Report and Master Plan, Portland and PWD shall submit reports of the results of CSO monitoring to the Department for review and approval. Monitoring Reports shall include summaries of all sampling data and a discussion of any deviations from the approved monitoring plans.

4. Sewer System Evaluation. Concurrently with the CSO monitoring referred to above, Portland shall conduct a study of its sewer system in order to evaluate volumes and sources of groundwater and surface runoff entering the system. The sewer system study shall be conducted in accordance with a plan of study submitted to the Department for review and approval. Monitoring points shall be established within the sewer system in order to measure the flows contributed from various drainage areas. The impact of flows from each area or sub-drainage system of discharges from CSO points shall be evaluated through use of a sewer system model or other means of predictive analysis. In conducting the study, significant sources of extraneous water entering the sewer system shall be described and if practical, identified and prioritized according to their contribution to CSO discharges and feasibility of corrective actions to abate them. A report of the study shall be submitted to the Department as part the Interim Report and the Master Plan.

5. Sewer System Master Plan. Portland and PWD shall develop a Master Plan describing steps and timetables for abatement of CSO discharges. Control or abatement of CSO discharges will not be technologically more stringent than that required to meet water quality standrds or other applicable technology-based requirements. Nothing in this Agreement shall prevent Portland and PWD from seeking a modification of water quality standards in accordance with applicable federal and State law where appropriate. The plan will include the findings of the studies and evaluations referred to above and methods to be used in rehabilitating or improving the sewer system as necessary. Prioritized implementation schedules for this work shall be provided.

   Prior to December 1, 1992, Portland and PWD shall submit the Master Plan to the Department for review and approval. The Master Plan submitted shall be complete except for revision in response to review comments provided by the Department. Appropriate revisions to the Master Plan will be completed within 3 months of receipt of the Department's review comments, if any, and the finalized copy will be provided to the Department. The Master Plan shall include: an evaluation of the effectiveness of the Best Management Practices, pretreatment program, and secondary treatment plant, and an assessment of alternative measures to abate CSO discharges or to apply treatment technology to improve the quality of such discharges, selection of abatement strategies for individual or groups of CSOs, and a timetable for completing CSO abatement projects. In developing an implementation schedule, consideration shall be given to water quality impacts, abatement alternatives selected and Portland's capacity to finance such measures.

   (a) Portland and PWD must assess a full range of possible alternatives, including reasonable combinations of elimination, reduction in discharge frequency or discharge volumes, relocations, and storage and treatment. In assessing each alternative Portland and PWD shall consider:

i. The minimum size and intensity storm required to activate each overflow, volume discharged from each overflow for various size storms, and volume discharged and number of overflow events per year based on historic rainfall data;

ii. The existing and designated uses of receiving waters under the State water quality standards in the area affected by each CSO discharge;

iii. The alternative's expected effects on in-stream water quality and uses;

iv. The effects of the best management practices to be implemented under paragraph 6, below, as well as the pretreatment program and the improvements of the secondary treatment plant;

v. The estimated cost and construction dates for implementing the CSO control strategies;

vi. A comparative analysis of the costs of each control strategy for each CSO or group of CSOs with the overall benefits to the in-stream water quality and uses within the study area of the CSO Master Plan derived from each such strategy; and

vii. A sewer rate analysis, including but not limited to an examination of grant funding, phasing of projects, and rate stabilization.

(b) In selecting and scheduling CSO abatement projects, Portland and PWD shall give priority to abating CSO discharges in the following order:

i. Those which are due primarily to infiltration of water into the sewer system during dry weather periods;

ii. Those which may impair water contact recreation uses or create public health concerns in the receiving waters;

iii. Those which discharge into areas determined to have shellfish resources;

iv. Those which contain significant industrial or high strength wastes;

v. Those which function during the months of June through September; and

vi. Those which cause localized nuisance conditions.

Additionally, high priority should be given to abating all CSO discharges which occur during the so-called "first flush" of suspended sediments from the sewer system at the beginning of a storm event.

(c) The CSO Master Plan shall also include a Compliance Monitoring Plan for the regular monitoring of the CSO discharges which may remain during and after implementation of the CSO Master Plan and the waters receiving those discharges.

(d) Portland and PWD shall provide periodic reviews of the Master Plan in order to evaluate the effectiveness of abatement projects. These reviews shall serve to supplement and/or amend the Master Plan as may be appropriate, taking into consideration projects completed, Compliance Monitoring Plan results or changes in the assumptions upon which the Master Plan was approved. Amendments to the Master Plan shall be approved by the Department. Reviews shall be made in accordance with a schedule provided in the Master Plan, but at least every two years.

6. Best Management Practices. During the time that studies, evaluations, and sewer system improvements are being completed and until modified through implementation of the approved Master Plan, Portland and PWD shall immediately take steps to minimize the discharge of pollutants from CSO points. These steps shall include but not be limited to the following:

(a) Adopt and or maintain an ordinance or rule prohibiting the introduction of uncontaminated water into the sewer system (such as roof or cellar drains, surface drainage, and non-contact cooling water) from private sources;

(b) Development and implemention where feasible of a plan for the removal of existing direct sources of water into the sewer system from private sources such as roof or cellar drains, surface drainage, and non-contact cooling water;

(c) Formal plans for regular cleaning of sewer lines, especially in those sections where the deposition of solids may restrict flow and cause surcharges which result in overflows;

(d) Development and implementation of a high flow management plan designed to optimize the use and overall effectiveness of the treatment system during high flows;

(e) Formal plans for maintaining overflow control structures, pumping stations, tide control gates and other structures in the sewer system in good working condition to minimize CSO discharges;

(f) Addition of septic tank wastes only to the treatment plant during times when all flows being received are given full secondary treatment;

(g) Special efforts to assure that industrial high strength wastewater and other non-"conventional" pollutants (such as hospital wastes) do not overflow and that such wastewater receives full treatment;

(h) Regulating the addition of new or increased volumes of industrial process or high-strength wastewaters into the sewer system under circumstances in which they could be discharged through a CSO point;

(i) Conducting periodic surveys all municipal discharges (CSO and stormwater) during dry weather to verify that no dry weather sanitary discharge exists;

(j) Effective street sweeping and catch basin cleaning; and

(k) Allowing the introduction of additional sanitary wastewater into the system only upon the removal of five gallons of uncontaminated water for each gallon of sanitary wastewater added. Sewer additions shall be based on the State Plumbing Code and calculated at the time building and plumbing permits are issued. Additions will be credited against sewer rehabilitation work completed within the preceeding two years or which will be done in the following year. Preference shall be given to CSO abatement in the area of the proposed addition, but sewer system-wide credits may be used. The effectiveness of rehabilitation projects shall be evaluated using inflow from a three-month storm observed infiltration rates and engineering estimates of the proposed projects.

7. Sewer System Rehabilitation and Improvements.

(a) Short-term Projects. During the period until 1993, Portland and PWD shall complete sewer system improvement projects in order to eliminate or abate CSO discharges. These projects shall be, to the extent possible, consistent with the priorities outlined in paragraph 9(A)(5), above. At a minumum, they shall include elimination of the Quebec Street CSO discharge, elimination of a CSO discharge in Sagamore Village and sewer separation work in the Libbytown area. Periodic reports of proposed projects and work completed shall be made to the Department.

(b) Long-term Projects. Beginning in 1993, and in each year thereafter, Portland and PWD shall complete CSO abatement projects described in the approved Sewer System Master plan referred to in paragraph (A)(5), above.

(B) prior to March 1, 1991, Portland shall submit to the Department a complete application for a Waste Discharge License for all combined sewer overflows maintained by the City;

IN WITNESS WHEREOF the parties have executed the Agreement consisting of 17 pages.

CITY OF PORTLAND

BY: Robert Ganley DATE: 1-10-91
its City Manager

PORTLAND WATER DISTRICT

BY: ________________ DATE: ________________
its

BOARD OF ENVIRONMENTAL PROTECTION

BY: ________________ DATE: ________________
E. CHRISTOPHER LIVESAY, CHAIRMAN

SEEN AND AGREED TO:
State of Maine

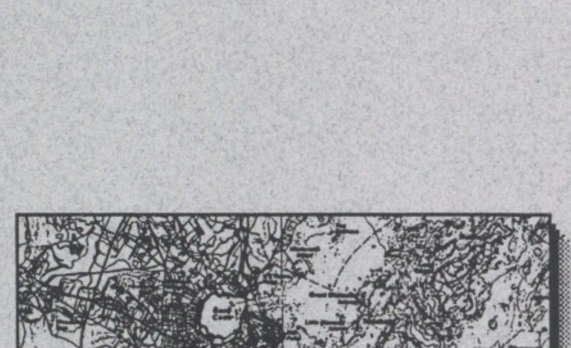
BY: ________________ DATE: ________________
Jon Edwards
Assistant Attorney General

PORTCA

1/4/91

Appendix B

Executive Summaries
Technical Memoranda



Executive Summary

Technical Memorandum No. 1

Infiltration/Inflow Evaluation

Purpose

The objective of the infiltration evaluation was to determine whether infiltration in combined sewers and infiltration/inflow (I/I) in separated sanitary sewers was great enough to significantly affect the quantity and frequency of CSOs.

The primary purpose of Technical Memorandum No. 1 was to quantify the average I/I entering the Portland sewer system. The memorandum conclusions became the basis for the I/I component of the Storm Water Management Model (SWMM).

Approach

The average I/I in the Portland sewer system was estimated through two methods: research of historical data and measurement of actual flow at various points in the system during the Spring and Summer of 1991.

Seven years of flow data from four major sewage pumping stations, eleven years of wastewater treatment facility flow records, and previous 1977 and 1983 I/I studies were reviewed.

In addition, four flow meters were installed in the sewer system and operated between May 1, 1991 and September 12, 1991. Eight sewers tributary to the Back Cove interceptor were also instantaneously gaged during the early morning hours of

April 18 and 26 and May 14. Pumping station flow data collection continued during the Spring months of 1991.

Results

The diurnal low flow received by the wastewater treatment plant for the month of April between 1981 and 1991 averaged 8.18 million gallons per day. The monthly average, dry weather low flows for the year July 1990 to June 1991 ranged from 4.4 mgd to 11.0 mgd. A 1983 I/I report noted a Spring average infiltration rate of 8.15 mgd.

Spring and Summer recorded low flows at the four continuously monitored sites were presented in figure form. Wet weather 24-hour hydrographs also showed the rainfall intensity as measured by the U.S. Weather Bureau station located at the Portland Jetport. Instantaneous readings at eight diversion structure locations (CSOs No. 6 through 13) were tabulated in the report.

No obvious inflow sources were discovered during the I/I investigation except for a few known stream interceptions by the combined sewer in the upper reaches of the Capisic Brook watershed. The removal of these streams was addressed in the Master Plan recommendations.

Conclusions

In general, the rate of infiltration has not varied during the period of 1981 to 1991. No discernable trend during that time period could be seen except that wetter Springs resulted in higher infiltration rates as would be expected. Treatment plant flow records showed monthly low flow variations between a 4 and 8 mgd rate. It appears that Spring infiltration does consume a significant amount of interceptor and pumping station capacity in some areas of the city. The effect of the estimated infiltration was considered in the storm water management model.

An average infiltration rate of 7.0 mgd was used as background flow in the SWMM. The volume represents approximately 2,000 gallons per inch per mile throughout the sewer system. The total amount of infiltration was apportioned throughout the system according to drainage area acreage. The infiltration occurring during a 6-hour storm event would be 1.75 million gallons. The total storm water and wastewater entering the combined sewer during an actual 2.8-year event was calculated to be 180 million gallons with 125 million gallons overflowing. The percent of infiltration versus total combined wastewater is 1 percent, and the percent of infiltration compared to the overflow volume is 1.4 percent.

Executive Summary

Technical Memorandum No. 2
System Modeling Approach

Purpose

The purpose of the Portland CSO Abatement Study is to identify cost- and water quality-effective methods of controlling Portland's CSO. A system rainfall-runoff-transport model will be developed to describe and quantify the overflows from the combined sewer system in sufficient detail to determine overflow volumes, frequency, and pollutant loadings, and to evaluate specific control technologies and systemwide management alternatives. TM No. 2 describes the CSO model to be used to determine the existing CSOs' frequency and volume and to aid in the evaluation of alternative control methodologies. Summarized in TM No. 2 are the theory, data sources, and assumptions inherent in building and applying the model.

Approach

The Portland combined sewer system consists of pipes, regulators, and pump stations. The system receives inflow from various sources and at varying rates depending upon time of year and rainfall conditions. In general, the sewer flow originates from:

- Base sanitary flow
- Inflow and infiltration including rainfall-derived (RDII) and groundwater

- Stormwater runoff in the combined sewer area

Base sanitary flow will be computed based on examining available dry-weather flow data, including wastewater treatment facility (WWTF) influent records. A constant base sanitary inflow component will be apportioned to each system subarea. Diurnal flow patterns will only be incorporated for short single-event simulations. Stormwater surface runoff inflow to the combined sewer system will be computed using the Storm Water Management Model (SWMM) Runoff block. Infiltration and inflow will be computed using a groundwater submodel component of the SWMM Runoff block. Inflows will be routed through the regulators, CSOs, interceptors, and pump stations of the system using the SWMM Extran block.

The accuracy of the model will be substantiated during the calibration/verification process. Model calibration refers to the process of refining estimates of parameters that cannot be directly measured to better fit the model to the application. Verification refers to a confirmation using an independent data set. Existing data will be used for preliminary calibration and verification of the model. Final model refinement will be achieved using data acquired during the monitoring program.

Results

The combined sewer model will be used to predict arrays of flow data at specified locations in the system for the 3-year continuous precipitation event selected as characteristic for Portland. The results will provide estimates of frequency and volume of overflows for each outfall and the volume of water discharged to the receiving water bodies. If desired, the simulation can be performed for event specific analyses.

Conclusions

The modeling concept described above represents the most direct approach necessary to define the frequency and volume of CSOs for existing conditions. During the evaluation of CSO control alternatives, additional detail may be incorporated into the model where warranted. The final model will serve as a tool for assessing the feasibility of and selecting between alternatives for reducing the volume of CSO to the receiving waters of the Portland area.

Agenda
Portland CSO Abatement Study
Recommended Alternative Presentation
December 3, 1992 1:00 p.m.

1. Background

    a. Purpose of this meeting
    b. Nature of the problem
    c. On-going City effort to reduce CSOs
    d. Overview of study approach

2. Impacts of CSOs

    a. Volume
    b. Frequency
    c. Mass loadings of pollutants
    d. Flooding
    e. Receiving water quality

3. Recommended Plan for Reducing CSOs

    a. Screening of technologies/alternatives
    b. Selection of levels of control for each receiving water
    c. Recommended plan for meeting desired levels of control

        - Philosophy of total stormwater management
        - Making best use of existing facilities
        - Structural components
        - Watershed management components
        - Continuance of best management practices

4. Benefits/Impacts of CSO Control Program

    a. Reductions of volume and frequency
    b. Receiving water quality improvement
    c. Flooding reduction
    d. Costs

Executive Summary

Technical Memorandum No. 3
Combined Sewer Modeling

Purpose

A precipitation-runoff-transport model was developed to analyze the Portland, Maine, combined sewer collection system. The general objective of the modeling study was to develop a tool for testing the effectiveness of various combined sewer overflow (CSO) control technologies. The model was also developed to gain an understanding of the sewer system hydraulics and to quantify CSO frequency, volume, and duration at each of the system's 43 CSO outfall structures under various storm conditions. The Storm Water Management Model (SWMM) was selected as the analytical tool. Technical Memorandum No. 3 presents a description of the effort to develop the system model with available physical data and calibrate it with available flow data. It also discusses recommendations for the monitoring plan based on preliminary simulation results.

Approach

The SWMM RUNOFF block was used to estimate runoff from 59 subareas of the system. The data necessary for the runoff model were developed from collection system maps, aerial photographs, field reconnaissance, previous studies, and interviews with the City of Portland and Portland Water District staff. The SWMM EXTRAN block was used to simulate the transport of water generated by runoff, infiltration/inflow, and base sanitary flow through the collection system. The use of EXTRAN enabled the modeling of surcharge, backwater, reverse flow, and tidal conditions as well as internal flow diversions within the system. Therefore, the various hydraulic factors controlling overflow events could be determined and simulated. The model specifically addresses the hydraulic characteristics of the flow regulators and the various interactions between the collection system, regulators, and pumping stations that make up the system.

Flow components, other than direct stormwater runoff, that make up the total flow in the collection system have been modeled using data specific to the City of Portland system. Peaking factors describing the diurnal fluctuations of base sanitary flow were calculated from flow data for dry weather flow periods. This base sanitary flow plus groundwater infiltration were directly input to the SWMM model. Rainfall derived infiltration/inflow during and after rainfall events was modeled within SWMM using a groundwater balance sub-program.

The model was first calibrated using data collected at the major pump stations and from limited flow data collected in previous studies. An approach was adopted in which a program of detailed flow metering and other data generation was initiated subsequent to the Task 3 modeling task. This approach was selected because available data were sufficient for developing, recalibrating, and verifying the model. Simulation runs could then be used to characterize the system and provide a basis for developing the monitoring plan. Additional model calibration and verification were performed when data generated during the monitoring period became available.

Results

Overflow frequency and volumes were estimated based on the first calibrated model. The calibration was based on a comparison of model generated flows and available flow data at CSO 7 (Ocean Avenue), which represents 20 percent of the system total combined sewer drainage area, and a location along the Commercial Street combined sewer near Emery Street. Model results were also compared to frequency of overflow data generated through a block test program at a number of CSO regulating structures. The blocks are placed on the regulator control structure (e.g., weir) and indicate an overflow event when displaced.

The monitoring program proposed as a follow-up to this task will improve the level of confidence in the model's predictive capability by collecting final calibration and verification data at significant system locations. The monitoring program was developed to improve the reliability of model results and thereby raise the level of confidence in any water quality assessment and control technology recommendations. The proposed monitoring plan includes the measurement of flow quantities and elevations at the following regulators:

1. Ocean Avenue (CSO 7)
2. Mackworth Street (CSO 10B)
3. Northeast Pump Station (CSO 20)
4. Maple Street (CSO 26)
5. Emery Street (CSO 28)

These sites were determined to be representative of sewershed areas in Portland, and were selected for their relative significance in representing water quality impacts. Based on experience with the SWMM model and the sewer system response to runoff from a given storm, it was determined that each of the sites would provide necessary and sufficient data to verify the model.

Conclusions

A system model has been developed which effectively represents the hydrology and hydraulics of the Portland combined sewer system and can be applied to estimate overflow volumes and frequencies. This capability will enable an assessment of water quality impacts and provide a tool for the initial evaluation of alternative control technologies to reduce overflow frequency, volume, and duration.

The model was developed based on available physical data and field reconnaissance. It was first calibrated with available flow data. While the intermediate calibration effort achieved high correlation, it was recognized that the few system locations for which flow data were available precluded achieving a high level of model confidence which is necessary for proper calibration and verification. However, the model was effectively used to characterize the system and develop the monitoring plan.

Executive Summary

Technical Memorandum No. 4

Water Quality Assessment

Purpose

The Portland, Maine, combined sewer system discharges waterborne pollutants during wet weather to surrounding receiving waters via CSOs. The effort to reduce the frequency and volume of CSO is driven by the desire to improve and enhance the quality of receiving waters in the area. A combined sewer system model has been developed to be used to predict overflow frequencies and volumes. The impact from these CSOs is dependent on the associated pollutant loads, receiving water characteristics, and ambient quality. TM No. 4 focuses on CSO and other source pollutant loads, characteristics, and quality of area receiving waters and state standards and classifications pertinent to the receiving waters.

Approach

The waters in the Portland vicinity include both fresh and marine waters. Major freshwaters are Capisic Brook, Fall Brook, Presumpscot River, and Stroudwater River. The predominant marine waters are Casco Bay, Back Cove, Portland Harbor, and Fore River. All of these waters have been affected by CSO and/or stormwater.

The state of Maine has developed a system to classify all waters of the state. This has resulted in different classifications for freshwaters and marine waters. The general classifications are AA, A, B, and C for freshwaters and SA, SB, and SC for marine waters. Classifications and water quality criteria exist for all area receiving waters.

The combined sewer system rainfall-runoff-transport model developed and preliminarily calibrated in Task 3 was used to predict frequency, volume, and duration of discharges to receiving waters at the 43 CSO outfalls. Simulation results were based on a continuous simulation of the combined sewer system using a representative 3-year period of precipitation. Available water quality data were examined to determine appropriate concentrations to apply to simulated CSO volumes to determine loads. Available receiving water quality data were used to estimate impacts resulting from CSO pollutant loads.

Results

Model results were generated using the 3-year precipitation record as input. Results indicated a total of 824 events, 387 occurring in summer; a total volume of 585 million gallons, 272 occurring in summer; and, a total duration of 4410 hours, 1761 occurring in summer. The percentage of the total CSO frequency, volume, and duration per receiving water is included in Table 1.

Table 1
Percentage of 3-year of Total CSO Frequency, Volume, and Duration

Receiving Water	Frequency (%)		Volume (%)		Duration (%)	
	Annual	Summer	Annual	Summer	Annual	Summer
Presumpscot	3	3	2	1	2	2
Casco Bay	4	5	2	2	3	3
Back Cove	41	39	63	63	52	53
Portland Harbor	29	29	16	14	24	23
Fore River	8	7	4	4	5	6
Capisic Brook	14	16	13	15	13	13

Event mean concentrations to be applied to Portland CSOs were determined based on data generated from CSO water quality sampling results in other cities including Bangor, Maine; Boston, Massachusetts; Portland, Oregon; and Pawtucket, Rhode Island. Other data used included WWTF influent data and published EPA averages. Estimated EMC's for Portland CSO pollutant loads consisted of the following:

- TSS = 150 mg/l
- BOD = 50 mg/l
- E. coli = 100,000/100ml
- Lead = 0.050 mg/l

The impact upon the receiving waters from Portland's CSOs are complicated by the extent of other sources of pollution as well as the assimilative capacity and other dynamics of the receiving waters. Because of these complications, detailed assessments of the water quality impacts on the receiving waters were not carried out at this stage of the project.

Conclusions

The receiving waters of Portland receive discharges from numerous unquantified pollutant sources in addition to Portland's CSOs. In addition, limited data exist on the quality of receiving waters. Therefore, an adequate receiving water ambient quality assessment was not attempted. Typical pollutant concentrations were applied to simulated CSO volumes to estimate pollutant loads. Although first flush effects are known to occur, no attempt was made to quantify this effect or its impact. CSO quality sampling for this study will commence in the spring of 1992 as part of the Task 4 Monitoring Plan. The scope of this work is described in detail in the Portland CSO Monitoring Plan, July 1991.

Technical Memorandum No. 5

Preliminary Screening of CSO Control Technologies

Purpose

Technical Memorandum No. 5 presents the preliminary screening of CSO control technologies. The objective of the preliminary screening task is to identify CSO control technologies applicable to the City of Portland study area. A regional economic optimization process was employed to identify and cost-effectively optimize applicable regional alternatives. The regional analysis provides direction for siting and sizing of regional facilities and for identifying site-specific technologies that can be incorporated into the regional plan.

Approach

The preliminary screening process includes the following steps:

- Step 1 Perform Initial Screening of Technologies
  - Develop a list of CSO control technologies
  - Develop a shortlist of CSO control technologies applicable to Portland
  - Review current projects which may impact technology selection

- Step 2 Develop Regional Alternatives
  - Delineate CSO control regions
  - Identify technologies for regional and site-specific application

- Step 3 Determine the Optimal Regional Solutions
  - Develop regional production and cost functions
  - Perform regional economic optimization analyses
  - Develop regional goals for final screening

Results

Approximately 40 CSO control technologies were reviewed with respect to their advantages, disadvantages, and applicability to Portland. A shortlist of technologies was developed including stormwater inflow reduction, pollutant source control, maximization of the existing conveyance and treatment system, storage, and treatment options. Storage and treatment options were selected as regional alternatives. For the purposes of the optimization analysis, Portland was divided into two optimization regions. Region 1 includes all combined sewer drainage areas tributary to the Northeast Pump Station, and Region 2 includes all combined sewer drainage areas tributary to the India Street Pump Station in addition to the Quebec Street (CSO 21) drainage area which flows by gravity to the Portland Wastewater Treatment Facility (WWTF).

The Portland WWTF and combined sewer system, under their present design, function at capacity during wet weather events. The regional analysis indicated that the Portland combined sewer system treats a substantial portion of wet weather flow as compared to other systems of cities in the New England area. The analysis also indicated that the total CSO volume and number of events could be cost-effectively reduced by 85 to 90 percent with the implementation of inflow reduction techniques and the addition of storage and treatment capacity to the system. The regional economic optimization analysis, however, does not take into account all technical, environmental, and implementation issues of applying regional technologies to site-specific locations.

Conclusions

A shortlist of CSO control technologies are recommended for final screening:

- Sewer system optimization
  - Static flow control
  - Optimize conveyance and treatment of existing system

- Inflow reduction technologies
  - Upland stormwater storage
  - Infiltration/inflow reduction
  - Flow slipping
  - Vortex valves
  - Swales/greenways
  - Sewer separation
  - Stream diversion

- Treatment
  - Vortex separator with Chlorination-dechlorination
  - Portland WWTF Expansion

- Storage
  - Closed concrete tanks
  - Storage conduits

These technologies will be evaluated to develop an overall CSO abatement plan for Portland during final screening. Final screening process will be presented in Technical Memorandum No. 6.

DEP and Comments and Resolution of Comments on the Draft Master Plan

Executive Summary

Technical Memorandum No. 6

Final Screening of CSO Control Technologies

Purpose

A shortlist of CSO control technologies applicable to the City of Portland study area were presented in Technical Memorandum No. 5, Preliminary Screening of CSO Control Technologies. A regional economic optimization analysis was performed utilizing regional storage and treatment combinations. The results of the regional optimization analysis suggested that 90 percent reduction of total CSO volume and events was a cost-effective goal for Portland. The optimization analysis, however, does not include all technical, environmental, and implementation issues regarding site-specific application of regional technologies.

Technical Memorandum No. 6 is a preliminary attempt at applying shortlisted CSO control technologies to specific sites, identifying implementation constraints, evaluating CSO control performance, and developing preliminary costs. The objective of this technical memorandum is to complete the final screening of site-specific and regional technologies and blend the selected technologies into specific CSO control alternatives.

Approach

Each CSO location and drainage area was reviewed for site-specific application of various CSO control technologies. Preliminary siting, sizing, and layout was determined based on preliminary modeling results of Portland CSO activity. Sites were identified where CSO activity could be greatly reduced by cost-effective, easy-to-implement, high performance technologies such as sewer separation of small, undeveloped, or low density residential areas and by blocking overflows exhibiting little or no activity. Regional technologies were most often applied to active CSO locations with frequent discharges and high volumes.

Results

The results of the final screening task are summarized by receiving water in Table 2. See Table 3 for identification of the CSO location.

Conclusions

Final screening of the alternatives detailed in this Technical Memorandum resulted in a CSO volume reduction of only 55 percent. The emphasis was on final screening of control alternatives for specific sites based upon a preliminary assessment of CSO activity at each site.

Technical Memorandum No. 6 reflected the summation of work performed under Task 3 of the CSO Abatement Study. The study continues with Task 4, Field Monitoring, and Task 5, Sewer System Master Plan Completion. In Task 5, the alternatives screened in Technical Memorandum No. 6 will be evaluated on the basis of costs, performance, implementation issues, regulatory requirements, environmental issues, and water quality improvements and formulated into a recommended CSO abatement plan for the City of Portland.

Selection and application of CSO control alternatives is an evolutionary process. Data collected in the monitoring task, ongoing projects for stormwater and flooding control, comments received from attendees of monthly progress meetings, and future public participation efforts will impact the selection of alternatives presented in Technical Memorandum No. 6. These changes will be reflected in the recommended CSO Abatement Plan that is developed in Task 5.

Table 2 Feasible CSO Control Alternatives						
			CSO Activity*			
			Base		Result	
CSO No.	Drainage Area (acres)	Alternative	No. of Events	Volume (MG)	No. of Events	Volume (MG)
Casco Bay						
1	14	Separate remaining catchbasins	5	0.3	0	0
3	3	Check system for I/I, correct problems/separate, and disconnect outfall pipe	1	<.01	0	0
4	0	No action–dependent upon actions at other Back Cove CSOs 5-16	5	6	5	6
20	29	a) No action. Results from Libbytown. b) Flow slippage c) 3-MG storage facility–size dependent upon Libbytown and other CSO projects.	15 15 15	11 11 11	15 NA 0	10 NA 0
21	43	Quebec Street flow slippage project	25	2.3	0	0
Presumpscot						
2	25	a) Reroute separated storm flows b) 0.3-MG storage at Arcadia Pump Station	17 17	2.1 2.1	NA 2	NA 0.2
Back Cove						
5	100	a) 1.6-MG storage tank b) Combine with CSO 6	40 69	16 27	4 10	2.1 7.3
6	108	a) Reroute separated storm flows b) 0.6-MG storage tank c) Combine with CSO 5 d) Combine with CSO 7	29 29 69 74	12 12 27 159	NA 4 10 NA	NA 4.1 7.3 NA
7	1,114	a) Upstream greenway storage/inflow reduction b) Outfall pipe storage c) 7-MG storage facility d) 50-MGD separator/chlor/dechlor at CSO 7 e) Potential combination with CSOs 5 and 6	45 45 45 45 45	147 147 147 147 147	NA NA 5 NA NA	NA NA 40 NA NA
8-16	622	Storage conduit (96-inch diameter and 6,000 feet in length, totalling 2.3 MG) consolidating CSOs to one point near Baxter Boulevard Pump Station. Overflow relief also assumed at intermediate point along conduit. Overflow excess either untreated or to separator facility at CSO 7. Potential combination with treatment facility at CSO 7.	311	92	17	69
17	528	Recommended Plan: - Sewer separate Upper Libbytown. - Detain stormwater inflow. - Flow slip and collect storm flows in Deering Oak Park/Pond. - Separate Deering Oak Pond discharge from sewer system and discharge to Back Cove. - Storage conduit (9' x 7' x 3,300' in length, totalling 1.6 MG) parallel to Old Almshouse.	18	100	7	30
18	46	a) No action. Results from Libbytown. b) Storage facility near shore of Back Cove	11 10	22 22	10 NA	22 NA

Table 2
Feasible CSO Control Alternatives

CSO No.	Drainage Area (acres)	Alternative	CSO Activity* Base No. of Events	Base Volume (MG)	Result No. of Events	Result Volume (MG)
19	188	a) No action. Results from Libbytown. b) No action. Controlled by CSOs 18 and 20. c) Flow slippage d) Storage facility for CSOs 18 and 19	4 2 2 2	0.3 0.1 0.1 0.1	2 4 NA NA	0.1 0.3 NA NA
Portland Harbor						
23	112	a) Storage tank (0.7 MG) b) Storage conduit (6' x 8' x 800 feet in length, totalling 0.3 MG) for CSOs 23 and 24 combined.	47 47	15 24	7 6	2.8 12
24	32	a) Conduit to storage tank (0.5 MG) at CSO 23 b) Increase India Street Pump Station	34 34	8.5 8.5	5 NA	2.6 NA
25	86	a) Separator facility without chlor/dechlor discharge pipe extended out to harbor b) Increase India Street Pump Station c) Storage conduit including CSOs 23 and 24 d) No action—dependent on actions at other CSOs	48 48 48 48	47 47 47 47	48 NA 43 NA	47 NA 46 NA
26	95	a) Separation in lower portion in place b) Flow slippage to Commercial Street stormwater system c) Dependent on actions at other CSOs d) Storage tank (0.8 MG)	9 9 9 9	2.9 2.9 2.9 2.9	NA NA NA 2	NA NA NA 1.1
27	39	a) Upland flow slippage to storm system on Commercial Street to harbor. b) Storage tank (0.4 MG)	52 52	7.6 7.6	NA 5	NA 1.5
28	39	a) Upland flow slippage to storm system on Commercial Street to harbor. b) Storage tank (0.8 MG)	58 58	20 20	NA 6	NA 6.5
29	28	a) Upland flow slippage to storm system on Commercial Street to harbor. b) Storage tank (0.2 MG)	40 40	3.7 3.7	NA 6	NA 1.9
		CSOs 27-29 consolidation: storage conduit (6' x 8' x 5,700' in length, totalling 2 MG)	60	35	4	7.3
Fore River						
30	7	Separation—part of Libbytown Project	38	2.5	0	0
31	23	No discrete outfall. CSO 31 overflows to CSO 32. No action is required.	0	0	0	0
32	9	0.2-MG storage tank near Thompson Point Pump Station	11	0.7	0	0
33	108	a) No action. Results from static flow control at CSO 36. b) Stormwater separation in upper part of basin c) Storage tank (0.4 MG) near Fore River Pump Station	2 2 2	0.6 1.0 1.0	2 NA 1	1.0 NA 0.2
34	3	Separate stormwater	11	0.3	0	0
35	11	Separate stormwater	10	0.4	0	0

Table 2
Feasible CSO Control Alternatives

CSO No.	Drainage Area (acres)	Alternative	CSO Activity*			
			Base		Result	
			No. of Events	Volume (MG)	No. of Events	Volume (MG)
36	411	a) No action. Results from upstream separations. b) Remove upstream brook inlets c) Static flow control in 10' diameter pipe d) Storage tank (3 MG) e) Separator facility	29 29 29 29 6	58 51 51 51 23	29 NA 6 4 NA	51 NA 23 7.7 NA
39	37	Close off	4	0.5	0	0
Capisic Brook						
37	6	No action—closed off	0	0	0	0
38	21	Separate stormwater	10	1.1	0	0
40	50	Complete separation project	29	3.6	0	0
41	11	Separate stormwater	8	0.4	0	0
42	298	a) Remove stream inlets at 2 upstream locations b) Storage tank (1 MG) c) Storage tank (1.5 MG) for CSOs 42 and 43	40 40 40	30 30 32	NA 7 NA	NA 14 NA
43	35	a) Storage tank (0.5 MG) b) Storage tank (1.5 MG) for CSOs 42 and 43	11 40	1.7 32	1 NA	0.03 NA
Areawide			--	616	--	276

* CSO Activity was estimated using a preliminary CSO Abatement Model and based on 1966 annual precipitation as input.
NA = Results are not available.

Table 3
Identification of Portland's Combined Sewer Overflows

ID No.	Location	Permit Holder	Permit No.	ID No.	Location	Permit Holder	Permit No.
1	Olympia Street	PWD	027	23	India Street	PWD	003
2	Arcadia Street	PWD	022	24	Franklin @ Middle St. (Thomas St.)	City	*
3	Berwick Street	PWD	023	25	Long Wharf	PWD	004
4	Tukey's Bridge Siphon	PWD	026	26	Maple Street	City	006
5	Randall Street (Wash. Ave.)	PWD	010	27	Clark Street	PWD	005
6	Johansen Street #2	City	052	28	Emery Street	PWD	006
7	Ocean Avenue (East Side Int.)	PWD	011	29	West Commercial Street	PWD	007
8	Clifton Street	PWD	020	30	St. John Street	PWD	008
9	George Street	PWD	012	31[1]	Congress St. @ Sewall St.	City	018
10	Mackworth Street	PWD	014	32	Thompson Pt. P.S.	PWD	028
11	Codman Street	PWD	017	33	Fore River P.S. (West Side Int.)	PWD	009
12	Vannah Avenue	PWD	018	34	Brewer Street	PWD	025
13	Forest Ave @ Belmont	City	033	35	Stroudwater Road	PWD	029
14	Forest Ave @ Coyles Gully	City	056	36	Capisic Pond Dam Overflow	City	025
15	Dartmouth @ Baxter Blvd.	PWD	019	37[1]	Mayer Road	City	*
16	Bank Street (Bedford St.)	PWD	021	38	Brighton Ave. @ Capisic Creek	City	*
17	Preble @ Marginal	City	036	39	Rowe Street	City	026
18	Franklin @ Marginal	City	037	40[1]	Sagamore Village Overflow	City	050
19	Diamond @ Marginal	City	038	41	Holm Avenue	City	*
20	Northeast P.S.	PWD	024	42	Warren Avenue 60"	City	051
21	Quebec Street	PWD	002	43	Warren Avenue 24"	City	051

*Permit application submitted to DEP; City awaiting DEP response.
[1]CSO was recently eliminated.

Note: Names in parentheses represent alternate names used to describe the same location. ID No. 22 is associated with the WWTF discharge and is not a CSO location.

Executive Summary

Technical Memorandum No. 7
Frequency and Volume of CSO

Purpose

The City of Portland CSO Monitoring Program was conducted during November 1991 through July 1992. The goal of the program was to acquire flow, frequency, and water quality data at representative locations in the combined sewer system. The data were then used to characterize the system CSOs and to estimate CSO impacts on receiving water quality. The flow, frequency, and pump station data, generated during the program, were also used to enhance, calibrate, and verify the SWMM model of the system. This effort was necessary because limited data were available during initial (Task 3) model development, which preceded the monitoring program. TM No. 7 discusses the monitoring program, presents data results, and documents subsequent efforts to enhance the model prior to final simulation related to the recommended plan.

Approach

TM No. 7 focuses on aspects of the monitoring program including precipitation, sewer flow at various locations, CSO frequency (block test data), and pump station records. In addition, TM No. 7 documents model changes from the previous (Task 3) modeling effort and presents calibration and verification results. The hydraulic model developed in Task 3 was reviewed in detail with an emphasis on enhancing it with respect to the following:

- Increased cognizance of the EXTRAN dynamic solution technique process and methods to eliminate solution instability.

- Updated knowledge of the physical aspects and hydraulics of the Portland combined sewer system.

- Flow, frequency, and pump station monitoring results from the monitoring program.

- Updates associated with the latest version of SWMM (Version 4.2, May 1992).

Results

The rainfall record for the Portland International Jetport gauge was used for the project. The record is 100 percent complete beginning May 1948 through August 1991. A statistical analysis was performed on the rainfall record to determine average and maximum volumes, intensities, and durations. Fifteen-minute rain gauge strip chart data were acquired for the monitoring period duration. The precipitation year 1966 was selected as the long-term continuous simulation period based on minimizing the sum of deviations of statistical parameters from long-term average.

Combined sewer flow data were acquired at 9 locations throughout the city. The locations were selected based on representative hydrologic and/or hydraulic characteristics of the system. The data collected supplements those available from previous studies and provides a means for characterizing the combined sewer system. The flow record at individual sites does contain anomalies, but in general provides a good representation of system flow under various precipitation events.

Frequency data for most CSOs were acquired using small wooden ("telltale") blocks attached by string to regulator control points. Results were used to characterize the activity of various CSOs and were compared with model simulated results.

The updated model was calibrated and verified using results of the monitoring program. Calibration and verification were performed using the flow monitoring results at each of the nine stations and the pump stations. The model was also run for each of the periods represented by the block test result.

Conclusions

The current model is believed to be functionally accurate for the purposes of CSO abatement and will be used as the primary tool for evaluating the effect of various control alternatives for reducing the volume and frequency of Portland's CSOs.

Executive Summary

Technical Memorandum No. 8

CSO Pollutant Evaluation

Purpose

Technical Memorandum No. 8 presents analytical results of the Portland CSO monitoring program. The analysis focused on three primary objectives to determine:

- Similarities and/or differences between monitoring sites
- Presence or absence of a first flush effect
- Area-wide or basin-specific event mean concentrations (EMC)

Approach

The Consent Agreement issued by the State of Maine to the City of Portland identified 23 pollutants of concern with respect to Portland's CSO discharges. Plots were generated to indicate whether there is a difference between pollutant levels at the various sites and whether a first flush effect is evident.

The data were analyzed graphically by plotting the dry weather concentrations, first flush concentrations, and falling limb of the hydrograph concentrations for each parameter for each storm event. Because of unusually dry weather during the monitoring period, data were collected for only two storm events. The data for the two storm events were collected in a flow weighted manner. The first flush was identified visually among the samples collected and composited by flow weighting. Similarly, the falling limb of the hydrograph was visually identified and the samples were composited by flow weighting.

EMCs were computed for each parameter at each sampling site by flow weighting the recorded concentrations. Therefore, each EMC for a specific sampling site incorporates the volume of CSO passing the sampler when the sample was composited. Area-wide EMCs were then computed by incorporating the total volume of CSO passing each sampling site during both wet weather events.

Results

The data plots indicated that there were differences in pollutant concentrations generated between sampling sites for the same event as well as between events at the same site. The differences observed were not consistent by parameter or event. In general, wet weather event 2 (total rainfall of 0.52 inches) generated higher concentrations than event 1 (total rainfall 2.39 inches). The Mackworth Street sampling site (CS2) had consistently lower concentrations for pollutant parameters than the other sampling sites during both wet and dry events.

A first flush effect was observed for all parameters except E. coli. The absence of a first flush effect for bacterial indicators is documented in several studies, including the Bangor CSO Facilities Plan study performed by CH2M HILL in 1991. The first flush effect is important in evaluating CSO control measures which focus on minimizing the load developed during the initial stages of the storm.

Table 4 summarizes pollutant concentrations for the five sampling sites, and the area-wide EMCs developed.

Table 4 Summary of Pollutant Concentrations						
Parameter	CS1 Ocean Ave.	CS2 Mackworth St.	CS3 Franklin St. PS	CS4 Bath Iron Works	CS5 Emery St.	Area-wide EMCs[a]
BOD_5 (mg/l)	28	12	56	38	39	34
TSS (mg/l)	239	56	164	87	76	217
TKN (mg/l)	4	4	7	9	9	5
Total P (mg/l)	0.7	0.5	1.3	1.4	1.5	0.8
E. coli (CFU/100 ml)	400,000	40,000	700,000	960,000	90,000	430,000[b]
Cadmium (μg/l)	0.4	0.4	1.3	0.7	0.4	0.6
Copper (μg/l)	29	17	69	54	138	38
Iron (μg/l)	3,400	1,800	4,400	2,700	1,300	3,500
Lead (μg/l)	28	29	98	113	65	44
Zinc (μg/l)	78	65	156	172	98	95

[a] Weighted by the volume of CSO recorded during sampling period at each sample site.
[b] Volume weighted geometric mean.

Table 5 presents Portland area-wide EMCs for several typical parameters for comparison with data from other sites in the northeast and nationally.

Table 5
Comparison of Portland, ME, CSO EMCs with Those of Other Cities

Parameter	Units	Portland, ME	Bangor, ME[a]	MWRA Boston[b]	Portland, OR[c]	EPA[d]
BOD_5	mg/l	34	24.5	90	30	115
Cadmium	μg/l	0.6	0.61	–	–	–
Copper	μg/l	38	30	85	–	–
E. coli[e]	CFU/100 ml	430,000	156,000	–	23,000	–
Fecal Coliform[e]	CFU/100 ml	–	181,000	680,000	163,000	670,000
Lead	μg/l	44	57	110	–	370
TSS	mg/l	217	250	188	148	370
Zinc	μg/l	95	114	110	110	–

[a] Bangor, ME, CSO Facilities Plan, CH2M HILL, 1991
[b] MWRA CSO Facilities Plan, CH2M HILL, 1989
[c] Portland, OR, CSO Facilities Plan, CH2M HILL, 1990
[d] Nonweighted average of data collected in Des Moines, Milwaukee, New York City, Racine, Rochester. Summary appeared in EPA document EPA-600/8-77-0 14, September, 1977.
[e] Geometric Mean computed for bacteria samples

Few of the nonstandard parameters (polyaromatic hydrocarbons, petroleum hydrocarbons, PCBs, and herbicides) were detected during the dry weather and second wet weather sampling events. Approximately half of the individual parameters were detected during the first wet weather event, indicating extreme variability between sampling events. Seventeen of the 33 parameters were not detected at any sampling site or event. Because of the small number of samples (one sample per event), and the nature of the samples (instantaneous grab samples), reliable EMCs for the detected non-standard parameters could not be estimated.

Conclusions

The monitoring data collected, and the ensuing analysis, indicated that there was variability in pollutant parameter concentrations generated between sampling sites and between events. The differences observed were also not consistent by parameter or event. These differences, however, are typical of CSO data.

A first flush effect was evident for all parameters except E. coli. Therefore, capture of the first flush will improve removal of parameters which exhibited a first flush (BOD, TSS, etc.) more than that for E. coli.

Although variable, the Portland monitoring data was well within the range anticipated for CSO data. Therefore, area-wide EMCs were developed to represent the mean concentrations anticipated from Portland's CSO discharges. These EMCs corresponded well with CSO concentration data collected in other cities, considering the extreme variability of CSO data.

(C) in the event that any of the actions described in paragraph 9(a) are not completed as required, Portland and PWD shall pay jointly and severally the Treasurer, State of Maine, the following total amounts:

1. for each day after March 1, 1991, that the Scope of Work required in paragraph 9(A)(1) is not submitted, the sum of $100;

2. for each day after December 1, 1992, that the Sewer Master Plan required in paragraph 9(A)(5) is not submitted, the sum of $200;

3. for each day after February 1, 1991, that the license application required in paragraph 9(B) is not submitted, the sum of $100;

10. Dispute Resolution. Any dispute arising under or with respect to this consent agreement shall, in the first instance, be the subject of informal negotiations between or among the parties to the dispute for a period of up to fifteen (15) working days from the time notice of the existence of the dispute is given. The period for negotiations may be extended by agreement of the parties to the dispute. If a dispute cannot be resolved by informal negotiations then the position of the Department shall be considered binding unless, within fifteen (15) days after being notified of the Departments position, Portland and/or PWD may petition the Board setting forth the matter in dispute, the efforts made by the parties to resolve it, and its proposed resolution. The Department shall have twenty (20) days to file a response to Portland and/or PWD petition with an alternative proposal for resolution of the dispute. Decisions of the Board with respect to disputes may be appealed to the Court. In proceedings on any dispute under this paragraph, Portland and/or PWD shall have the burden of showing that its proposal meets the requirements of the agreement.

11. Force Majeure. If any event occurs which causes or is anticipated to cause delays in the achievement of any requirement of this consent agreement. Portland and/or PWD shall, within ten (10) business days from when they knew or reasonably should have known of such event, notify the Department in writing describing the cause or causes of the delay and a preliminary estimate of the length or anticipated length of the delay. Within thirty (30) days, Portland and/or PWD shall notify the Department in writing providing a detailed explanation of the length or the anticipated length of the delay, the measures taken and to be taken to prevent or minimize the delay and the timetable by which those measures will be implemented. Reasonable measures to avoid or minimize any such delay shall be adopted. If the parties agree that the delay or anticipated delay has been or will be caused by reason of force majeure beyond Portland and/or PWD's reasonable control, the time for performance hereunder shall be extended for a period no longer than that attributable to the delay resulting from such force majeure. In the event that there is any dispute as to whether all or a portion of Portland and/or PWD's failure to comply with any action required to be taken by it pursuant to this Administrative Consent Agreement and Enforcement Order, Portland and/or PWD shall have the burden of proof to show: (i) that the noncompliance was caused by circumstances beyond its reasonable control; (ii) the period of noncompliance that resulted from circumstances beyond its reasonable control; and (iii) that Portland and/or PWD took all reasonable measures to minimize the number of days and degree of any noncompliance. The provisions of this

Executive Summary

Technical Memorandum No. 9

Receiving Water Assessment

Purpose

TM No. 9 describes the physical, mixing, and water quality characteristics of the receiving waters within the Portland corporate limits. The purpose of the study task was to describe the existing conditions in the receiving waters and, to the extent practicable, assess the impact of Portland's CSO discharges on receiving water quality. The fresh receiving waters include the Presumpscot River, Capisic Brook, Stroudwater River, and Fall Brook. Marine receiving waters include Back Cove, Fore River, Portland Harbor, and Casco Bay.

Approach

The assessment of water quality in the receiving waters focuses on toxicants, bacteriological indicators, and floatable solids, based on discussions with DEP and the results of the CSO and receiving water monitoring programs. Toxicants are associated with impacts to aquatic life and human health through either drinking water supply (after treatment) uses or aquatic organism consumption. Bacteriological indicators are associated with impacts on drinking water supply (after treatment) uses, recreational uses, and shellfishing waters. Significant floating solids associated with many CSO discharges often violate Maine's narrative criterion concerning floating solids.

Other pollutant sources, such as upstream discharges and separate stormwater, are not considered quantitatively in the analysis. Quantification of the effects of these other sources would require a long-term, comprehensive receiving water monitoring program far beyond the scope of this effort. DEP has taken a reasonable approach to CSO facilities planning which allows municipalities to focus their efforts on assessing the contribution of their own CSOs to the receiving waters.

The effect of toxicants was evaluated by comparing the pollutant event mean concentrations (EMCs) developed in TM No. 8 with the EPA's Final Acute Values (FAVs) for several common toxicants. EPA and many states have in some cases conservatively used the FAVs for aquatic life criteria for evaluating acutely toxic releases to receiving waters. The comparisons are conservative because FAVs are computed on a longer time of exposure (typically 96 hours) than would be encountered in a first flush. Also, FAVs are intended for fully-mixed instream comparisons that include dilution, whereas EMCs do not include any dilution in the receiving water.

Pathogenic impacts on water quality were evaluated by receiving water monitoring and analysis for bacteriological indicators. Samples were analyzed for E. coli in fresh waters, and fecal coliform and enterococcus in marine waters during both dry and wet weather. The results were compared spatially, temporally, and with water quality criteria. Dye/drogue studies helped evaluate the impact of floating solids in addition to providing information on mixing characteristics of the receiving water.

Results

Toxicity

Table 6 presents the result of the comparison of FAVs with EMCs developed in the CSO monitoring program for five toxic metals. Only the EMC for copper exceeds the

FAV, even though the EMCs do not consider the beneficial effect of dilution in the receiving water.

Table 6
Comparison of Portland CSO EMCs and FAVs

Parameter	EMC (μg/L)	FAV[a] (μg/L) Freshwater	FAV[a] (μg/L) Marine
Cadmium	0.6	3.59[b]	86
Copper	38	18.5[b]	5.8
Iron	3,500	*No Criterion*	*No Criterion*
Lead	44	67.6[b]	280
Zinc	95	130[b]	190

[a] FAV is an estimate of the concentration of a toxicant corresponding to a cumulative probability of 0.05 in the acute toxicity values for all genera for which acceptable acute tests have been conducted.
[b] EPA criteria adjusted to hardness of 50 mg/L

Pathogenic Indicators

One method of assessing the effect of CSO on receiving water quality is a comparison of background, or dry-weather, indicator bacteria data to monitoring data collected during wet-weather events. Background data are generally not available for the Portland area, with the exception of East End Beach. Thus, dry-weather monitoring was conducted to provide background data suitable for comparison. E. coli for fresh waters, and enterococcus values for marine waters, were compared to the respective State criteria. The E. coli criterion for Class C waters is for the period May 15 through September 30, requiring a geometric mean of ≤142 CFU/100 ml or an instantaneous level of ≤949 CFU/100 ml. The enterococcus criterion for Class SC waters is for the same time period, and requires a geometric mean of ≤14 CFU/100 ml or an instantaneous level of ≤94 CFU/100 ml.

Freshwater

The E. coli data for both wet-weather events indicated that all three freshwater locations monitored during the first wet-weather event had elevated levels of indicator bacteria above the background, or dry-weather, levels as sampled on September 1, 1992. There was a gradual decline with time of indicator bacteria levels in Capisic Brook at the Lucas Street bridge. The last sampling at this location on September 29, 1992, showed indicator bacteria levels still exceeding the background levels recorded during the dry-weather event. The small amount of data for Fall Brook at Ocean Avenue is inconclusive regarding the duration of indicator bacteria impact. E. coli levels at Fall Brook (with no CSO discharge) were comparable to those in Capisic Brook (with CSO discharges). These observations indicate significant bacteria impact from non-CSO sources.

Marine

There are two major marine flow paths within the greater Portland receiving water system. One flow path is from Capisic Brook and Fore River through Portland Harbor to Casco Bay. The sequence of locations monitored along the path is Outer Congress Street, I-295 Bridge, Clark Street Outfall, Maine State Pier, and East End Beach. The second flow path is from Back Cove to Casco Bay. The sequence of locations monitored is Tukey's Bridge to East End Beach.

Bacterial indicator data were also collected for the marine water sites. The Portland Harbor at Clark Street and Back Cove at Tukey's Bridge locations exhibited both fecal coliform and enterococcus wet-weather levels significantly higher than background, or dry-weather, levels. Fecal coliform and enterococcus data show the same two distinct flow paths to Casco Bay as described previously.

Floating Solids and Mixing Characteristics

Two locations were chosen for the CSO and floating solids movement demonstrations: 1) outlet of Back Cove at Tukey's Bridge and 2) CSO 24–Franklin Street overflow at Maine State Pier. The outlet of Back Cove demonstrates the discharge of large quantities of CSO into an open harbor area. CSO 24 is a large, active overflow which discharges into a very confined area between two wharfs.

The action of wind, particularly on floatables, was simulated by grapefruit drogues. The liquid portion of a CSO controlled by wind and currents was simulated using a dye solution. Both items were tracked over time. Some of the general observations from the detailed discussion included in TM No. 9 are:

- Wind influenced movement of floatables primarily when currents were slow (low and high slack tides)
- Liquid movement was not greatly influenced by wind, even in choppy waters
- Liquid and floatable movement can be significantly delayed in the pipe during high tide
- Liquid moves quickly to the main channels during outgoing tides

Conclusions

Portland's CSOs indicate little potential for acute toxicity at end-of-pipe, even when considering little or no dilution in the receiving waters. In addition, the FAVs are developed based on a relatively long (96-hour) exposure time which, based on the results of the mixing studies, is significantly longer than the flushing time in the receiving waters. The studies demonstrated that CSO may remain in discharge locations for up to a 12-hour cycle. Once CSO reaches the major channels, it moves quickly during outgoing tide with minimal impact to shorelines.

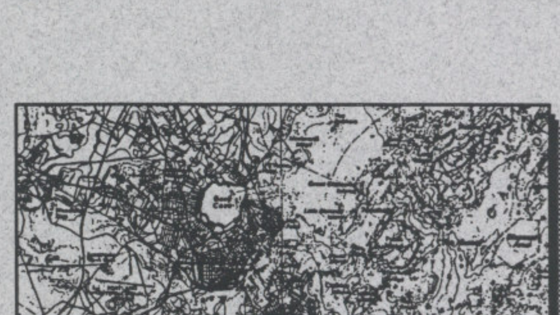
Bacteria sampling at freshwater locations showed levels exceeding the water quality criterion for E. coli in both Capisic Brook and Fall Brook during wet weather. Samples in the Capisic Brook were taken at locations downstream of the CSOs. No CSOs discharge to the Fall Brook. Elevated indicator bacteria levels at both locations during storm events show that bacterial loadings to Portland's fresh receiving waters are not solely related to CSO, but also to non-CSO sources such as stormwater and nonpoint discharges.

Data from marine receiving water sampling locations were analyzed for indicator bacteria enterococcus and fecal coliform. A number of marine samples exceeded the enterococcus criterion, including the dry-weather samples from East End Beach and Back Cove at Tukey's Bridge. Only these locations exceeded the enterococcus criterion during dry weather. All locations frequently exceeded bacterial indicator criteria during wet-weather events.

The results suggest that exceedences of indicator bacteria criteria are likely due to a combination of background contamination (East End Beach), separate stormwater discharges (Fall Brook), and CSOs. Also, the dye/drogue studies indicate that exceedences of criteria for floating solids vary greatly with wind direction, wind velocity, and tidal cycle. However, East End Beach appears to be one of the areas most susceptible to floatable solids accumulations. Bacterial indicators and floating solids should therefore be the primary focus of CSO controls.

Appendix C

Formation of a CSO/Stormwater Utility and Sources for the Financial Analysis



Appendix C
Part I

Formation of a CSO/Stormwater Utility

The City of Portland will investigate the formation of a CSO/stormwater utility as one option for implementing some or all of the CSO facilities recommended in this plan. A utility approach is based on the premise that developed property generates a need for public services that can be charged in proportion to the need for those services.

This section provides a brief overview of a four-phased approach that could be used to investigate and implement a separate CSO/stormwater utility. Phases are:

- Define study parameters/conduct preliminary evaluation of fees
- Develop a program rate strategy
- Conduct a billing data pilot study and public information program
- Prepare billing data and implement rate strategy

These phases are sequential, with the results from one phase providing information required to proceed with subsequent phases of the project. Experience in other locations has shown that it is important to involve decision makers and the public throughout the process in order to improve the likelihood for success of the program. The timing to implement these activities will depend on the availability of data and nature of the public involvement and decision processes selected by the City. Estimated duration for each phase based on experience of other communities is included below. The City is prepared to act quickly to set up a CSO/stormwater utility; therefore, the shorter estimated durations of each phase are most likely.

Phase 1 Define Study Parameters/Conduct Preliminary Evaluation of Fees

The first tasks in investigating opportunities to form a CSO/stormwater utility would be to identify the parameters for the utility study and to develop a rough estimate of the rates to be charged to accomplish the utility's objectives. The objectives of the utility should be defined by answering questions such as:

- What geographic area should be included in the utility? The City of Portland? Other neighboring jurisdictions?

- Which of the CSO facilities recommended in this plan should be undertaken by the utility, and which should be undertaken by other entities?

- What is the scope of non-CSO stormwater management needs to be considered for the utility?

In addition, certain data should be gathered from the relevant property assessment offices regarding property sizes and the square footage used for structures, subareas, and extra features. This information would be used to develop a preliminary assessment of fees necessary to accomplish the utility's objective. These estimated fees could then be compared with the user charge estimates based on current user charge methods, contained in this facility plan. A more refined assessment of likely rates and a more detailed consideration of utility rate options will be included in Phase 2.

Also during Phase 1, there should be a review of the legal and institutional context for forming a utility in Portland. This would include a review of:

- State of Maine regulations pertaining to the authority to organize and finance work by such a utility
- Existing contracts and other agreements between the City, the PWD, and other neighboring jurisdictions that might participate in the utility
- Current provisions for implementing CSO and stormwater work by the City's various departments and other local agencies
- Program needs to satisfy local, state, and federal permit requirements for CSOs and/or other stormwater issues

A report on the findings of the Phase 1 studies should be prepared and presented to the City Council, which would determine if and how to proceed with remaining phases of the program.

Estimated duration for Phase 1 is two to three months from the time property data are made available.

Phase 2 Develop a Program and Rate Strategy

The focus of this phase is to identify alternative rate formulations and to determine the formulation that best satisfies the needs of the City on a long-term basis. Tasks to be performed during this phase include:

- Define revenue requirements for the utility. The capital and operating costs for CSO facilities included in this plan will be a key element of the revenue requirements for the proposed utility. Additional requirements to be estimated include such items as capital and operating costs for non-CSO stormwater projects, public information, administration, and billing systems.

Appendix C
Part II

Sources for Primary Data Used in the Financial Capability Analysis Portland, Maine CSO Facilities Plan

I. Financial/Cost Data

A. Existing Charges/Other Committed Expenditures

1. Debt service schedule for previously issued debt

   - Debt Service schedule provided by Jerry Goodall of the City of Portland's Accounting Department on 10/23/92

2. Future Capital Projects (Non-CSO)

   - Estimate provided by Bill Goodwin of the City's Engineering Department during telephone conversation on 10/21/92, based on capital expenditure history for non-CSO projects during the past ten years, and anticipated levels of future expenditure

3. Existing rates and planned rate increases

   - Rate schedule dated 2/13/92, and additional information regarding industrial surcharge rates contained in a letter from Bill Goodwin dated 10/14/92 and a memorandum regarding sewer use fee calculations to Robert Ganley from Ellen Sanborn dated 1/3/92

4. Typical use for a residential customer, and resulting sewerage bill

   - Derived from rate schedule dated 2/13/92 and the number of persons per household indicated in the 1990 U.S. Census of Population for Portland, Maine based on a telephone conversation on 10/21/92 with George Patterson, Bureau of the Census, Housing and Household Economic Statistics Division

5. Current sewer fund revenues from rates and other sources

   - Memorandum to Robert Ganley from Ellen Sanborn, Director of Budget/Purchasing, dated 1/3/92

- Evaluate rate structure alternatives (e.g., definition of billing units), taking into account rate-making criteria such as equity and efficiency, based on cost of service considerations.

- Identify billing data requirements, including procedures for setting up billing account data base and collection, updating, and file maintenance requirements.

- Evaluate alternate billing methods and make a recommendation for implementation.

- Evaluate billing software and hardware currently in place in light of future needs to implement the selected rate structure and billing system.

- Prepare and adopt a program strategy. This strategy, to be approved by both City staff and Council, should include items such as establishment of revenue requirements and a basis to assess fees, development of ordinance modifications, and identification of accounting and billing procedures.

- Develop a public information program that can be used during Phase 3 to educate and inform the public of options being considered and to involve the public in the decision-making process.

- Prepare a draft ordinance creating and empowering the utility.

Estimated duration for Phase 2 is three to six months from the conclusion of Phase 1.

Phase 3 Conduct a Billing Data Pilot Study and Public Information Program

Having adopted a long-term program strategy, possible procedures for compiling the billing data should be evaluated through a pilot study. This would involve comparing various methods to collect and verify impervious area measurements for appropriate utility customer categories, including residential/commercial, small unregulated industries, and regulated industries. Tasks to be performed during this phase include:

- Prepare pilot study procedures

- Compile pilot area data

- Evaluate pilot study results

- Initiate public information program, including a hearing and adoption process for the draft ordinance

Estimated duration for Phase 3 is three to twelve months from the conclusion of Phase 2.

Phase 4 Prepare Billing Data and Implement Rate Strategy

Having adopted a rate structure at the completion of Phase 2, a billing account database should be established for the area to be served. Based on the results of the Phase 3 pilot study, Phase 4 would include the following tasks:

- Prepare billing software to be fully operational to support the requirements identified in Phase 2 and Phase 3
- Compile billing data records for the entire proposed service area
- Secure staff training for City staff in the operation of the data base program
- Continue public information support

Estimated duration for Phase 4 is four to six months from the conclusion of Phase 3.

6. True interest rate for most recent (July, 1992) bond issue

   - Telephone conversation with Jerry Goodall of the City's Finance/Accounting Department on 10/21/92

B. CSO Project Expenditures

1. Capital & O&M costs

   - CH2M HILL

2. Implementation schedule options for CSO alternatives

   - CH2M HILL

3. Financing assumptions (e.g., debt vs. equity, bond term, interest rates)

   - Assumption of 20-Year GO bonds provided by the City in a letter to Mike Domenica from Bill Goodwin, dated 10/14/92; eight percent interest rate estimated by CH2M HILL in light of recent Portland bond ratings, interest rates, debt margin, and possible market conditions during a ten or fifteen year implementation period

II. Customers, Growth & Other Parameters

A. Number of customers, by class

   - Letter from Bill Goodwin to Mike Domenica, dated 10/14/92

B. 1990 median household income data

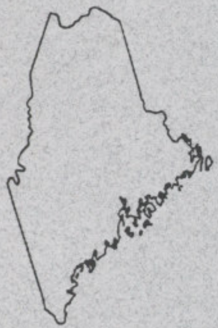
   - Telephone conversation on 10/21/92 with George Patterson, Bureau of the Census, Housing and Household Economic Statistics Division

C. 1990 population data, other general background economic and financial characteristics (e.g., legal debt margins, bond ratings for recent bond issues)

   - Letter from Bill Goodwin dated 10/14/92 plus sections of the official statement for general obligation bonds issued on July 1, 1992 in the amount of $9,390,000

D. Growth rate in population/number of customers

- Derived based on conversations with Bill Goodwin on 10/21/92, a letter from Mr. Goodwin to Mike Domenica on 10/14/92, and the percentage growth in consumption between 1992 and 1995 projected in the memorandum regarding Sewer User Fee Calculation from Ellen Sanborn to Robert Ganley, dated 1/3/92



Appendix D

Precipitation Record From Portland Jetport

		Description of 1966 Precipitation Events*					
Return Period (Months)	Month	Day	Year	Volume (Inches)	Max. Intensity (Inches/Hr.)	Avg. Intensity (Inches/Hr.)	Duration (Hours)
21.5	11	2	66	3.39	0.39	0.09	39
7.8	10	19	66	2.42	0.31	0.09	26
7.4	8	22	66	2.39	0.64	0.15	16
4.5	1	30	66	2.04	0.32	0.11	19
3.7	9	4	66	1.84	0.38	0.14	13
3.2	12	29	66	1.78	0.55	0.16	11
2.6	2	25	66	1.64	0.15	0.06	27
2.4	3	24	66	1.59	0.52	0.09	17
1.7	2	13	66	1.37	0.29	0.10	14
1.3	1	23	66	1.19	0.14	0.04	27
1.0	9	21	66	1.01	0.26	0.09	11
0.9	6	5	66	0.91	0.46	0.30	3
0.7	8	11	66	0.82	0.30	0.07	11
0.7	2	28	66	0.81	0.21	0.08	10
0.7	8	22	66	0.80	0.24	0.09	9
0.7	10	1	66	0.77	0.07	0.04	21
0.6	3	4	66	0.72	0.19	0.03	21
0.6	1	8	66	0.72	0.11	0.03	21
0.6	9	14	66	0.68	0.20	0.05	14
0.5	5	8	66	0.60	0.12	0.07	9
0.5	1	2	66	0.57	0.09	0.04	16
0.4	7	19	66	0.48	0.17	0.08	6
0.4	11	28	66	0.48	0.15	0.02	23
0.4	12	7	66	0.48	0.10	0.05	9
0.4	12	14	66	0.47	0.14	0.05	10
0.4	4	30	66	0.45	0.08	0.05	10
0.4	6	29	66	0.42	0.23	0.10	4
0.4	5	12	66	0.41	0.11	0.03	15
0.4	4	8	66	0.40	0.16	0.10	4
0.4	2	16	66	0.40	0.09	0.05	8
0.4	12	24	66	0.40	0.08	0.03	16
0.3	8	16	66	0.39	0.20	0.08	5
0.3	6	24	66	0.35	0.31	0.17	2
0.3	8	2	66	0.35	0.20	0.09	4
0.3	6	13	66	0.29	0.10	0.04	8
0.3	9	29	66	0.29	0.07	0.03	10
0.3	11	5	66	0.29	0.05	0.02	14
0.3	5	19	66	0.28	0.11	0.04	8
0.3	11	30	66	0.26	0.15	0.05	5
0.3	6	9	66	0.26	0.04	0.02	12
0.3	10	16	66	0.25	0.09	0.04	7
0.3	1	6	66	0.23	0.08	0.02	10
0.2	3	5	66	0.21	0.10	0.03	7
0.2	6	7	66	0.18	0.06	0.03	6
0.2	11	17	66	0.18	0.05	0.02	12
0.2	3	30	66	0.17	0.09	0.02	7
0.2	8	25	66	0.17	0.06	0.03	6
0.2	3	12	66	0.17	0.03	0.02	10
0.2	6	10	66	0.15	0.13	0.08	2
0.2	10	10	66	0.15	0.06	0.02	7
0.2	11	25	66	0.14	0.07	0.03	5
0.2	12	2	66	0.14	0.03	0.02	8
0.2	7	29	66	0.13	0.11	0.04	3
0.2	5	9	66	0.13	0.06	0.03	4
0.2	4	24	66	0.13	0.04	0.01	9
0.2	6	15	66	0.12	0.12	0.12	1
0.2	11	16	66	0.12	0.06	0.03	4

Return Period (Months)	Month	Day	Year	Volume (Inches)	Max. Intensity (Inches/Hr.)	Avg. Intensity (Inches/Hr.)	Duration (Hours)
0.2	5	28	66	0.12	0.04	0.01	9
0.2	6	7	66	0.11	0.11	0.11	1
0.2	5	9	66	0.11	0.04	0.01	9
0.2	1	27	66	0.11	0.04	0.02	7
0.2	6	25	66	0.11	0.03	0.02	7
0.2	7	20	66	0.10	0.06	0.03	3
0.2	7	28	66	0.10	0.05	0.02	5
0.2	12	7	66	0.09	0.02	0.01	9
0.2	6	16	66	0.08	0.02	0.01	7
0.2	4	9	66	0.07	0.03	0.02	4
0.2	11	10	66	0.06	0.05	0.03	2
0.2	7	6	66	0.06	0.03	0.02	3
0.1	3	13	66	0.06	0.01	0.01	10
0.1	11	11	66	0.05	0.04	0.03	2
0.1	4	11	66	0.04	0.04	0.04	1
0.1	7	10	66	0.04	0.03	0.01	5
0.1	6	6	66	0.04	0.03	0.02	2
0.1	5	18	66	0.04	0.01	0.01	5
0.1	8	15	66	0.04	0.01	0.01	5
0.1	5	3	66	0.03	0.03	0.03	1
0.1	12	6	66	0.03	0.03	0.03	1
0.1	4	2	66	0.03	0.02	0.02	2
0.1	11	27	66	0.03	0.01	0.00	7
0.1	1	19	66	0.03	0.01	0.01	3
0.1	1	20	66	0.02	0.02	0.02	1
0.1	3	19	66	0.02	0.02	0.02	1
0.1	4	21	66	0.02	0.02	0.02	1
0.1	5	6	66	0.02	0.02	0.02	1
0.1	7	3	66	0.02	0.02	0.02	1
0.1	7	12	66	0.02	0.02	0.02	1
0.1	9	22	66	0.02	0.02	0.02	1
0.1	12	6	66	0.02	0.02	0.02	1
0.1	12	16	66	0.02	0.02	0.02	1
0.1	3	27	66	0.02	0.01	0.00	5
0.1	1	14	66	0.02	0.01	0.01	2
0.1	1	23	66	0.02	0.01	0.01	2
0.1	4	24	66	0.02	0.01	0.01	2
0.1	8	27	66	0.02	0.01	0.01	2
0.1	12	11	66	0.02	0.01	0.01	2
0.1	1	21	66	0.01	0.01	0.01	1
0.1	1	21	66	0.01	0.01	0.01	1
0.1	2	3	66	0.01	0.01	0.01	1
0.1	3	24	66	0.01	0.01	0.01	1
0.1	4	7	66	0.01	0.01	0.01	1
0.1	4	9	66	0.01	0.01	0.01	1
0.1	4	10	66	0.01	0.01	0.01	1
0.1	4	29	66	0.01	0.01	0.01	1
0.1	4	29	66	0.01	0.01	0.01	1
0.1	5	19	66	0.01	0.01	0.01	1
0.1	6	2	66	0.01	0.01	0.01	1
0.1	6	5	66	0.01	0.01	0.01	1
0.1	7	6	66	0.01	0.01	0.01	1
0.1	8	16	66	0.01	0.01	0.01	1
0.1	10	5	66	0.01	0.01	0.01	1
0.1	10	24	66	0.01	0.01	0.01	1
0.1	11	9	66	0.01	0.01	0.01	1
0.1	12	21	66	0.01	0.01	0.01	1
* Precipitation record obtained from the Portland International Jetport							

Hourly Precipitation Data
from Portland Jetport Rain Gauge

May-September 1989
May-September 1990
May-September 1991
May-September 1992

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

MAY 1989
PORTLAND, ME
14764

DATE	A.M. 1	A.M. 2	A.M. 3	A.M. 4	A.M. 5	A.M. 6	A.M. 7	A.M. 8	A.M. 9	A.M. 10	A.M. 11	A.M. 12	P.M. 1	P.M. 2	P.M. 3	P.M. 4	P.M. 5	P.M. 6	P.M. 7	P.M. 8	P.M. 9	P.M. 10	P.M. 11	P.M. 12
01	T	T																		T	T		T	0.01
02	0.04	0.03	0.05	0.07	0.12	0.15	0.15	0.04	0.05	0.19	0.20	0.10	0.19	0.07	T	T	0.01	0.01	T					
03																		T						
04																	T							
05																				T	T	0.02	T	
06	0.02	0.10	0.41	0.52	0.33	0.23	0.02	0.04	0.01	0.02		0.01												
07		0.03	T	0.03	T	T	T	T	T															
08																								
09																								
10																			T	T	T	T	T	T
11	T	T	T	0.03	0.03	0.10	0.07	0.08	0.09	0.13	0.13	0.23	0.32	0.13	0.10	0.16	0.17	0.16	0.22	0.48	0.26	0.20	0.13	0.10
12	0.08	0.77	0.32	0.09		T	0.23	0.16	0.03	0.01	0.01	T	T	T	T									T
13	T	T	T	T	T	T	T	T	T	T	T	T	T	T		T	T	T	T				T	T
14	0.01	T	T	T	T	T																		
15																								
16																								
17																								
18																								
19																								
20																								
21																		T	0.01	T				
22															T									
23																								
24							T	T	T	T	T	0.01	T	0.01										T
25	T		T	0.01	T																		T	T
26															0.34			0.01	T		0.01			
27													T	T	0.03	0.01								
28																								
29																								
30																								
31											T	T	T						T	T	T			

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.11	0.20	0.25	0.29	0.39	0.58	0.77	0.88	1.03	1.15	1.25	1.33
ENDED: DATE	06	06	06	06	06	06	12	06	06	06	06	06
ENDED: TIME	0258	0412	0415	0412	0412	0412	0159	0412	0415	0415	0421	0529

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
BILL CLAYTON

SUBSCRIPTION PRICE AND ORDERING INFORMATION AVAILABLE FROM:
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38175
DUFRESNE-HENRY, INC.
ATTN: RUTH CARR
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

JUN 1989
PORTLAND, ME

14764

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01										T		
02												
03												
04						T	T	T	0.04		T	T
05												
06			T					0.01	0.03	0.20	0.22	0.24
07												
08	0.02	0.02	0.01	0.01	0.02	0.01	0.06	0.05	0.04	0.01	0.09	T
09												
10	T	0.04	0.10	0.17	0.47	0.32	0.21	0.25	0.01	0.01	T	T
11												
12												
13								T	T	0.01	0.02	0.01
14												
15				T	T		0.01	T	T	0.01	0.01	0.03
16	0.12	0.30	0.08	T	T	T	0.02	T	T	T		
17			T	T	T	T	0.01	T	T	T	T	T
18			0.01	0.02	0.03	T						
19												
20												
21												
22												
23												
24												
25												
26												
27												
28								T	0.02	0.01	T	0.01
29												
30												

P.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12	DATE
01													01
02			T	T	T	0.02							02
03													03
04													04
05													05
06	0.23	0.07	T	0.01	T	T	0.01	T					06
07			T		T	T	T	T	T	T	0.02	0.04	07
08	T	0.01	T	T	T	T	T						08
09						T	T	T			T	T	09
10	T	T	T					0.03					10
11													11
12													12
13	0.05	0.01	T										13
14													14
15	0.03	0.01	T	0.05	0.01	0.07	0.06	0.05	0.02	0.07	0.07	0.15	15
16									T				16
17						T							17
18					T	0.01			T	T			18
19													19
20													20
21													21
22													22
23								T					23
24													24
25													25
26													26
27													27
28	T	T	T										28
29													29
30													30

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.06	0.10	0.15	0.19	0.27	0.40	0.50	0.62	0.72	0.81	0.91	1.00
ENDED: DATE	10	10	10	10	10	10	10	10	10	10	10	10
ENDED: TIME	0501	0501	0507	0501	0511	0511	0525	0523	0556	0600	0632	0717

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
DON GRISINGER

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BUFRESNE-HENRY, INC.
ATTN: RUTH CARR
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

JUL 1989
PORTLAND, ME

14764

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02					T	T	T		T	T		
03												
04					T	T						
05									T	T	0.01	T
06	0.04	0.01	T	0.06	0.06	0.04	0.03	T		T	T	
07												
08	T	T	T	0.01	T	T						
09												
10								T	0.01	0.02	0.06	T
11												
12												
13												
14							T	T	T	T	0.09	0.06
15												
16												
17				T	0.01	0.04	0.11	0.07	0.11	0.18	0.14	0.13
18	T	T										
19												
20												
21												
22												
23												
24												
25												
26												
27												
28	0.09	0.02			0.05	0.06	0.01					
29												
30												
31												

P.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01				T	T	T	T	0.04	0.04	T		
02						T						
03												
04												
05	T	T	T	T	T	T	T	T	T	T	0.01	0.01
06			T	T								
07			T			T	T					
08												
09												
10	0.14	0.17	T									
11				T	T	T						
12												
13												
14	0.01					T						
15												
16												
17	0.05	T										
18												
19												
20									0.01	0.01		
21												
22										T	T	
23												
24												
25												
26						T	T					
27											0.06	0.06
28	0.11	0.03										
29												
30			T	0.23					T			
31												

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.09	0.16	0.17	0.17	0.18	0.18	0.23	0.24	0.29	0.34	0.41	0.48
ENDED: DATE	30	30	30	30	30	30	30	17	17	17	17	17
ENDED: TIME	1519	1519	1523	1523	1539	1539	1559	1010	1030	1050	1120	1150

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

AUG 1989
PORTLAND, ME
14764

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
01			T	T	T	T	T	T																	01
02																									02
03		T	T	0.02	T	T	T																		03
04							T	0.01	0.02										T	T					04
05					0.01									0.02	T		T	0.05	T						05
06																									06
07																				T	T	T	T	T	07
08	T	0.03	0.02	0.02	0.02																				08
09																									09
10																									10
11										T	T	T	T	T	T	0.05	T	T	0.01	0.03	0.01	T	0.38	T	11
12	0.01	T	0.02	T	0.01	T	0.01	0.01	T	0.05	T				T	T			T	T					12
13							0.08	0.02	0.03	T				0.18	0.02		T	T		0.02	0.11	T			13
14																									14
15																									15
16			T	T	T	0.01	T	T																	16
17																	T								17
18																									18
19																									19
20					T	0.05	0.06		T	T					0.24	T	T	0.02	T						20
21																									21
22																									22
23																									23
24																									24
25																									25
26																									26
27																									27
28					T	T																			28
29																						T	0.04	0.01	29
30		0.03	T	T	T																				30
31																									31

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.15	0.22	0.28	0.31	0.36	0.37	0.38	0.39	0.39	0.39	0.40	0.41
ENDED: DATE	11	11	11	11	11	11	11	11	11	12	12	12
ENDED: TIME	2257	2257	2257	2257	2257	2257	2257	2327	2327	0012	0012	0056

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES) SEP 1989 PORTLAND, ME 14764

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01																	T	0.01	0.03	0.05	0.12	0.11	0.18	0.05	01
02																									02
03																									03
04																									04
05																									05
06																									06
07																									07
08																									08
09																									09
10																									10
11																		0.01	T						11
12																									12
13																									13
14									T						T	0.02	0.02	0.01	0.05	0.05	T	0.04	0.08	0.15	14
15	0.45	0.27	0.43	0.08	0.03	0.03	T	T	0.02	T															15
16																			T	T	T	0.01	0.01	0.05	16
17	0.04	0.01	T	0.25	0.04	0.01																			17
18																									18
19									T	T	T	0.07	0.05	0.11	0.05	0.04	T	0.02	T	T	0.02	0.04	0.06	0.01	19
20	0.02	T	T	T	T	T	T	T	0.06	T	T	0.01	0.03	0.03	0.01	0.01	T								20
21																									21
22									T															T	22
23	0.10									T	T	0.01				T	0.01	0.08	0.07	0.01	T				23
24																									24
25																									25
26				T	T	0.08	0.11	0.13	0.12	0.16	0.09	0.08	0.07	0.01	T					T					26
27																									27
28																									28
29																			T						29
30																									30

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.07	0.13	0.19	0.24	0.34	0.44	0.51	0.59	0.67	0.87	1.07	1.15
ENDED: DATE	15	15	15	15	15	15	15	15	15	15	15	15
ENDED: TIME	0238	0234	0239	0242	0240	0109	0123	0144	0238	0241	0254	0259

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
DON GRISINGER

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SOUTH PORTLAND, ME 04106

LCD-17-14764-PD-9009

11433

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES) | MAY 1990 | PORTLAND, ME | 14764

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12
01	T	T	T	T	T	T	T	T	T			T	T				T	T					T	T
02	T	T	T	0.02	T																			
03																								
04																								
05	T	0.01	0.02	T	0.02	0.01	0.01	T	0.01	0.17	0.11	0.01	0.03	0.02	0.01	T	0.01	0.01	T	T		T	0.01	T
06	T			0.01	T													T						T
07	T	T						T	T	T	0.01	0.05	T			T	T	0.15	T	0.02	T	T		
08																			T	T	T	0.02	T	
09																								
10									T	0.02	0.01									T	0.03	0.21	0.43	0.30
11	T	0.01	0.01			T																		
12																								
13		T	0.02	0.06	0.06	0.06	0.03	0.02	0.06	0.12	0.04	0.07	0.08	0.02	0.01	T	T	0.01	0.14	0.14	0.01	0.02	0.01	T
14	0.02	T																						
15																					T			
16																					T	T	T	T
17			T										T	0.02	0.01	0.02	0.08	0.10	0.08	0.19	0.01	0.03	0.03	0.02
18	T	T	T	T																				
19		T																	T					
20																				T	T	T	0.01	
21	T	T	0.02	0.02	0.02	0.01	T	0.01	T	0.02	T	T	0.01	0.01	0.01	0.01	T	T	0.01	0.01	T	T	T	T
22	T	T	T	T	T	T	T	T		T	T	T	0.02	T	T	0.02	0.02	T	T					
23																		T	T	0.01	T			
24																								
25																								
26																								
27																								
28																								
29													T			T	T	0.03	0.06	0.01	0.04	0.10	0.25	0.16
30	0.23	0.22	0.09	0.09	0.08	0.12	0.11	0.05	T	T	T	T												
31																								

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.07	0.14	0.20	0.24	0.31	0.41	0.50	0.64	0.76	0.82	0.88	0.94
ENDED: DATE	10	10	10	10	10	10	10	10	10	10	10	10
ENDED: TIME	2211	2211	2213	2211	2217	2233	2243	2314	2323	2338	2359	2359

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

SUBSCRIPTION PRICE AND ORDERING INFORMATION AVAILABLE FROM:
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LCD-17-14764-PD-9006

38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES) JUN 1990 PORTLAND, ME 14764

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01																									01
02																									02
03																							T	T	03
04		0.02	0.07	0.03	T							0.03	T												04
05																		T							05
06												0.03	0.02	0.02											06
07		T	0.02	0.04	T									T	T		0.02								07
08																					T	T	T	0.02	08
09	0.03	T	0.01	0.03	0.06	0.01																T	0.01	T	09
10		T	T						T	T				T	T	T	T	T	T	T		T	0.01	0.01	10
11	0.01	0.02	0.02	0.08	0.07	0.01	0.02	0.03	0.06	0.13	0.01	T	0.10	0.02	T										11
12																									12
13																									13
14																				T	T	T	T	T	14
15	T	T	T	T	T	T																	T		15
16			T	T																					16
17																									17
18																									18
19					T	T	T														0.07	0.29	0.01		19
20			T	T	T	T	T	T				0.02	0.02	T	T		0.01	T	T				T	T	20
21	T	T	T	T	T	T	T	T	T	T										0.01	T	0.16	T		21
22			T	T	T	T																			22
23	T	0.01	0.02	0.05	T	T	0.01	T	T	0.02	T	0.18	0.64	0.08	0.04	0.04	0.46	T		0.01	0.05	0.01	T	T	23
24				T																					24
25													T	T	T										25
26																									26
27																0.09									27
28																									28
29															0.08	0.31	0.05	T	0.05	0.07	0.05	T	0.08	0.02	29
30	0.01	0.02	0.01	T	T																				30

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.58	0.58	0.58	0.58	0.58	0.64	0.79	0.83	0.87	0.88	0.88	0.94
ENDED: DATE	23	23	23	23	23	23	23	23	23	23	23	23
ENDED: TIME	1244	1244	1244	1244	1244	1244	1250	1252	1316	1316	1316	1440

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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U.S.MAIL

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LCD-17-14764-PD-9106

38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

AUG 8 1990

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES) JUL 1990 PORTLAND, ME 14764

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02		T										
03												
04	T	T	T	T	T	T	T					
05	T			T	T							
06												
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08												
09	T	0.02	T		0.03	0.01	0.03	T				
10												
11												
12										T	T	T
13	T											
14												
15												
16												
17												
18												
19												
20												
21												
22												
23		0.06	0.35	0.08	0.04	0.03	T	T	T	T	T	T
24	0.03	T										
25	T		0.01	0.04	0.12	0.18	0.03	T				
26												
27												
28			T	T	0.01	0.01	T	T	T	T		
29												
30						T	T					
31												

P.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02												
03											T	T
04					0.01	T	T				T	0.41
05												
06												
07												
08												T
09						T						
10												
11												
12	T	T	T	T	T			T		T	0.01	T
13												
14												
15												
16	T											
17												
18												
19												
20		0.04	0.70	0.20	0.12	T	T	T	T	0.01	T	T
21												
22												
23								T	T		0.03	0.11
24	0.22	0.08	0.12	0.03	T	T	T	T				0.03
25			T	0.01	T		T				T	T
26												
27												
28												
29								T	T	T		
30												
31												

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.30	0.49	0.59	0.61	0.69	0.76	0.80	0.90	0.94	0.95	1.07	1.07
ENDED: DATE	20	20	20	20	20	20	20	20	20	20	20	20
ENDED: TIME	1415	1418	1422	1425	1436	1436	1508	1509	1536	1536	1619	1633

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

SEP 18 1990

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES) AUG 1990 PORTLAND, ME 14764

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01																									01
02																									02
03																									03
04																									04
05																									05
06		T	T					T	T				T	T	T	T	T	T	T	0.04	0.03	0.04	0.03	0.01	06
07	T	T	T	T	0.01	0.01	0.01												T	T	T	T	T	T	07
08	T	T	T	0.01	T	T	T	0.01	T						T	0.02	T	T							08
09																					T	T	T	T	09
10					T	0.01	T	T	T													T	T	0.19	10
11	0.07	0.01	0.01			0.20	T		0.38	0.04	0.01	0.25	0.20	0.04	0.03	0.01	0.04	0.02	0.01						11
12																									12
13							T	T																	13
14			T																						14
15																									15
16																									16
17																									17
18																									18
19					T	0.06	0.03																		19
20																									20
21																									21
22																									22
23					T	T																			23
24																									24
25					T	T		T	0.02	0.03	T	T							T	T					25
26				T	T																				26
27																			T	T					27
28																									28
29	T																T	T	0.01						29
30																									30
31																									31

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.19	0.22	0.26	0.29	0.35	0.36	0.38	0.39	0.41	0.45	0.46	0.50
ENDED: DATE	11	11	11	11	11	11	11	11	11	11	11	11
ENDED: TIME	0831	0835	0841	0845	0853	0908	0859	0938	1248	1259	1338	1125

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

OCT 2 2 1990

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12
01																								
02			T	T											0.53	T	T		0.01	0.04				
03			T	T																				
04																								
05						T																		
06																								
07						T			T		T	T	T	0.07	0.23	0.04			0.24					
08																								
09																				T	T		T	T
10		T	0.01	0.02	0.02	0.04	0.01	0.02																
11																			T	T	T	T	T	0.01
12	T	T	T	T	T	T		T	T															
13			T																					
14																			T	T	T			
15				T		0.03					0.15	0.05	0.01			T								
16																							T	T
17																T		0.02	T					
18											T			T	T									
19																			T	T	T	0.01	T	0.08
20	0.15	0.09	0.07	0.03	T																			
21																								
22								T	T	T	T	T	T			T	T	0.02	0.01		0.04	0.05	0.10	0.21
23	0.29	0.21	0.05	0.01																				
24																								
25																								
26					T																			
27			T	T	T	T	T	T	T													T	T	
28			T	T			T	T																
29																								
30				T	T	T	T	0.03	0.01	0.01	0.01	0.02	T	T	T								0.07	T

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.28	0.37	0.45	0.49	0.50	0.51	0.53	0.53	0.54	0.54	0.63	0.72
ENDED: DATE	02	02	02	02	02	02	02	02	02	23	23	23
ENDED: TIME	1408	1413	1418	1420	1432	1432	1459	1508	1508	0147	0147	0147

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND, ME 04106

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
01	0.02	0.01	0.02			T	T	T	T									T	T	T	T	T			01
02									T	0.01								T	T						02
03																									03
04																									04
05																									05
06										T	T	0.02	0.02	0.01	0.06	0.10	0.25	0.50	0.58	0.46	0.14	0.06	0.03		06
07																									07
08																									08
09																									09
10																									10
11																									11
12																									12
13																									13
14														T											14
15																									15
16																									16
17														T			T	0.20	0.04	0.05	0.22	0.04	0.01	0.06	17
18	0.01	0.01	T	T	T																				18
19																									19
20																									20
21																									21
22																									22
23																						T	T		23
24	T	T	T	T																					24
25												T	0.24	0.02	T	0.01	T								25
26																		T	T	T	0.02	T	T	T	26
27	T	0.01	0.16	0.06	0.03	T	T	0.01	T	T			T	T	T	T	0.01	0.01	0.01	T			T	T	27
28					T	T	T	T																	28
29														T	T	T									29
30																T	T	T	T						30
31							T	T	T							T	0.10	0.07	T	0.04	0.04				31

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.10	0.16	0.23	0.30	0.44	0.64	0.82	0.97	1.10	1.21	1.47	1.60
ENDED: DATE	06	06	06	06	06	06	06	06	06	06	06	06
ENDED: TIME	1957	1749	1754	1759	1809	1823	1838	1859	1913	1939	2001	2021

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE

SOUTH PORTLAND ME 04106

JUN 1991 PORTLAND, ME 14764

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01			T	T	T							
02												
03												
04	0.07	0.11	0.05	0.11	T	T	0.04	0.01	T	T	0.02	T
05	0.02					0.01	T					
06												
07												
08												
09												
10												
11												
12			T									
13					0.01	0.02	0.01	T				
14												
15					T	T	T	T				
16	0.01	0.02	T						0.03	0.07	T	
17	0.01	T	T	T	0.01	0.01	T	T	T	0.01	T	
18				T	T	T						
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27												
28												
29												
30			T		T	T	T	T	T	0.01		

P.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02												
03								T	0.02	0.09	0.15	0.02
04	T	T	0.01	T	0.01	T	0.01	T	T	T	T	T
05		T	T	T		T	T	T				
06												
07												
08												
09												
10												
11					0.09		T	0.09	0.03			T
12		T	0.01	T	T							
13												
14												
15		T	T	0.02				T	T	T		T
16	0.03	0.02	0.02	0.01	T		0.02	0.08	T	0.05	0.01	0.02
17												
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26												
27												
28												
29				T	T							
30												

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.07	0.07	0.09	0.09	0.10	0.13	0.17	0.19	0.22	0.24	0.26	0.28
ENDED: DATE	11	11	11	11	04	03	03	03	03	03	03	03
ENDED: TIME	1628	1628	1635	1635	0402	2230	2248	2259	2248	2259	2337	2352

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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LCD-17-14764-PD-9206

38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE

SOUTH PORTLAND ME 04106

JUL 1991 14764
PORTLAND, ME

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12
01																								
02																								
03																								
04																								
05							T	T	T	T	T	T	T	T		T								
06				T	0.03	0.01																		
07		0.01	0.15	0.15	T							T		T	T	T	T			T	T		T	T
08	T									T	0.05	T		0.08	T									
09																								
10																T	T	T						
11																								
12																								
13								T	T	0.02	0.01	0.01	T	T			T	0.01	0.21	0.24	0.07	0.10	0.03	0.01
14	0.01	0.01	T																					
15																								
16																								
17																							T	T
18																								
19																								
20																								
21																T	T							
22																								
23			T	0.02	0.45	T	0.14	T																
24																								
25																								
26	T			T	T								T	T	0.03	0.05	0.03	0.04	0.02	0.07	0.05	0.03	0.06	0.01
27	0.13	0.01																						
28																								
29																								
30																								
31																								

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.12	0.21	0.30	0.39	0.41	0.43	0.45	0.45	0.46	0.47	0.56	0.59
ENDED: DATE	23	23	23	23	23	23	23	23	23	23	23	23
ENDED: TIME	0453	0454	0453	0454	0454	0454	0459	0511	0511	0459	0658	0717

VALIDATED BY:
MATTHEW BODOSKY

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

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38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FLUKA
400 SOUTHBOROUGH DRIVE
SOUTH PORTLAND ME 04106

AUG 1991 14764
PORTLAND, ME

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02												
03												
04		T	T					T	T	T	0.43	1.00
05	T	T	T	T							T	
06	T	T	T	0.02	T							
07												
08												
09												
10	0.03	0.02	0.09	0.28	0.36	0.60	0.58	0.70	0.18	0.24	0.01	0.03
11												
12												
13												
14												
15												
16												
17												
18												
19	0.46	0.37	0.02	0.16	0.02	0.12	0.03	0.03	0.14	0.05	0.22	0.30
20												
21	T	0.67	0.12	T	0.03	0.05	0.01	0.14	0.05	0.04	0.01	T
22												
23												
24												
25												
26												
27												
28												
29												
30												
31						0.06	0.24	0.06	0.01			

P.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01												
02												
03												
04	0.05	T	T	0.01		T	T	T	T	T	0.01	T
05			0.01	0.12	T			T				
06												
07												
08												
09			T	T	T	T	0.01	0.01	0.02	0.01	0.13	0.09
10	0.10	0.02										
11												
12												
13												
14												
15		T	T	T	T		0.01	0.01				
16												
17												
18				T	T	T				T	T	0.08
19	0.24	0.25	1.20	1.05	0.77	2.08	0.15	0.01	0.05	0.03		
20								T	T	0.08	0.28	0.05
21	T	0.02	0.28			T	T	T				
22												
23												
24												
25												
26												
27												
28							T	T	0.01			
29												
30												
31												

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.49	0.74	0.96	1.18	1.58	1.90	2.16	2.36	2.64	2.97	3.47	4.00
ENDED: DATE	04	19	19	19	19	19	19	19	19	19	19	19
ENDED: TIME	1109	1741	1746	1747	1747	1801	1806	1807	1807	1803	1751	1807

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

VALIDATED BY:
MATTHEW BODOSKY

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ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DRIVE
PORTLAND ME 04106

SEP 1991 14764
PORTLAND, ME

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
01																									01
02																									02
03																									03
04															T	T		T							04
05			0.13	0.18	T		T	T																	05
06																									06
07																									07
08																									08
09																									09
10																				T	0.02	0.02	0.02	0.01	10
11	T					T																			11
12																									12
13																								T	13
14	0.01		T	0.01	0.01																				14
15					T	T							T	T	T	0.06	0.10	0.10	0.10	0.02	0.01	T	T		15
16		T	0.02	0.02	T	0.02	0.02	T																	16
17																									17
18																				T					18
19	T	T	T	T	T						0.01	0.05	0.20	0.04	0.08	0.07	0.05	0.05	0.02	0.02	0.05	0.15	0.12	0.10	19
20	0.07	0.08	0.05	0.08	0.03	T	T																		20
21																									21
22																									22
23								T				T		T	0.01	0.03	0.03		T	0.01					23
24																									24
25	T	0.05	0.08	0.16	0.27	0.15	0.15	0.14	0.25	0.20	0.20	0.33	0.15	0.01	T	T	T	0.01					T	T	25
26	T	0.03	0.07	0.11	0.18	0.09	0.12	0.05	0.06	0.13	0.06	0.05	0.03	0.01	T	T									26
27																									27
28																									28
29														T	0.01	T	0.01								29
30																									30

MAXIMUM SHORT DURATION PRECIPITATION

TIME PERIOD (MINUTES)	5	10	15	20	30	45	60	80	100	120	150	180
PRECIPITATION (INCHES)	0.09	0.17	0.18	0.19	0.22	0.29	0.35	0.46	0.55	0.60	[illegible]	0.76
ENDED: DATE	05	05	05	05	25	25	25	25	25	25	[illegible]	25
ENDED: TIME	0310	0310	0314	0319	1132	1134	1217	1220	1220	1238	1230	1149

THE PRECIPITATION AMOUNTS FOR THE INDICATED TIME INTERVALS MAY OCCUR AT ANY TIME DURING THE MONTH. THE TIME INDICATED IS THE ENDING TIME OF THE INTERVAL. DATE AND TIME ARE NOT ENTERED FOR TRACE AMOUNTS.

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PORTLAND ME 04106

MAY 1992 14764
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HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01			T		T	T																	T	T	01
02			T	T	T	T												T	0.01	0.03	0.02	0.05	0.03	0.03	02
03	T	T	T	T	T	T	T																		03
04						T																			04
05											T	T		T	T	T									05
06																									06
07																									07
08																T	T						0.03	0.01	08
09	0.01	0.02	0.03	0.01	0.01	T	T							T											09
10																T	T	T					T		10
11																									11
12																			T	T		T	T	T	12
13							T	T											T	T	T	T	T	T	13
14				T	T	T	T	T																	14
15																									15
16			T	0.01	T	0.01	T																		16
17																									17
18								T	T	T	T														18
19																									19
20																									20
21																									21
22																									22
23																									23
24									T	T	0.07	0.08	0.07	0.19	0.11	0.14	0.01	T	0.01	0.01	0.02	T	T	T	24
25	T																								25
26																									26
27																									27
28													T	0.05	T			T							28
29																									29
30																									30
31																	T	0.02	0.02	0.01	0.01	T	0.01	0.01	31

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HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

A.M. HOUR ENDING AT

DATE	1	2	3	4	5	6	7	8	9	10	11	12
01	T	T	0.01	0.02	0.01	0.01	0.07	0.04	0.11	0.09	0.09	0.05
02												
03												
04												
05								T	T	T	T	T
06	T	0.01	0.02	0.12	0.45	0.25	0.29	0.40	0.35	0.18	0.30	0.01
07	0.01											
08						T	T					
09												
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18												
19												
20												
21		T	T		T	T						
22	T	0.01	T	T	T	0.01	T					
23												
24											T	T
25	0.02	0.02	0.01						T	T		
26												
27										T		
28												
29												
30												

P.M. HOUR ENDING AT

1	2	3	4	5	6	7	8	9	10	11	12	DATE
0.05	0.05	0.03	0.09	T	T							01
												02
												03
				0.17	0.03	T						04
T	T	T				T	T		T	0.01	0.01	05
T	T	T	T	T	T				T	0.01	T	06
						T	0.01					07
	T	0.06	0.01									08
												09
												10
												11
												12
												13
												14
												15
												16
												17
												18
							T		T			19
										T		20
											T	21
			T	0.18	T							22
												23
0.02	0.10	0.04	T	T	T		0.01	T		0.03	0.01	24
					T	T						25
T		0.08	0.02	T								26
												27
		0.01		T								28
												29
										T		30

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HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01																									01
02																									02
03																						T	T	T	03
04	T	0.07	0.02	0.01	0.03	0.01	0.01	0.08	0.05	0.10	0.02	0.06	0.02	0.04	0.04	0.07	T	T	T	T	0.01	0.02	T	T	04
05	0.01	T	T	T																T					05
06			0.02	0.02	0.04	0.05	0.01	T																	06
07																0.03	T								07
08																								T	08
09	T	0.01	0.01	0.06	0.04	0.10	0.09	0.06	0.01	T	T	T			0.15	T									09
10																									10
11	0.01		0.01	0.06	0.18	T	T	T																	11
12																					T	T		0.01	12
13	0.04	0.23	0.02	T	T			T	T																13
14										T	0.03	0.01	0.01	0.07	T	T	0.16	T							14
15	T	0.01	T	T	0.02	0.02	0.02	0.01	0.06	0.04	T	T	T	T											15
16																									16
17																									17
18	T	T	T	0.30	0.01	0.02																			18
19																	0.07	0.30	0.15	0.07	0.01	T			19
20																									20
21						0.02																			21
22																									22
23												T	T	0.01	0.04	T	T	T							23
24	T	T																							24
25																									25
26																									26
27					T	T													T	T	T	T	T	T	27
28																									28
29																									29
30																									30
31										0.01	0.02	0.01	0.01	T	T	0.03	T	T	T	0.02	T	0.03	0.42	0.12	31

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400 SOUTHBOROUGH DR
PORTLAND ME 04106

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PORTLAND, ME
USCOMM - NOAA - ASHEVILLE, NC 200

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT												P.M. HOUR ENDING AT												DATE
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
01	0.01	0.01	T	T		T	T																		01
02																									02
03																									03
04						0.03	T					T					0.01	0.37	0.07		T	T			04
05																									05
06																									06
07																									07
08																							T		08
09					0.05	0.17	0.08	0.06	0.01		T	0.02	0.05	0.05	0.01	T	T	T	T	0.01	0.01	0.02	0.01	T	09
10	T	T	T	T																					10
11																									11
12																									12
13														T											13
14		T	T	0.01	T	T	T	T																	14
15																T	T								15
16	T	T	T	T	0.01	0.01	0.01	T	0.01	0.01	0.01	0.01	T	T	T	T	T	0.01	T	0.01	0.01	0.02	T	T	16
17	T	0.01	0.01	T				T									T	T	T	0.01	0.02	0.02	0.06	0.10	17
18	0.21	0.14	0.08	0.07	0.17	0.17	0.22	0.01	0.02	0.01	T	0.01	0.01	T	0.01	T	T								18
19															0.03	0.01	T		T						19
20																									20
21																									21
22																									22
23																									23
24																									24
25																									25
26																									26
27			T	T	T												T	T	T	T					27
28					T	T	T	T	T																28
29				0.01	T	T	T	T																	29
30																									30
31																									31

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DUFRESNE-HENRY INC.
SOUTH PORTLAND, ME

38175
DUFRESNE-HENRY, INC
ATTN: KEVIN FEUKA
400 SOUTHBOROUGH DR
PORTLAND ME 04106

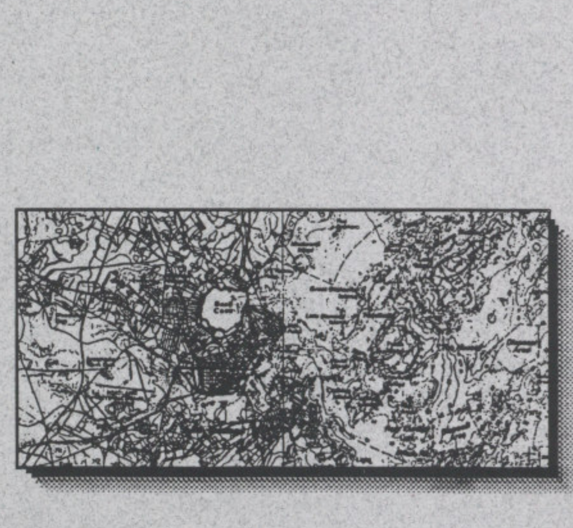
SEP 1992 14764
PORTLAND, ME
USCOMM - NOAA - ASHEVILLE, NC 200

HOURLY PRECIPITATION (WATER EQUIVALENT IN INCHES)

DATE	A.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	P.M. HOUR ENDING AT 1	2	3	4	5	6	7	8	9	10	11	12	DATE
01																									01
02																									02
03											T	0.07	0.06	0.20	0.17	0.15	0.09	0.03	0.05	0.02	0.18	0.15	0.12	0.06	03
04	T	T	T	T	T																				04
05																									05
06																									06
07			T	T																					07
08																									08
09						T	T	T		T	T														09
10																							T	T	10
11	T	0.04	0.01	T	T	T	T	T																	11
12																									12
13																									13
14																									14
15																									15
16																									16
17																									17
18																									18
19						0.10	0.02	0.01																	19
20																									20
21																									21
22						0.02	0.01	T	T	T	T	T	T							T		0.11	0.06	0.08	22
23	0.08	0.08	0.02	T																					23
24																									24
25																									25
26																T	0.01	0.01	0.01	0.01	0.03	0.02	0.03	0.12	26
27	0.54	0.32	0.01	T	T	T	T	T	T	T							0.01	T	T						27
28																									28
29																									29
30																	T	T							30

Appendix E

Draft Master Plan Comments Received



STATE OF MAINE

DEPARTMENT OF ENVIRONMENTAL PROTECTION

JOHN R. McKERNAN, JR.
GOVERNOR

DEAN C. MARRIOTT
COMMISSIONER

DEBRAH RICHARD
DEPUTY COMMISSIONER

August 24, 1993

RECEIVED
AUG 30 1993
DEPARTMENT OF PUBLIC WORKS

Bill Goodwin
City of Portland
Dept. of Park and Public Works
55 Portland St.
Portland, ME 04101

Dear Bill:

This is to offer our comments on the City's CSO Master Plan.

At the outset I would like to recognize the tremendous effort the City has put into development of the plan. It clearly reflects the many hours of dedicated work by City personnel. Throughout the study period it has been gratifying to see the level of support and enthusiasm that has been contributed at the local level. This adds significantly to what an outside consultant can offer by contributing local knowledge and innovative ideas.

We have coordinated our review with the EPA and are in agreement with their comments. Our specific technical notes are attached. We will be pleased to discuss in more detail any particular point or questions which may arise. Also, we have offered comments, both verbal and written, during development of the plan; these will serve supplement our notes here.

In preparing a final implementation plan, we suggest projects which remove water from the system, provide treatment at the plant, BMPs and other relatively straignt-forward improvements be done first. During that period, system monitoring should continue to evaluate progress as projects are completed. This will allow updating and reassessment of subsequent projects in the Master Plan.

We firmly support the concept of watershed management to control flood and stormwater together. This approach offers many opportunities to manage stormwater at its source to achieve true pollutant control rather than simply redirecting them to a new direct discharge pipes as is the case with classic sewer separation projects. We encourage the use of source controls whenever possible.

The plan does seem weak in some areas. It focuses on combined portions of the system and does not address infiltration which may be cost effective to remove. Some reference to private inflow such as roof drains is made, but it is not clear how thorough an effort was made to identify these system wide. BMPs have not been stressed, except to note what is already in place. Although the City seems to be doing a good job, a review for improvements might be beneficial. The capture of first flush is not clear; however, it is probably good except along Commercial Street. The relocation, if necessary, of outfalls to remain was not considered. No estimation is presented on what storm conditions would be required to trigger CSO events under the proposed plan. Many are simply said t be active under "normal" conditions.

Our major concern lies with the low level of control proposed for Commercial Street area. There still would remain a high number of CSO events with resulting water quality impacts. Further control measure for this area in particular need to be evaluated. The draft plan only examines technologies believed to be affordable and not a full range of alternatives. One possible scenario would be to convey more flow to the treatment plant for at least primary treatment by enlarging pumps, piping and treatment tanks as necessary. In-line or off-line storage could also be utilized in conjunction with an expanded infrastructure.

As always, if questions arise please do not hesitate to give me a call.

Sincerely,

DENNIS MERRILL
Division of Licensing, Enforcement
and Field Services
Bureau of Water Quality Control

DM:tlj/WDMGOOD

cc: Steve McLaughlin, DEP
Susan Beede, EPA
Jim Jones, DEP

Technical Notes on Portland CSO Master Plan

ES 19 8.0% interest rate is too high.

ES 19-20 (and Table 9-1)
There seems to be only minor differences in the annual costs between a ten and fifteen year implementation schedule. Why 15 years, then?

What rationale was used in determining the levl of controls for each receiving water area?

Table ES-3 Land Acquisition costs are not included in the capitol costs. The Fall and Capisic Brook projects will probably involve the purchase of significant amount of land to accomplish the CSO and stormwater management goals. At least a gross estimate of cost should be included for land.

1-11 Roofleader and Sump Disconnect Program. Recent studies show that Stormwater removal from roofleaders can be more effective than any other stormwater reduction program. What are the City's plans for expanding its existing programs?

1-12 Street sweeping: Does the city use flush and sweep or vacuum street cleaners? How much more could be collected with more frequent sweeping?

Catch basins Cleaning: Are the 7600 basin cleanings spread out throughout the warmer months, or done in a particular time period?

3-9 Some of these points do not seem to match very well. Ten were less than 75% match. What is considered good?

3-12 What limitations are created by using only one year of precipitation data? Use of other, selected periods (e.g. a significant storm) might help to fill the gaps.

3-27 There appears to be a source of fluorinated compounds at CS4.

4-12 BMPs do have several positive considerations which need to be evaluated. Mass loading of pollutants are reduced. The full capacity and function of pipes, etc. is maintained.

4-15 The adverse impacts and perhaps high costs of separation can be mitigated by application of source controls and alternate means of stormwater management.

Table 5-1 and 5-2
Thirty-six remaining CSO events into Portland Harbor with a 41% volume reduction is of concern to the DEP. We feel that further analysis is needed here. What actions (with cost estimates) would be needed to reduce the CSO events in Portland Harbor to a level consistent with other portions of the system?

Table 5-2 What rainfall events (or other conditions) are need to trigger overflows?

5-6 BMPs in combined area should not be dismissed. Significant inflow reductions can occur in CSOs by aggressively pursuing stormwater management in these areas.

Figure 5-8
A cost/benefit analysis should be done to determine the feasibility of moving the consolidated CSO18 to outside Tukey's Bridge.

5-12 Did block monitoring show any CSO events at CSOs 3 or 4?

5-23 Rather than requiring new storm sewers, the City should encourage alternatives for localized solutions.

5-26 What other alternatives were considered for CSOs 10-18?

5-30 Agree the alternative suggested here and others if possible, needs further exploration. What would be involved in and benefits of further increasing the size of ISPS?

8-11 Shouldn't there be a long-term monitoring location in Back Cove?

9-6 Based on 2% MHI benchmark for affordable user changes, additional work could be supported.

10-6 Consideration should be given to utilizing, the Casco Bay Estuary Program to facilitate on-going CSO public participation, both within the City and area-wide.

General Comments

A. Capisic Brook and Fall Brook Watershed: The DEP fully supports the City's concept of a holistic approach to flood control, stormwater management and CSO elimination in these areas. However, the costs, both financially and politically, to achieve the desired results is very difficult to determine. There could be significant amounts of land needed, either through purchase or easements, in order to implement the stormwater BMPs needed. There will be resistance from landowners to having others using their "back yards" for walking/bike paths, detention ponds, etc. If this approach fails to gain support from landowners in the area; what other methods (with cost estimates) could be used to accomplish the same level of CSO control?

B. Cost vs. CSO control: Although there was discussion in a technical memorandum on this, there should be a summarized discussion on various city wide levels of CSO control versus costs to the average resident. Only in this manner can someone get a sense of the cost effectiveness of the recommended plan compared to any other level of control that may have been chosen.

WDMSTEVE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

RECEIVED AUG 06 1993 DEPARTMENT OF PUBLIC WORKS

August 2, 1993

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Bill Goodwin
City of Portland
Department of Parks and Public Works
55 Portland Street
Portland, ME 04101

Re: Combined Sewer Overflow Abatement Study Master Plan for the City of Portland, ME, 12/1/92 Draft Final Report

Dear Mr. Goodwin:

The United States Environmental Protection Agency, Region I, ("EPA") has reviewed the Combined Sewer Overflow Abatement Study Master Plan for the City of Portland, ME, 12/1/92 Draft Final Report (hereafter the "Report") and prepared comments that we have discussed with the Maine Department of Environmental Protection (DEP.) We have tried to select only our most significant comments on the Report. They are presented in the attached document. Our intention is that the comments be used to help produce a complete final facilities plan. We ask that your consultant prepare a response letter.

The final facilities plan should provide the basis for the city's selection of the final CSO abatement plan. The 12/1/92 Report proposes diverting some of the wet weather flow entering the treatment plant around the secondary portion of the plant. The City of Portland must demonstrate that all such bypasses are necessary in accordance with 40 C.F.R. § 122.41(m) and will not violate water quality standards. In order for EPA to approve the Final Report or authorize the bypasses in the city's NPDES permit, the Final Report must demonstrate that the bypasses would occur in accordance with Part 122.

As you are aware, the City of South Portland is also preparing a Combined Sewer Overflow Abatement Facilities Plan. In our review of both plans, we have attempted to the extent possible to consider the likely impact of the proposed abatement options on the common receiving waters.

We would like to meet with you and the Maine DEP to discuss our comments once you have had the opportunity to review them. We look forward to receiving your response. If you have any questions regarding the comments, please call Susan Beede of my staff at 617/565-3520.

EPA Region I Comments on Combined Sewer Overflow Abatement Study Master Plan for the City of Portland, ME, 12/1/93 Draft Final Report

I. Key Concerns

1. Assessment of CSO Abatement Options

The Report evaluates three levels of treatment defined as "Limited", "Intermediate" (90% reduction of CSO frequency), and "High" (90% reduction of CSO volume), and presents a recommended plan that is a combination of the three treatment levels. The treatment levels and recommended plan are largely the product of an economic optimization analysis performed to determine the most cost-effective level of control and are not directly related to the attainment of water quality standards. We are concerned that the Report did not assess the option of total CSO elimination or document that the recommended option meet water quality standards in receiving waters that support critical uses and sensitive resource areas such as beaches, spawning beds, nesting sites, and shellfish beds.

We cannot evaluate the cost effectiveness of the Report's recommended plan without knowing the marginal costs of providing treatment beyond recommended levels and eliminating all CSOs. In addition, EPA cannot approve a CSO abatement plan, like the one proposed in the Report, that fails to eliminate all violations of water quality standards caused by CSOs in all receiving waters, unless the plan provides sufficient technical and economic information to justify a partial reclassification of the affected receiving waters. Currently, the report lacks information demonstrating that a greater level of control or even elimination of all of Portland's CSOs would be technically infeasible, so costly as to result in widespread economic hardship, or impose substantial costs for little additional benefit. For each CSO receiving water, please provide a cost versus CSO flow elimination curve in terms of both volume and number of discharge events per year. Provide justification for selection of the recommended level of control including an explanation of why higher levels of control provide only small amounts of additional control at disproportionately high cost.

2. Water Quality Issues

The report does not identify or prioritize critical uses and sensitive resource areas in each of the six CSO receiving waters. The location and areal extent of critical uses and sensitive resources areas should be clearly marked on a map showing the location of Portland's CSOs, stormwater and industrial discharges. The critical uses and sensitive areas should be verified and prioritized through a public process using this map option discussed.

Because success of the recommended plan would depend heavily on maximizing conveyance and treatment of wet weather flows with few structural improvements, the City of Portland and the Portland Water District would need to operate the wastewater collection and treatment system at peak efficiency at all times. This would require that they commit to expanding and adequately funding their sewer system maintenance program to ensure that substantial grit buildup, pipe blockages, pump station failures, tidegate or regulator malfunctions, and excessive infiltration/inflow do not occur. It also would require that the Portland Water District have a high flow operations plan for the treatment plant in place so that the maximum flow practicable receives secondary treatment before any wet weather flow is diverted. In order for the Portland Water District to be able to implement high flow operational techniques whenever required, it must maintain a rigorous preventative maintenance program at the treatment plant to ensure all units are kept in operational condition. The final recommended CSO abatement plan should include a description of the city's plans and commitment to ensure that adequate funding, equipment, and personnel will be provided to operate and maintain the wastewater collection and treatment system in the manner required for the CSO abatement program proposed to be successful.

5. Generic Bypass

The recommended plan proposes conveying up to 80 mgd of wet weather flow to the treatment plant. The plant will provide secondary treatment for up to 37 mgd. The remainder will be diverted and receive primary sedimentation and disinfection. The diversion of wet weather flow around the secondary portion of the treatment plant will require that a generic bypass provision be included in the Portland Water District's NPDES Permit. Under 40 C.F.R. § 122.41(m), a municipality may bypass treatment when the municipality can demonstrate that the bypass will not violate water quality standards, that there is no economically or technically feasible alternative to the bypass, and that failure to bypass the plant would cause damage to the plant.

The City of Portland must provide this justification for the generic bypass in the final CSO abatement if the plan is to be accepted by the regulatory agencies and a generic bypass permitted for the city. This will require, at a minimum, that Portland (1) provide justification for the cut off point at which flow will be diverted from the secondary portion of the treatment plant, (2) provide an economic benefit analysis demonstrating that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives such as storage and pump back for secondary treatment, sewer separation, or satellite treatment, and (3)

8. Definition of CSO Activity

The Report appears to define CSO activity in two ways; as the number of days an overflow event is occurring and as the number of times an overflow event occurs of 0.1 cubic feet per second (CFS) or greater. Why are two definitions used, and why is the former used to characterize CSO water quality impacts and the impact of the recommended plan? Use of two different definitions seems to have created significant differences between the CSO frequencies or "events" and flow volumes reported in Table 1-7 (CSO Water Quality Impact Summary), 3-4 (Summary of CSO Frequency, Volume, and Duration under Existing Conditions), and 5-2 (Recommended CSO Control Plan). Please explain these differences.

9. Best Management Practices

The City of Portland has several ongoing Best Management Practice programs to control CSO that would be continued and expanded as part of the recommended plan. We are concerned that no quantitative assessment of these BMPs has been performed. Data should be collected and or modeling estimates generated to gauge the impact of these practices on the flows and pollutant loads entering the treatment plant during wet and dry flows.

The recommended plan also does not provide for the control of solid and floatable materials, oil, and grease that would be discharged from the ten remaining CSOs. This is a significant omission because Maine water quality standards require that "all surface waters shall be free of settled substances that alter the physical and chemical nature of bottom material and free floating substances, except as naturally occur, that impair the characteristic and designated uses ascribed to their class." The Report indicates that the City of Portland has identified a pretreatment oil and grease problem, but the plan does not recommend a solution or potential modification of Portland's pretreatment program. Also, there appears to be no provision for public notification of CSO occurrences and CSO impacts. At a minimum, signs should be posted identifying the location of all Portland CSOs.

10. Evaluation of CSO Technologies

In Table 4-1, what were the specific CSO control technologies selected to estimate CSO event and flow reduction, cost per overflow event reduction, and cost per 1,000 gallons of flow reduction for each of the three treatment levels, in each receiving waters? Also, in Table 2 of Technical Memorandum No. 6, what levels of CSO control (Limited, Intermediate, & High) are the alternatives associated with?

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

October 28, 1993

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Mr. Bill Goodwin
City of Portland
Department of Parks and Public Works
55 Portland Street
Portland, ME 04101

Re: Response to ME DEP and EPA Comments on Portland's Combined Sewer Overflow (CSO) Abatement Study Master Plan, 12/1/92 Draft Final Report

Dear Mr. Goodwin:

Thank you for giving us the opportunity to discuss with you our comments on Portland's Draft Final CSO Master Plan. We have reviewed the 10/20/93 Memorandum prepared by CH2M HILL on resolution of ME DEP and EPA comments and concur with the proposed response to comments contained in the resolution document (Attachment 1.) We would like to re-iterate, however, our most critical concerns about Portland's final master plan.

1) It is essential that the final master plan demonstrate that a higher level of CSO control would be technically infeasible, so costly as to result in widespread economic headship, or impose substantial costs for little additional benefit. For each CSO receiving water, the master plan must provide a cost versus CSO flow elimination curve in terms of both volume and number of discharge events per year. The master plan must also identify the specific control technologies or practices used to develop the cost estimates for each CSO receiving water.

This analysis will be needed to help justify a generic bypass and partial use reclassification of receiving waters where CSOs would remain after plan implementation.

2) The final master plan must include a table comparing total model predicted flows and total measured flows at all monitoring locations for all monitored storms; and model predicted flows and block test results at all block tested locations. The recurrence interval of the individual 1966, calibration, and verification storms must also be documented.

3) The final master plan must include adequate justification for a generic bypass. This will require, at a minimum, that Portland (1) provide justification for the cut off point at which flow will be diverted from the secondary portion of the treatment plant, (2) provide an economic benefit analysis demonstrating

that conveyance of wet weather flow to the POTW for primary treatment is more beneficial than other CSO abatement alternatives such as storage and pump back for secondary treatment, sewer separation, or satellite treatment, and (3) demonstrate that the proposed bypass will not cause or contribute to water quality violations.

If you have any questions regarding the comments, please call Susan Beede of my staff at 617/565-3520.

Sincerely,

Stephen Silva, Chief
Water Compliance Section

cc: Dennis Merrill, ME DEP
Sam Gollis, EPA - RCW
Bruce Johnson, CH2M HILL

Resolution of DEP and EPA Comments Discussed on October 13, 1993

(Item #s correspond to attached Table.)

DEP Letter

<u>Item #</u>	<u>Resolution</u>	
1.	No action.	
2.	a.	No action.
	b.	Discussion will be included with regards to continued commitment to a vigorous BMP program. BMPs will be an important part of the overall optimization plan.
	c.	Consolidation of the Portland Harbor CSOs and an evaluation of eliminating CSO 18 in Back Cove by extending the consolidation conduit so that overflow will occur at CSO 20 into the Casco Bay will be included in the alternatives analysis.
	d.	To indicate which CSOs, that remain active under the proposed plan, will overflow under various storm sizes, SWMM will be run for storm events of 3-month, 6-month, 1-year, 2-year, and 5-year occurrence intervals. A 5-year storm will be picked from analyses of the 40 years of record used in the study. The remaining storms can probably be picked from 1966, the year used for continuous simulation, as 1966 includes up to 2-year storms. The size of storm which triggers an overflow will be indicated. (Coordinate with EPA Comment 36.) The EPA will provide a recommendation of the antecedent condition to use before each storm.
3.	Options for a higher level of control for the Commercial Street Area (overflows to Portland Harbor) will be developed and evaluated based on cost, benefits, and implementability.	
4.	No Action. Eight percent was accepted as being reasonable considering that the City floats bonds annually.	
5.	Additional discussion will be included to better document the rationale for spreading construction out over 15 years rather than 10 years. (Need to conduct monitoring to refine various project stages, complex implementation of watershed/stormwater control elements, better ability to secure funds if	

spread out over a longer time, etc.). A more detailed evaluation of why 10-year funding is less desirable will also be included.

6. Better documentation will be provided for the rationale behind developing and selecting the four levels of control included in the Master Plan. This will include looking at the cost and feasibility of complete CSO elimination. It will also include enough detail to allow the DEP and EPA to determine that the Presumptive Approach to CSO Control is a valid rationale for Portland. (Achieving 85 percent volume reduction or reduction to four events per year does not guarantee EPA approval of a CSO plan. EPA makes the final determination based on meeting water quality standards. If less than complete CSO elimination is the most feasible and cost-effective, but it does not result in meeting water quality standards, then sufficient analysis and documentation must be provided in the Master Plan to support possible revision of receiving water classification and water quality requirements.) The final Master Plan will include a range of costs and a description of the trade-off of various technologies and their effectiveness. Public and agency input towards determining level of control will also be incorporated. (Coordinate with EPA Comment 32).

7. A statement will be included to the effect that land costs will be developed in more detailed follow-up studies such as the Capisic Brook Greenbelt/ Stormwater Abatement Study.

8. A statement will be included that clarifies what the City has already done and what it intends to do with regards to a roof leader and sump disconnect program.

9. Additional detail will be provided to describe the City's street sweeping and catch basin cleaning programs.

10. The match of predicted vs. actual block test results is considered very good. In coordination with EPA Comment 36, a table will be developed to further define how well the model works in predicting frequency of overflow.

11. Refer to Response 2.d. For the proposed plan, overflow frequency and volume will be estimated by using SWMM with 3-month, 6-month, 1-year, 2-year, and 5-year individual storm events. For 1966, the year used for continuous simulation, the storms will be categorized by size (return frequency based on volume and maximum intensity) and selected from this categorization for all sizes, if possible, except a 5-year storm. There will be additional discussion of how 1966 was selected as a typical year and documentation of how it is typical by comparing it with 40 years of record. The 5-year storm will be selected from another year and will be an actual storm event that best matches a 5-year storm derived from statistical

evaluation of 40 years of record. The impacts on the receiving waters and its uses will be discussed qualitatively for each of the different sized storms.

12. No Action for CSO Master Plan. City will review industrial pretreatment program to see if it is possible that some industry could be contributing higher concentrations of fluorinated compounds in this area.

13. The benefits of BMPs will be expanded further in the text.

14. Additional text will be included to expand on the advantages of source controls in comparison with extensive separation.

15. Higher levels of control will be evaluated for the Portland Harbor. Coordinate with Comment 3.

16. Rainfall events that trigger CSO overflows for the recommended plan will be evaluated by looking at 3-month, 6-month, 1-year, 2-year, and 5-year storms (see Comments 2.d and 11).

17. Additional text will be added to emphasize the importance of BMPs in combined areas as well as in separated areas.

18. An evaluation, including costs, will be made of the option of closing CSO 18 and extending the consolidation conduit to outside of Tukeys Bridge. Coordinate with Comment 2.c.

19. More discussion will be included on CSOs 3 and 4 based on the results of the block testing and SWMM.

20. Localized solutions have been included in the recommended plan where feasible. Revise text for emphasis.

21. No action. Other alternatives already documented in TMs 5 and 6 and Progress Meeting Minutes.

22. Increasing the size of the India Street Pump Station will be discussed in conjunction with the alternative to increase the size of the treatment plant to a size greater than 80 mgd. This has been looked at but needs to be documented.

23. Some explanation will be included in the text to describe why it is not possible to monitor at CSO 18.

24. No action. If the recommended plan increases the program costs, then an evaluation will be made to determine if the new costs are within the 2 percent MHI benchmark.

25. Text will be revised to include using Casco Bay Estuary Program to facilitate ongoing CSO public participation.

26. The Master Plan will include more detail on the other options examined for the Capisic and Fall Brook areas in addition to the features included in the recommended plan. It will be pointed out that details will be developed in subsequent study.

27. Cost curves will be developed to summarize the cost for various levels of control. Cost to the average resident will be determined from the curves.

EPA Letter

<u>**Item #**</u> <u>**Resolution**</u>

28. No action. The EPA is not trying to differentiate between "Master Plan" and "Facilities Plan."

29. Additional discussion will be included to give justification for a bypass around secondary treatment in the WWTP during large wet weather events. To provide justification the report will:

    a. Define at what point it will not be possible to send any more flow to secondary treatment and it becomes necessary to bypass. This definition will include the size storm that triggers a bypass, the volume of bypass, and the frequency of bypasses during the simulation year.

    b. Present a benefit analysis that shows it is more cost-effective to convey additional flow to the treatment plant and provide primary treatment and then bypass than other possible alternatives. Also include evaluation of costs to convey and treat more than the current 80-mgd maximum capacity of primary treatment.

    c. Demonstrate that the bypass will not contribute to water quality violations. This includes demonstrating that coliform limits for the blended effluent can be met.

    Items a and b above can be demonstrated. Item c is more difficult. The EPA stated that if a good job is done in demonstrating items a and b above, some flexibility can be allowed in how item c is addressed. See comments on Item 39 for additional detail.

30. No action.

31. No action.

32. Some additional work will be done with respect to documenting the levels of treatment selected for the recommended plan. For comparison, some cost analysis will be done for complete elimination in Back Cove and Portland Harbor to demonstrate why some lesser level of control is recommended. Impacts on sensitive resource areas/critical uses will be addressed qualitatively. It is not possible to address this quantitatively. (Coordinate with DEP Comment 6).

33. Curves of cost vs. volume of overflow and number of events will be prepared. In addition, a qualitative assessment will be made of impacts to the receiving water. Marginal costs and qualitative benefits will be used to provide documentation for the selected level of control and, if necessary, provide justification for reclassification of affected receiving waters if it is not practical to provide the level of control that will prevent all violations of water quality standards caused by CSOs.

34. A simplified map will be prepared showing sensitive uses and areas. (This will probably only include East End Beach and sensitive nesting and shellfish areas, if there are any. Check with Lee Doggitt). Better documentation will be provided to show how we arrived at the priority of sensitive use and public/agency input into shaping those priorities. The Casco Bay Estuary Project's Citizens Advisory Committee could provide valuable input.

35. Better documentation will be provided to show qualitatively how receiving waters and critical uses will be protected by the recommended plan. Analysis for various sized storms will be used to show this. Where separation is being done, documentation of what will be done to make sure water quality is not worse than before separation will be provided. Some very general wording will be provided to indicate what is being done to control non-CSO sources.

36. This work has already been done; it just needs to be presented so it is clearer. A table will be prepared which documents storm sizes used for calibration and verification and shows the total flow the model predicted in comparison with actual flows observed in the monitoring program. This table will also include a comparison of predicted and actual block test results.

37. As part of evaluating the bypass option, assessment will be made of the cost and practicality of expanding the treatment plant by adding a fourth process train and increasing conveyance/pumping capacity. This will be used to justify selection of increasing flow to the treatment plant up to 80 mgd.

38. A statement will be provided indicating that the City and PWD are committed to funding the operation and maintenance cost associated with treating up to 80 mgd.

39. See Comment 29. The PWD has two permits. The state permit allows 200 coliform/100 ml in the Primary Bypass and 15 coliform/100 ml in the secondary discharge, both of which can be met. The federal permit allows a maximum of 15/100 ml in the combined primary and secondary discharge, which cannot be met. To obtain a generic bypass the EPA requires that it be shown that the discharge will not violate water quality standards. This will be difficult to do. The EPA suggests that in the Master Plan, we document the feasibility of the bypass as discussed under Item 29 and we use historical effluent data provided by PWD to document likelihood of meeting permit conditions/water quality standards. After the Master Plan is approved, the PWD must ask for permission to do what is outlined in the Master Plan which may differ from their permit. Since the EPA will have already approved the Master Plan, they can issue an administrative order to allow the bypass until the permit is up for renewal, at which time the generic bypass can be included.

40. Additional justification will be provided to document why we selected the 15-year schedule. Additional wording will be added to Section 5 to identify key components and staging of work for the watershed management projects (coordinate with DEP Comment 5).

41. See Comments 2.d and 29. Additional storm sizes will be evaluated. In addition, the storm sizes that maximize plant capacity at 80 mgd will be determined and an assessment of how often the plant would bypass if it were allowed to take up to 80 mgd will be documented.

42. The definition of CSO event will be clarified.

43. Additional documentation will be provided to emphasize BMPs and their impacts in Section 5. Impacts may only be summarized qualitatively with regards to receiving water impacts. Discussion will be included with regards to removal of oil and grease via the Industrial Pretreatment Program. A statement will be included that the City will post signs by each of its CSOs.

44. A summary of TM 6 will be included in the Master Plan to document the technologies evaluated and why certain ones were eliminated from consideration. Clarification will be provided to Table 4-1.

45. Some events from TM 9 will be inserted in the Master Plan to qualitatively indicate how remaining CSOs, after implementation of the recommended plan, will affect water quality and sensitive areas.

46. The systemwide sewer map will not be included but either a copy of the Monitoring Plan will be provided to the EPA or the drawings showing monitoring locations will be included in the Master Plan.

47. Other options considered as alternatives to watershed management projects will be discussed. State that land purchase and refinement of costs will be developed further in the next phase of study, the Capisic Brook Greenbelt/ Stormwater Abatement Study.

Portland CSO Abatement Study Master Plan
Actions in Response to Comments from EPA and DEP
for Discussion at October 13, 1993, Meeting

Reference	Issue	Action: Discuss/Address/Clarify/No Action	Item #
DEP Cover Letter			
para. 1-4	overview	**No Action Required**	1
para. 5	1) infiltration/ inflow (I/I) 2) BMPs 3) consolidation of remaining CSOs 3) storm triggers	1) **Clarify/No Action:** See Technical Memorandum (TM) 1; systemwide infiltration accounts for only 1% of the total combined sewer volume and no discernable inflow sources, aside from brook inflow which is addressed by the Master Plan, was found. Quebec Street Demonstration Study to serve as pilot study for volunteer sump and roof leader disconnect program. 2) **Address:** Develop system optimization plan to highlight commitment to BMPs. 3) **Address** 4) Storm triggers are provided in Table 5-2.	2
para. 6	Portland Harbor CSOs	**Address**	3
DEP Technical Notes			
ES 19	8.0 % interest rate	**Clarify/No Action:** Consistent with 1992 interest rate of 8.5 % used for facilities planning projects by all federal water agencies in accordance with Public Law Section 80, 93-251.	4
ES 19-20/ Table 9-1 para. 1	15-year implementation	**Clarify/No Action:** Recommended for data collection to refine plan as needed; easier to secure funding and manage in smaller increments.	5
ES 19-20 para. 2	rationale for level of control	**Clarify/No Action:** See Section 4; levels of treatment are largely based on use of the receiving waters.	6

Table ES-3	land acquisition costs	**Clarify/No Action:** Difficult to quantify; use Capisic Brook Greenbelt/Stormwater Abatement Study as a future guide.	7
1-11	roof leader and sump disconnect	**Clarify/No Action:** See response to DEP Cover Letter para. 5 above.	8
1-12	street sweeping and catch basin cleaning	**Address:** Revise text.	9
3-9	model vs. block test results	**Clarify/No Action:** 75 % considered good considering precision of block test data (i.e., checked once per week - not after every storm) and sensitivity of EXTRAN.	10
3-12	one year of data	**Discuss goal 10/13:** "Typical" year of rainfall best describes sewer system response and annual average CSO activity. 1966 includes a variety of storms, up to a 2-year storm, typical for Portland.	11
3-27	source at CS4	**Clarify/No Action:** Address under Industrial Pretreatment Program.	12
4-12	BMPs	**Address:** Revise text.	13
4-15	separation	**Address:** Revise text.	14
Table 5-1 and 5-2	Portland Harbor CSOs	**Address**	15
Table 5-2	rainfall trigger	**Clarify/No Action:** See Table 5-2.	16
5-6	BMPs	**Address:** Revise text.	17
Figure 5-8	CSO 18	**Address**	18
5-12	CSOs 3 and 4	**Address**	19
5-23	localized solutions	**Clarify/No Action:** The plan recommends stormwater management and BMPs where feasible; however, in order to capture the first flush in developed areas and convey it to the plant or convey stormwater to open land requires some conventional piping.	20
5-26	CSOs 10-18	**Clarify/No Action:** See TMs 5 and 6.	21
5-30	ISPS	**Address**	22

8-11	CSO 18 monitoring	**Clarify/No Action:** Long-term block testing recommended; other monitoring difficult to implement.	23
9-6	2 % benchmark	**Clarify/No Action:** This was not a goal; abatement plan far exceeds 85% reduction of combined sewer volume as proposed in the Draft CSO Policy of 12/92.	24
10-6	utilizing Casco Bay Estuary Program	**Address:** Revise text.	25
DEP General Comments			
A	Watershed Management	**Clarify/No Action:** Watershed management is a unique low structural approach encouraged and strongly supported to control and manage CSOs and stormwater. The Capisic Brook Greenbelt/ Stormwater Abatement Study is a demonstration project of this approach. The CSO Abatement Plan has always been viewed as an evolving plan able to accept alterations to meet the ultimate goals as necessary.	26
B	cost vs. CSO control	**Address**	27
EPA Cover Letter			
para. 1	final facilities plan and response letter	**Address:** This is an abatement plan not a facilities plan; final abatement plan due 11/24+/93; response letter to be discussed 10/13.	28
para. 2	wet weather secondary bypass w.r.t. 40 CFR Part 122	**Discuss 10/13:** DEP Wastewater Discharge License allows wet weather flows above secondary capacity (36.8 mgd) to receive only primary treatment and disinfection prior to discharge. Abatement plan far exceeds 85% reduction of combined sewer volume as proposed in the Draft CSO Policy of 12/92.	29
para. 3	EPA reviewing South Portland's CSO plans	**No Action Required**	30

para. 4	schedule meeting to discuss comments	**Clarify/No Action:** Scheduled: 10/13/93 at 10:00 AM at the Dept. of Parks and Public Works.	31
EPA Key Concerns			
1. para. 1	1) basis for level of treatment (limited, intermediate, high) 2) total CSO elimination for critical uses/ sensitive areas	1) **Clarify/No Action:** Levels of treatment are largely based on use of the receiving waters which is based on achieving water quality. 2) **Clarify/No Action:** Total CSO elimination for typical year is achieved in 4 out of 6 receiving waters including those with critical uses/sensitive areas.	32
1. para. 2	1) reclassification of waters 2) cost vs. CSO abatement curves	1) **Clarify/No Action:** Use attainability/receiving water classification is beyond this scope. 2) **Address:** Provide cost versus CSO abatement curves for final report.	33
2. para. 1	mapping of critical uses and sensitive resources; CSOs; stormwater and industrial discharges	**Clarify/No Action:** Critical uses and sensitive areas presented verbally in Sections 1 and 7; CSOs mapped on Figures ES-1, 1-3, and Map 1; information/locations of stormwater and industrial discharges was provided by the City. Mapping these uses/areas and public verification was not part of this scope - see Consent Order p.2 (A) 2.	34
2. para. 2	1) protection/ restoration of critical uses 2) control of non-CSO sources in these areas	1) **Clarify/No Action:** See Section 7; cannot quantify beyond reduction of CSO activity. 2) **Clarify/No Action:** DEP directed the focus of this abatement study to be on CSO sources, not non-CSO sources.	35

3. Model Calibration and Verification	Tables of: 1) predicted flows for each CSO and monitoring location 2) whether block tests indicated an overflow or not 3) total measured flows at all monitoring locations for all monitored storms 4) storm recurrence intervals	1) **Clarify/No Action:** Monitored and modeled flows for each monitoring location are presented in hydrographs in TM 7. Predicted flows for each CSO are in Master Plan Table 3-4. 2) **Clarify/No Action:** Block test results are provided in TM 7, Table 3-3. 3) **Clarify/No Action:** All acceptable data collected is included in TM 7. 4) **Clarify/No Action:** See Table 2-5 in TM 7 for storm descriptions.	36
4. para. 1	maximizing flow through existing system	**Address:** Provide cost estimate and marginal cost curves for conveyance and WWTP increase above 80 mgd and addition of fourth process train.	37
4. para. 2	commitment to maintenance	**Address:** Discuss existence of rate structure to fund programs; develop system optimization plan to highlight commitment.	38
5. para. 1 and 2	wet weather secondary bypass	**Discuss 10/13:** See Action noted above to EPA Cover Letter para. 2.	39
6.	implementation schedule and phasing	**Clarify/No Action:** Back Cove is scheduled after upstream improvements are nearly complete. Fall Brook encompasses numerous small projects which impact CSOs discharging to Back Cove. Again improvements are from upstream to downstream, and small projects are easier for the City to fund and manage.	40
7.	assessment of design storms	**Clarify/No Action:** Specific design storms were not required and not requested during the study; see Consent Order p.6 (a)i; one year continuous record was used for assessment which provides annual average CSO activity.	41

8.	definition of CSO activity	**Address**	42
9. para. 1 and 2	best management practices (BMPs)	**Clarify/No Action:** See Section 1 and Table 1-2 for effectiveness of BMPs. Implementation of BMPs and enforcement of the Industrial Pretreatment Program provides control of solid and floatable materials, oil, and grease. **Address:** See response to EPA Key Concern 4. para. 2 above and include recommendations that the City have a CSO notification program and post signs at CSO locations.	43
10.	evaluation of CSO technologies	**Address**	44
11.	impact of remaining CSOs	**Clarify/No Action:** Impacts from the remaining CSOs are discussed in Section 7; cannot quantify further. Maps showing the results of the dye and drogue studies are in TM 9.	45
12.	sewer system map	**Clarify/No Action:** Information provided on street maps and on excerpts of sewer system maps where necessary; city-wide sewer system mapping/updating not included in this scope.	46
13.	cost estimates of watershed projects	**Clarify/No Action:** See response to DEP General Comment A above.	47

Summary of Comments Received from Presentations of the Draft Master Plan on November 17 and December 3, 1992

MEMORANDUM

CH2M HILL

TO: Bill Goodwin/City of Portland
George Flaherty/City of Portland
Dave Peterson/City of Portland
Charles Perry/City of Portland
Dan Jellis/Portland Water District
Jay Hewitt/Portland Water District
Mark Jordan/Portland Water District
Dick Michael/Dufresne-Henry
Dennis Merrill/Maine DEP
Jim Jones/ Maine DEP
Lee Doggett/Maine DEP
Joe Payne/Friends of Casco Bay
Mike Domenica/CH2M HILL
Rita Fordiani/CH2M HILL
Cliff Bowers/CH2M HILL

FROM: Bruce Johnson/CH2M HILL

DATE: January 12, 1993

SUBJECT: CSO Abatement Study Master Plan Presentations of November 17 and December 3, 1992

PROJECT: BOS31506.B5

The following is a summary of the key issues discussed and comments received at the presentation held on November 17 at the Portland Regional Vocational Technical Institute and the presentation held on December 3 at the Maine Audubon Society Library in Falmouth, Maine. A copy of the agendas are attached. Those attending the November 17 meeting include:

George Flaherty - City	Wende Rosier - US Fish & Wildlife Service
Bill Goodwin - City	Carmel Rubin - Friends of Casco Bay
Dave Peterson - City	Dick Michael - Dufresne-Henry
Kathi Staples - City	Jay Hewitt - Portland Water District (PWD)
Dennis Merrill - DEP	Dan Jellis - PWD
Steve McLaughlin - DEP	Mark Jordan - PWD
Jim Jones - DEP	John Emerson - PWD
Stuart Rose - DEP	Cliff Bowers - CH2M HILL
Sandra Tate - DEP	Mike Domenica - CH2M HILL
Susann Nachman - EPA	Rita Fordiani - CH2M HILL
Martha Bosworth - EPA	Bruce Johnson - CH2M HILL

Those attending the December 3 meeting include:

George Flaherty - City	Joseph Payne - Friends of Casco Bay
Bill Goodwin - City	Brigette Kingsbury - Friends of Casco Bay
Kathi Staples - City	Jeff Clements - Friends of Casco Bay
Dennis Merrill - DEP	Carmel Rubin - Friends of Casco Bay
Steve McLaughlin - DEP	Alix Hopkins - Portland Trails
Kathy Jansen - DEP	Peter Shelley - Conservation Law Foundation
David Chiappetta - SCS	Dick Michael - Dufresne-Henry
Mark Jordan - PWD	Kevin Feuka - Dufresne-Henry
Bob Savage - ME Audubon	Mike Domenica - CH2M HILL
Todd Burrows - ME Audubon	Bruce Johnson - CH2M HILL

The presentations were similar; therefore, a brief summary of the topics are included followed by the comments received at both meetings on the CSO Abatement Master Plan for the City of Portland.

<u>Overview of the CSO Abatement Study Presentations</u>

The focus of the Portland CSO Abatement Study has been to cost-effectively reduce CSO impacts to area receiving waters. Alternatives were considered which also reduce other wet weather challenges such as stormwater flooding and sewer surcharging. The City has already implemented several programs to increase the capture of pollutants generated during wet-weather events. It is estimated that approximately 720 million gallons of CSO is discharged annually to Portland's receiving waters. Back Cove, by far, receives the drainage from the largest combined sewer tributary area. Fifty-eight percent of Portland's CSO volume is discharged to Back Cove.

The selected alternatives were screened from an original list of approximately 40 CSO control technologies. The recommended plan consists of increased treatment at the existing Wastewater Treatment Facility, storage, sewer separation, stormwater detention, flow slippage, and closure of specific CSO locations. Details of the plan and the methodologies used to develop the plan are discussed in the *Draft Final Report, Combined Sewer Overflow Abatement Study Master Plan* prepared for the City of Portland, Maine by CH2M HILL and Dufresne-Henry, December 1, 1992.

Comments Received at the November 17, 1992, Presentation

Bill Goodwin provided the following comments:

- Review layout of the storage conduit consolidating CSOs 10 through 18 along Back Cove to check the feasibility of linking it to CSO 20 and discharging it at the CSO 20 location instead of the CSO 18 location.

- Review flow slippage possibilities in drainage areas 24, 25, 26, 27, 28, and 29 along Portland Harbor

John Emerson provided the following comment:

- Review area adjacent to the Fore River and Thompson Point Pump Stations for use as potential stormwater or CSO storage to allow pumping and treatment of more flow from the Portland Harbor drainage area.

Comments Received at the December 3, 1992, Presentation

WWTF. A question was raised as to what primary treatment of 80 mgd would include. Primary treatment at the Portland WWTF includes screening, sedimentation, chlorination, and dechlorination.

Implementation Schedule. A question was raised as to what the justification was for recommending a 15-year versus 10-year implementation schedule? The primary reason is to limit the impacts of the construction schedule which is very aggressive even over 15 years. Also, land acquisition, permitting, monitoring, and plan re-evaluation must be accomplished.

Use-Attainability. A question was raised on if a use-attainability study was going to be completed. A use-attainability study was not included in the scope for the CSO Abatement Study.

Real Time Controls. A question was raised on whether real time controls were considered. Yes; real time controls were considered. However, according to PWD, previous attempts to implement real time controls in the Portland sewer system have failed. Mark Jordan stated that although new real time control technology exists, it is most likely cost-prohibitive for the minimal potential applications in Portland.

Cost. A question was raised about the cost of implementation of the recommended plan. The estimated cost of the plan is $50 million, averaging $3 to $4 million per year. The public participation program is important to determine the residents' opinion of the value of the program and its associated costs.

Joe Payne had the following comments:

- The term "separation" should be used with caution as it denotes several unique control strategies.
- Although the City of Portland is currently exempt from federal stormwater regulations; stormwater regulations may become a challenge for the City of Portland in the future particularly in those areas where separation is implemented
- Joe has a concern that upgrading the WWTF to 80 mgd of primary treatment may be counterproductive without corresponding upgrades to secondary treatment.
- Higher control of CSOs discharging to Portland Harbor should be examined.

Comments Received

Comments received during the public participation presentations will be addressed in the revised *Final Report*.

Agenda
Portland CSO Abatement Study
Recommended Alternative Workshop
November 17, 1992 10:00 a.m.

1. Introduction

   a. Need for the project
   b. On-going City efforts to reduce CSOs
   c. General approach for the study
   d. Purpose of this workshop

2. Background

   a. Base impacts from CSOs–No Project

      - Volume
      - Frequency
      - Mass loading
      - Flooding

   b. Highlight greatest contribution
   c. Receiving water impacts

3. Development of Alternatives

   a. Screening of technologies
   b. Cost effective optimization routine
   c. Development of levels of control (base, limited, intermediate, high)
   d. Selection of level of control goal
   e. Recalibration of model and refinement of impacts/benefits

4. Presentation of Recommended Alternative

   a. General Overview

      - Components (system wide, basin-by-basin)
      - Benefits (volume, frequency, general mass loading)
      - How well are level of control goals met

- Costs

b. Stormwater Management Approach

- More than CSO reduction program
- Fall Brook Drainage
- Capisic Brook Drainage

5. Implementation

a. Schedule/phased approach
b. Rate impacts
c. Public participation/acceptance

6. Summary

a. Key Issues for successful project
b. Water quality/environmental impacts/benefits
c. Input

5. Key Issues

   a. Schedule for implementing
   b. Environmental benefits/impacts
   c. Multiple-use/benefit philosophy
   d. Commitment to total stormwater management

6. Discussions/Comments/Input