TC 3338-26
Draft Report

EVERETT HARBOR ACTION PROGRAM: EVALUATION OF POTENTIAL CONTAMINANT SOURCES

by

Tetra Tech, Inc.

for

U.S. Environmental Protection Agency
Region X - Office of Puget Sound
Seattle, Washington

July 1988

Tetra Tech, Inc.
11820 Northup Way, Suite 100
Bellevue, Washington 98005

PREFACE

This document was prepared by Tetra Tech, Inc. for the U.S. Environmental Protection Agency (EPA) Region X, Office of Puget Sound, under the Everett Harbor Action Program work assignment of U.S. EPA Contract No. 68-02-4341. The primary objective of the Everett Harbor Action Program is to identify toxic contamination and appropriate corrective actions in Port Gardner and the lower Snohomish River. Corrective actions include source controls and sediment remedial actions. An Interagency Work Group, comprising representatives from the U.S. EPA, Ecology, and other resource management agencies, provides technical oversight for all work conducted under this work assignment.

In this report, potential contaminant sources in the Everett Harbor study area are evaluated. A revised action plan (PTI and Tetra Tech in preparation) will be developed based on the findings of this study and on the recently completed analysis of toxic problem areas in the receiving environment (PTI and Tetra Tech 1988b).

The following reports are in preparation or have been drafted under the Everett Harbor Action Program:

- Analysis of toxic problem areas (PTI and Tetra Tech 1988b)
- Evaluation of potential contaminant sources (this report)
- Development of a revised action plan (PTI and Tetra Tech in preparation).

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ACKNOWLEDGMENTS

This document was prepared by Tetra Tech, inc., under the direction of Dr. Jean M. Jacoby, for the U.S. Environmental Protection Agency in partial fulfillment of Contract No. 68-02-4341.

This project was funded through the National Estuary Program under the authorities of the Clean Water Act as amended. Funding was approved by the U.S. EPA Office of Marine and Estuarine Protection. Dr. Jack Gakstatter, Ms. Clare Ryan, and Dr. Lawrence McCrone served as U.S. EPA Project Officers, and Dr. Don Wilson served as the Tetra Tech Program Manager.

The primary authors of this report are Mr. Raymond Luce II, Mr. Robert Storer, Ms. Sharon Steele, and Ms. Lynne Kilpatrick-Howard of Tetra Tech. Dr. Jean Jacoby of Tetra Tech provided technical review of this document. Ms. Sue Trevathan of Tetra Tech performed technical editing and supervised report production. Collection of source samples was performed by Ms. Beth Schmoyer of the Washington Department of Ecology (Ecology), formerly of Tetra Tech; Pieter Booth of PTI, formerly of Tetra Tech; and Karen Keeley of Tetra Tech. Ms. Stacey Vineberg of Tetra Tech provided data management support. Assessment of chemical data quality was performed by Ms. Lynne Kilpatrick-Howard of Tetra Tech.

Technical guidance information was provided by representatives of many agencies and organizations including Mr. Dan Mathias, Mr. Carl Baird, and Mr. Jeff Kerwin of the City of Everett; Mr. David Wright and Mr. Dave Murdock, both of Ecology; Mr. Dennis Gregoire of the Port of Everett; Mr. Tim Bechtel of Scott Paper; and Mr. David Peterson, Snohomish County Health Department, Sanitation Division.

The Everett Harbor Action Program has benefited from the participation of IAWG and a Citizen's Advisory Committee (CAC). Duties of the IAWG and

CAC members included 1) reviewing program documents, agency policies, and proposed actions; 2) providing data reports and other technical information to U.S. EPA; and 3) disseminating action program information to respective interest groups of constituencies. We thank the IAWG and CAC members for their past and continuing efforts. We are especially grateful to Ms. Joan Thomas and Mr. Dave Murdoch for chairing the IAWG, and to Mr. Gary Wold for chairing the CAC.

1.0 INTRODUCTION

1.1 OBJECTIVES

The Everett Harbor Action Program was initiated, in cooperation with U.S. EPA, Ecology, and other resource management agencies, to identify and control toxic contamination in Port Gardner and the lower Snohomish River. A preliminary assessment of toxic problem areas, potential contaminant sources (Tetra Tech 1985b), and a review of existing plans for corrective actions (Tetra Tech 1986c) provided the framework for an analysis of potential sources of toxic contaminants in these problem areas. Results from the analyses of additional samples collected from the nearshore receiving environment are presented in PTI and Tetra Tech (1988b).

The objectives of the source evaluation are to:

- Evaluate potential sources based on contaminant concentrations measured in sediments collected from two combined sewer overflows (CSOs), a storm drain (SD), and in groundwater samples collected from three wells in October 1986

- Link potential contaminant sources to the problem areas observed in the offshore receiving environment.

The source sampling program was designed as an initial screening measure to identify the major problem chemicals in a limited number of drains discharging into Port Gardner and in groundwater samples from three monitoring wells at the Mukilteo Defense Fuel Supply Depot. A more comprehensive source sampling effort will be required to adequately characterize the contributions of contaminant sources to the project area. Ranking and prioritization of sources were not performed because of the limited number of sources sampled during this investigation.

The source evaluation section of this report focuses on the high-priority problem areas in the receiving environment that were identified in PTI and Tetra Tech (1988b). Relationships between high-priority problem areas and potential sources are identified using available chemical data on stormwater runoff, groundwater, and receiving environment and drain sediment. Ancillary information on drainage basin characteristics, industrial activities, and historical sources was also reviewed as part of the assessment.

1.2 OVERVIEW OF REPORT

A physical description of the project area is provided in Section 1.3. Section 2.0 presents an overview of potential sources of toxic contaminants in the Everett Harbor project area. The approach used to evaluate sources of toxic contaminants and a summary of source sampling methods is presented in Section 3.0. A discussion of drain sediment and groundwater chemical data is provided in Section 4.0. In Section 5.0, the distributions of chemicals in onshore samples are compared with distributions in the offshore receiving environment to link potential contaminant sources to problem areas offshore. In Sections 4.0 and 5.0, file information (e.g., permits, inspection reports, monitoring programs, accidental spills, citizen complaints, additional ongoing studies) provided by the agencies involved in the Everett Harbor Action Program is used to identify additional potential sources (e.g., nonpoint sources, direct discharges to the harbor, spills) contributing to the contamination in the problem areas.

The following six appendices are provided in this document:

- Appendix A - Physical and chemical data for the drain and groundwater samples
- Appendix B - Potential contaminant sources in the Everett Harbor project area
- Appendix C - NPDES and City of Everett industrial pretreatment permits

- Appendix D - Grain size characteristics in the sediments from the drains and offshore receiving environment
- Appendix E - Elevation of drain sediment contaminant concentrations above reference values
- Appendix F - Dredging history in the project area
- Appendix G - Puget Sound air pollution registration file listings in the project area.

1.3 DESCRIPTION OF PROJECT AREA

Everett Harbor is located adjacent to the eastern shore of Possession Sound near the City of Everett, WA (Figure 1). The study area is defined as the area east of a line joining Elliott Point in Mukilteo with the western point of Mission Beach at the entrance of Tulalip Bay. The Everett Harbor project area includes the Snohomish River estuary east to Interstate 5 (I-5). This area is about 7 mi wide at the mouth and 3 mi wide from the inner harbor to the outer boundary. The Everett Harbor project area also includes nearshore areas of Port Gardner, the Snohomish River delta, and the lower Snohomish River delta, and the lower Snohomish River estuary.

The East Waterway and the entire portion of the Snohomish River within the project area have been significantly altered from their natural states. In the early 1900s, a dike was built to divert Snohomish River flow southward along the Everett shoreline and to convert Port Gardner into a freshwater port. The original dike extended from the south end of Smith Island and paralleled the Everett shoreline. However, heavy sedimentation occurred in the area upstream of Preston Point. As a remedy, a large gap was cut in the dike near the old river mouth at Preston Point to allow part of the river flows to travel out across the delta. The main portion of the river flow still travels along the Everett waterfront and enters Port Gardner near the East Waterway. Currently, the Snohomish River is used as a navigational channel from the East Waterway up to River Mile 6.0. This channel is

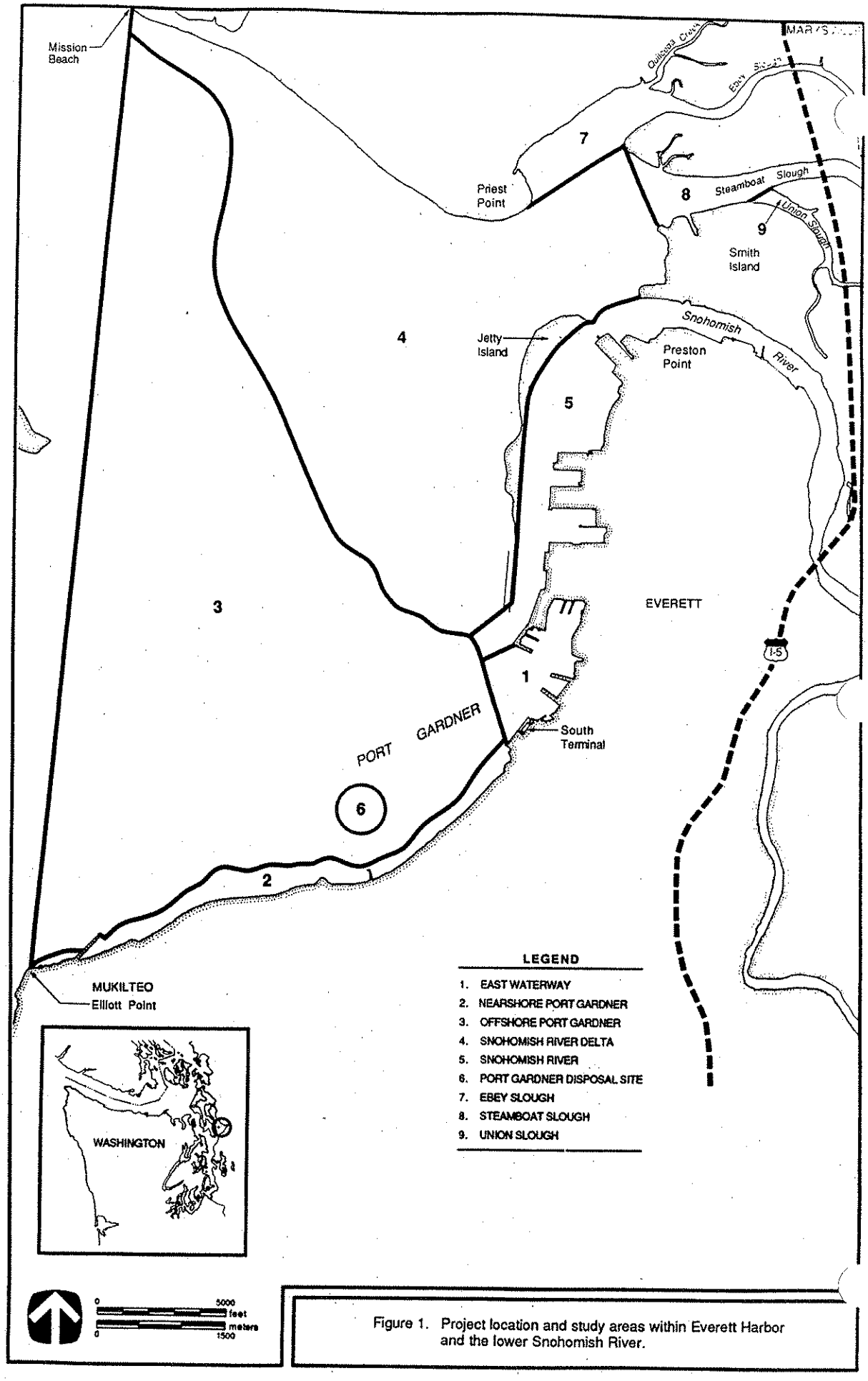


Figure 1. Project location and study areas within Everett Harbor and the lower Snohomish River.

maintained by U.S. Army Corps of Engineers dredging projects every 2-3 yr. Expansive intertidal sand flats and seagrass beds exist west and north of the river entrance to Port Gardner.

1.3.1 Drainage Patterns

The project area watershed encompasses about 170 mi^2 of primarily forest and agricultural lands within the Snohomish River basin. The boundaries of the project watershed are roughly defined by Highway 9 to the east and Casino Road to the south, and extend as far north as the Arlington airport (PTI and Tetra Tech 1988b).

The cities of Everett, Marysville, and Mukilteo are the major urban centers within the project area (see Figure 1). Surface-water runoff from Everett is collected by a combined sanitary and storm sewer system, treated at the Everett wastewater treatment plant (WTP), and discharged into the Snohomish River about 0.8 mi downstream of the I-5 bridge. Before 1960, raw sewage was discharged into Port Gardner and the Snohomish River via 14 outfalls. Marysville and Mukilteo each have storm drain systems that are separated from their sewage collection systems. Storm drains within the Marysville area discharge into Quilceda Creek, Allen Creek (which discharges into Ebey Slough approximately 0.5 mi southeast of Marysville), and Ebey Slough. Aside from two storm drains within the City of Mukilteo, most of the runoff from Mukilteo and southwest Everett is discharged to southern Port Gardner via numerous small streams. The northern portion of the project watershed includes largely forested and agricultural lands that drain to Quilceda and Allen Creeks (PTI and Tetra Tech 1988b).

The Snohomish River is the largest source of fresh water to Port Gardner and the second largest freshwater inflow to Puget Sound. The Snohomish River basin covers about 1,700 mi^2, extending to the crest of the Cascade Mountains. The average annual flow measured near Monroe by the U.S. Geological Survey from 1963 to 1979 was about 6,400 MGD (Williams et al. 1985).

The Snohomish River estuary within the project area includes four main branches: Ebey Slough, Steamboat Slough, Union Slough, and the lower Snohomish River channel. The latter carries the major portion of the total river flow. During the dry season, tidal saltwater intrusions have been observed as far upstream as 0.62 mi from Preston Point (PTI and Tetra Tech 1988b).

1.3.2 Study Areas

A major objective of this report is to evaluate potential sources of toxic contaminants contributing to the contamination observed in the nearshore region of Everett Harbor and the lower Snohomish River. To facilitate spatial analysis of chemical and biological data, the nearshore region (i.e., less than approximately 164-ft water depth) was divided into nine smaller areas (see Figure 1) based on geographic features and locations of potential sources of contaminants. Area boundaries and major features are as follows:

1. East Waterway (EW)--All of the East Waterway north and east of a line from the Snohomish River mouth to the southernmost boundary of the historical Weyerhaeuser Pulp Mill dock (South Terminal).

2. South (Nearshore) Port Gardner (NG)--Shoreline areas (less than or equal to a 33-ft depth) from Elliott Point (Mukilteo) to the southernmost boundary of the South Terminal including the area near the Mukilteo Defense Fuel Supply Depot.

3. Offshore Port Gardner (OG)--All deep-water (>33 ft) areas of Port Gardner exclusive of other defined areas.

4. Snohomish River Delta (SD)--The area west of a line drawn between the downstream shoreline of Ebey (approximately 0.6 mi to the east of the Everett wastewater treatment plant) and Smith Islands out to the 33-ft depth contour.

5. Snohomish River (SR)--The main navigable river channel downstream from the I-5 bridge to the mouth of the river.

6. Port Gardner Disposal Site--The area that is the designated disposal site for dredged materials.

7. Ebey Slough (ES)--The channel adjacent to the northern boundary of Ebey Island west of I-5 to a line downstream between Priest Point and the western tip of Ebey Island.

8. Steamboat Slough (SS)--The channel between Ebey and Smith Islands west of I-5 to a line between the western tip of Ebey Island and the northwestern tip of Smith Island.

9. Union Slough--The portion of the slough west and north of I-5.

In this report, the phrase "Everett Harbor system" refers to the entire project area as defined above.

2.0 OVERVIEW OF POTENTIAL SOURCES

Potential contaminant sources in the Everett Harbor study area can be divided into eight major point and nonpoint categories: industrial discharges, wastewater treatment plants, CSOs, landfills, surface runoff, groundwater, atmospheric deposition, and accidental spills.

Industrial discharges are the permitted and nonpermitted discharges of process wastewater and stormwater runoff from commercial sites. Industrial discharges may be routed to the waterways through city or private drains. These discharges are permitted by Ecology under the National Pollutant Discharge Elimination System (NPDES) program. In addition, industrial facilities may also discharge process wastewater to the city's combined sewer system. These discharges are permitted through the City of Everett's industrial pretreatment program (see Appendix C for a list of major dischargers).

There are four wastewater treatment plants in the study area. These plants are located in Everett, Mukilteo, Marysville, and on the southwestern edge of the Tulalip Indian Reservation (Figure 2). The individual discharge volumes from these plants and their exact outfall locations are presented in Section 2.2.

CSOs in the study area are part of the City of Everett's combined sewer system. Within Everett's North End Sewer System (NESS) there are 16 outfalls (2 of which are deactivated). Eight of these outfalls discharge into Port Gardner and six discharge into the Snohomish River (Figure 3). Discussions of individual outfalls are presented in Section 2.3.

Everett and Tulalip landfills are located within the study area (Figure 2). Contaminants from these landfills can be transported to waterways by direct surface runoff, leachate, or by atmospheric deposition

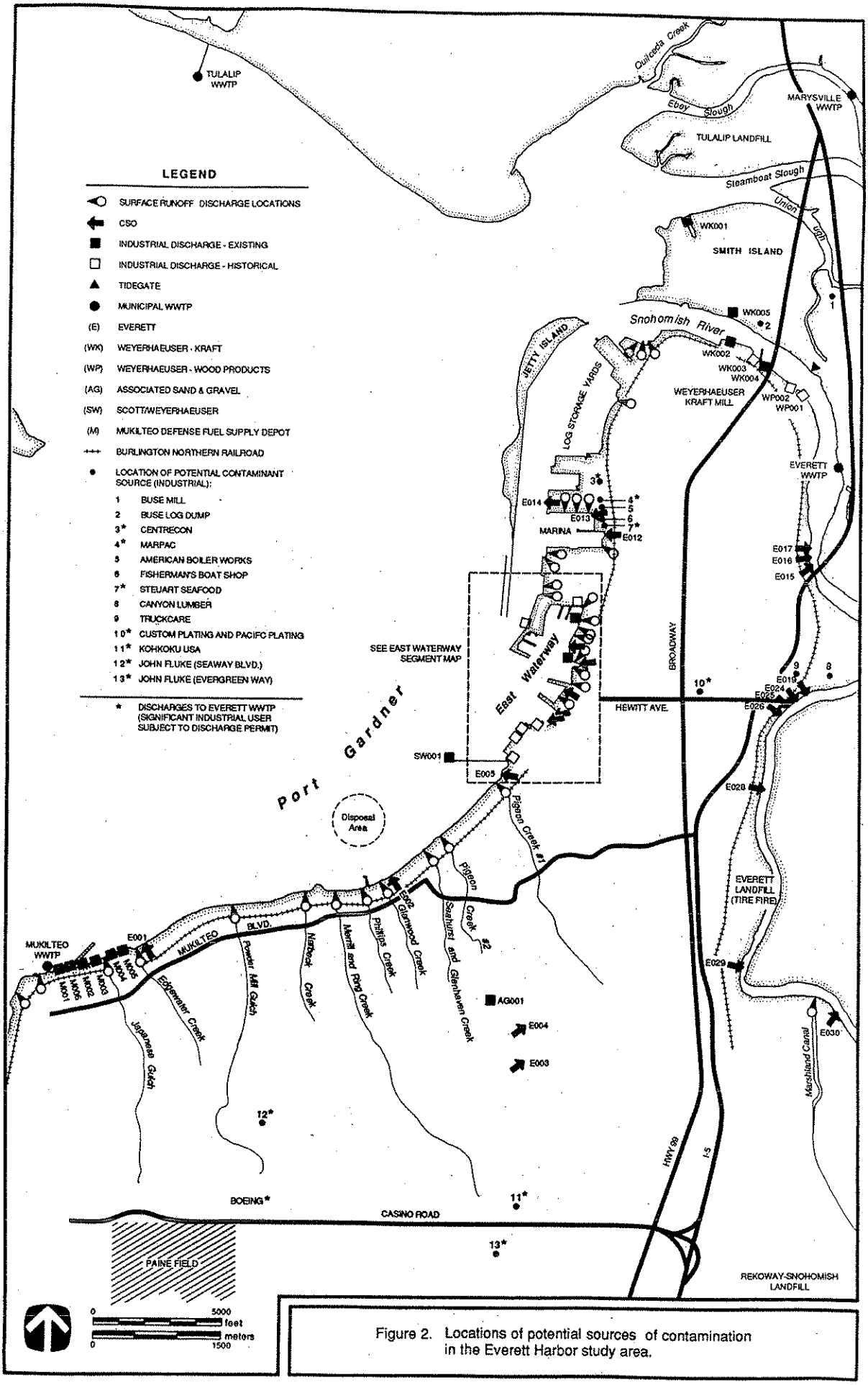


Figure 2. Locations of potential sources of contamination in the Everett Harbor study area.

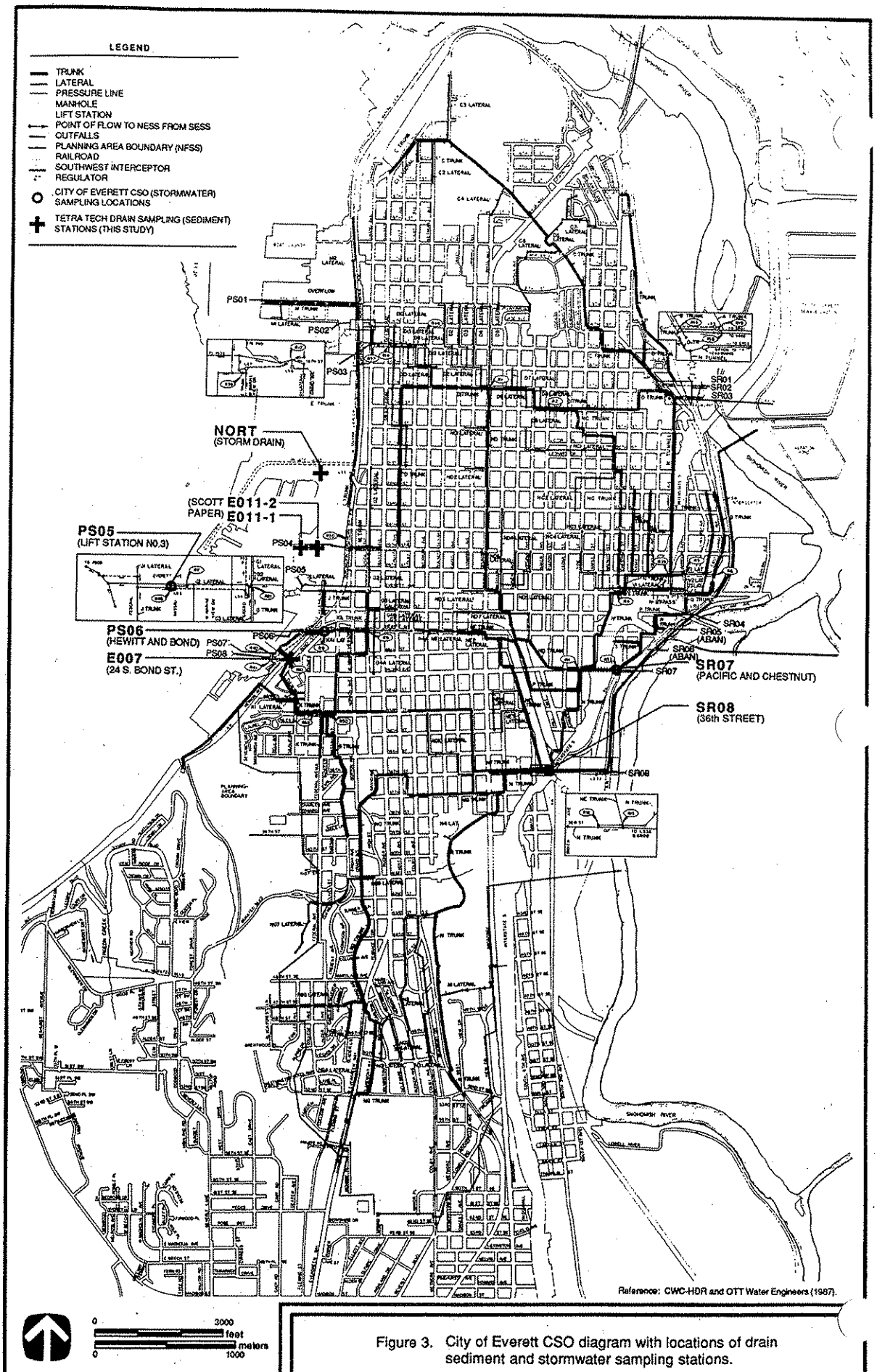


Figure 3. City of Everett CSO diagram with locations of drain sediment and stormwater sampling stations.

(e.g., Everett tire fire). A characterization of contaminants migrating from these two landfills is presented in Section 2.4.

Surface runoff is primarily considered a nonpoint source and occurs when excess precipitation washes off the land surface and discharges to the waterways through natural drainages (i.e., streams, creeks) and direct surface runoff. Surface runoff can also occur as a point source from industrial areas that maintain storm drains. Surface runoff sources are discussed in Section 2.5.

Groundwater sources include any subsurface transport of contaminants into the study area. Groundwater contamination may occur as a result of improper waste disposal practices or accidental spills. The Tulalip landfill, Everett landfill, Mukilteo Defense Fuel Supply Depot, and the Boeing Test Facility (see Figure 2) have the potential for groundwater contamination in the study area and are described in Section 2.6.

Atmospheric deposition is the process by which airborne pollutants are deposited directly on the water surface. Airborne material that is initially deposited on the land surface and then transported to the waterways by stormwater runoff is classified as surface runoff. Airborne emissions from 13 industries are currently being monitored in the study area and are discussed in Section 2.7 and Appendix G. Accidental spills of contaminants, recorded in the study area since 1972, are discussed in Section 2.8.

The following sections provide background on the major potential contaminant sources present in the study area and summarize available information on discharge locations, drainage basin areas, flow rates, permitted facilities, contaminant loading, and historical problem sites. This information supplements information on contaminant sources previously compiled and summarized in Tetra Tech (1985b).

2.1 INDUSTRIAL FACILITIES

The industrial facilities that might contribute contaminants to the problem areas identified in the Everett Harbor study area defined by PTI

and Tetra Tech (1988b) are those industries with direct or indirect discharges of wastewater or waste material into the area waterways. Locations of industrial sites in the study area are shown in Figures 2 (see Section 2.0) and 4. The area adjacent to the East Waterway supports one of the most highly industrialized sites in the project area (Figure 4). The industries near the East Waterway, the offshore Port Gardner area, the nearshore Port Gardner area, the Snohomish River, and Ebey Slough are discussed in the following sections.

Contaminants from industrial facilities can enter area waterways through permitted (or unpermitted) direct discharges or through an overflow event at a combined sewer overflow (CSO) (Section 2.3). The direct dischargers deposit treated process wastewater, untreated noncontact cooling water, and stormwater directly into the area waterways. A summary of the current direct industrial dischargers is provided in Table 1.

Indirect industrial dischargers are connected to the municipal treatment plants via the sewer system. These industries participate in the City of Everett Industrial Pretreatment Program and are regulated through the NPDES program. A summary of these indirect industrial dischargers is presented in Table 2.

Other sources of contaminated material to the study area include leachates and spills that are carried through a storm drain or the sanitary sewer system to the waterways. These sources, along with the unpermitted discharges, are more difficult to detect or monitor. Table 3 is a list of industries noted by the Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) as potential sources of industrial contamination. Most of these facilities are discussed later in this report.

The major sources of information on the origins of industrial chemicals in the project area are Ecology's NPDES permit and industrial information files, Tetra Tech (1985b), the Snohomish County Environmental Health District files, and personal communications.

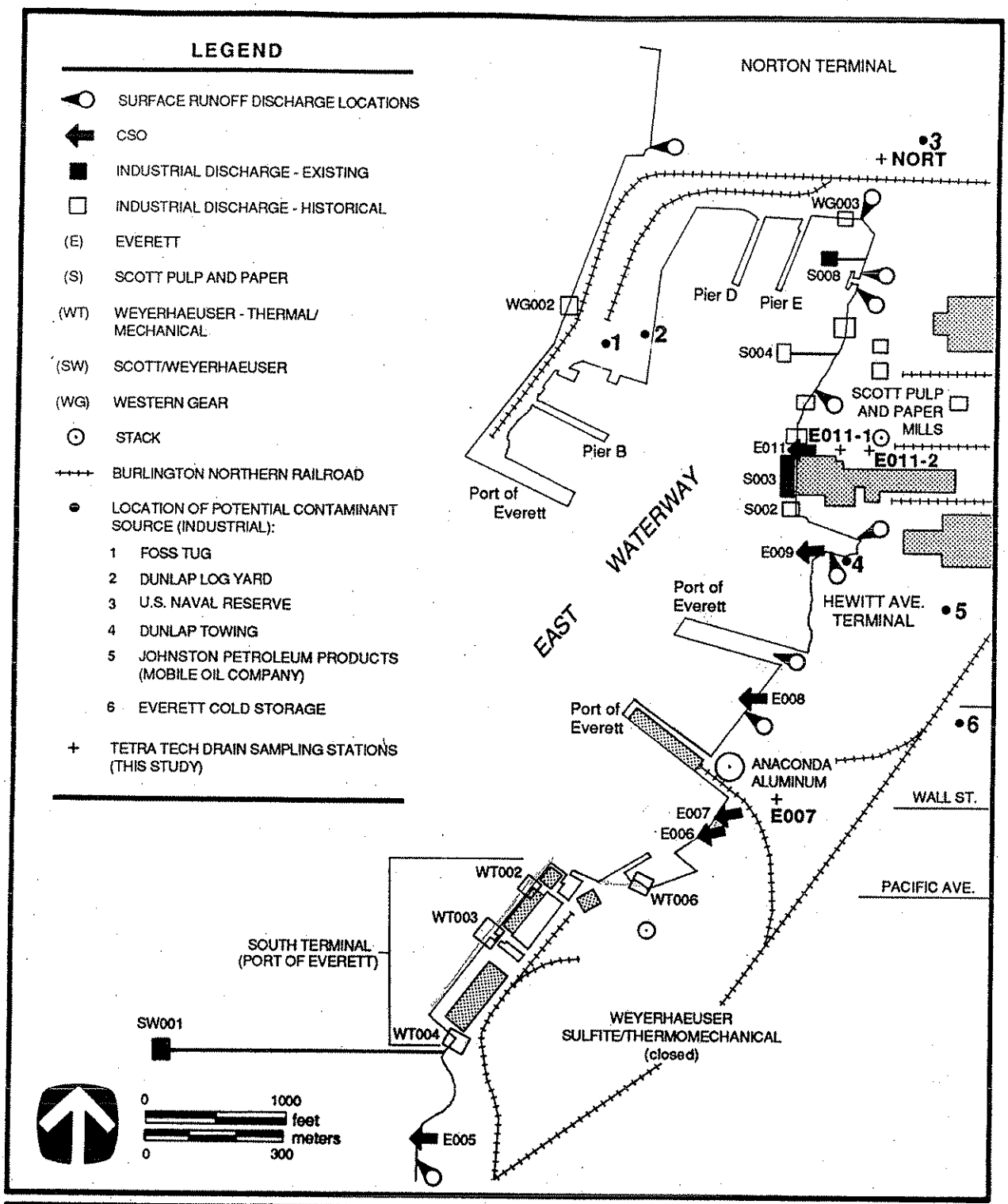


Figure 4. Locations of drain sampling stations, industrial discharge outfalls, CSOs, and storm drains in the East Waterway study segment.

TABLE 1. PERMITTED INDUSTRIAL DISCHARGERS

Study Area	Name	Permit No. Exp. Date	Average Flow (MGD)	Average Load (lb/day)	Description and Notes
NG	Defense Fuel Support Point - Mukilteo - Port Gardner Bay Mukilteo, WA	WA-002523-2	2.2×10^{-4}	Oil and grease 0.1[a]	Outfalls M001-M005 Fuel condensate (water) and storm water
			4×10^{-7}	Oil and grease 0.1[a]	Outfall M006 Fuels lab operation
	Associated Sand and Gravel 6300 Glenwood Ave. Everett, WA	WA-000112-1 (I) Exp. 9/4/90	1.3×10^{-4}	TSS 25[d] Total oil 115[d] ppm	Pigeon Creek #2 via Seahurst Storm Sewer
OG-01	Scott Paper Co. Paper Co. 26th Street and Federal Avenue Everett, WA	WA-000062-1	7.9	BOD 4,661[b] TSS 4,717[b]	Deep water diffuser SW001 Pulp and paper mill effluent-primary treatment
EW	Scott Paper Co. Paper Co. 26th Street and Federal Avenue Everett, WA	WA-000062-1	6.0	BOD 3,159[b] TSS 2,364[b]	Nearshore diffuser S003 Paper mill effluent-primary treatment
			14.1	BOD 2,812[b] TSS 6,747[b]	Secondary treatment plant Outfall S008 Pulp mill effluent
	Western Gear 2100 Norton Avenue Everett, WA (closed 1988)	WA-000341-7 Exp. 3/14/88	2.5×10^{-2}[a]	--	Outfall WG003 noncontact cooling water (East Waterway)
			4.5×10^{-2}[a]	--	Outfall WG002 noncontact cooling water (Snohomish River)
SR-05	Weyerhaeuser Co. Everett Kraft Mill Alverson Boulevard Everett, WA	WA-000300-0 Exp. 5/25/90	0.4[c]	BOD 8[c,d] TSS 67[c,d]	Outfalls WK002 Plant site stormwater runoff and condensate
			11[c]	BOD 230[c,d] TSS 1,150[c]	Outfall WK004 River water bypass filter bed backwash
			0.3[c]	BOD 7.5[c,d] TSS 168[c,d]	Outfall WK005 Surface water runoff
SS	Weyerhaeuser Co. Everett Kraft Mill Alverson Boulevard Everett, WA	WA-000300-0 Exp. 5/25/90	19.4[c]	BOD 4,300[c] TSS 4,600[c]	Outfall WK001 Aerated stabilization basin-wood pulping, bleaching, drying, chemical recovery, and gas scrubbing (Steamboat Slough)
			20.5[b]	BOD 4,488[b] TSS 4,585[b]	BOD - Outfall WK001 only Total TSS - Outfalls WK001 and WK004

[a] Permit requirement.

[b] Three and one-third-yr averages.

[c] Permit application.

[d] Daily maximum allowed by permit.

TABLE 2. DISCHARGES TO EVERETT WTP
EVERETT NPDES-PERMIT FACILITIES - PRETREATMENT PROGRAM PARTICIPANTS

Facility Name	Permit Number	NPDES Expiration Date	Type of Industry	Discharge Type and Permit Limits	Flow Rate (GPD)
Boeing Commercial Airplane Co. 3003 W. Casino Rd., Everett	NA	NA	Aircraft manufacturing	NA	NA
Centrecon 1130 W. Marine View Dr., Everett	5142	8/30/90	Concrete pole manufacturing	TSS 205 mg/L	10,000
Custom Pacific Plating 2421 Hewitt Ave., Everett	NA	NA	Electroplating, anodizing, and painting	NA	NA
John Fluke Mfg. Co. #1 6920 Seaway Blvd., Everett	5183	6/8/86	Electronic manufacturing	Total metals 1 mg/L	44,000 Total cooling waters 8,900
John Fluke Mfg. Co. #2 9028 Evergreen Way, Everett	5147(I)	12/17/89	Electronic manufacturing	Oil & grease 50 mg/L Total metals 6.8 mg/L Total toxic organics 4.57 mg/L	216,800
Kohkoku (USA), Inc. 1407-80th St. SW, Everett	5175	5/31/89	Polyvinyl chloride plastic films and sheeting	BOD 7 lb/day TSS 17 lb/day Oils 100 mg/L	500,000
Pacific Plating 2421 Hewitt Ave., Everett	NA	NA	Electroplating, anodizing, and painting	NA	NA
Cathcart Landfill 109th St. SE and 39th Ave. E.	NA	NA	Landfill	NA BOD 200 mg/L (97 lb/day) TSS 250 mg/L (120 lb/day)	NA
Steuart Seafood 1520 W. Marine View Dr.	5153(I)	12/23/91	Fish processing (salmon & bottom fish)	Oil & grease 50 mg/L	58,000
Tri-Coatings, Inc. (Marpac) 1104 10th, Everett	NA	NA	NA	NA	NA

NA = Information unavailable for this report. New permits will be issued end of July 1988 (Kerwin, J., 14 June 1988, personal communication).

TABLE 3. LIST OF INDUSTRIES - CERCLIS SITE LOCATION
SUPERFUND DATABASE - 18 FEBRUARY 1988

CERCLIS	U.S. EPA ID
Boeing Commercial Airplane Co. 3303 Casino Road S., Everett	WAD041585464
Everett landfill 2902 36th Street S.E., Everett	WAD980639405
Pallister Paint 1037 Center Road, Everett	WAD980979769
Scott Paper Co. 2600 Federal Avenue, Everett	WAD009250820
Simpson Lee Co.-Pulp/Deinking (Closed) N.E. of South 3rd Avenue at 48th Street S.E., Everett	WAD980977383
Snohomish Co.-Reckoway landfill	WAD980638936
Weyerhaeuser Sulfite-Pulp Mill (Closed) 101 Marine View Drive, Everett	WAD009273129
Lake Stevens landfill 131st Avenue N.E., Lake Stevens	WAD980511612
Biringer Berry Farm 6219 88th Street N.E., Marysville	WAD076635358
Boeing Company Tulalip Test Site	WAD980185789
Tulalip Indian Tribe-Marine Disposal Site Tulalip landfill	WAD980639256
USAF Defense Fuel Support Point Front Street and Loveland Avenue, Mukilteo	WA2971590003

2.1.1 East Waterway

The East Waterway problem area is located west of downtown Everett and east of the mouth of the Snohomish River channel (see Figures 2 and 4). This area, particularly along the eastern shoreline, is the most highly contaminated in the entire Everett study area. The maximum concentration of nearly every chemical measured during the receiving environment survey was found in the East Waterway (PTI and Tetra Tech 1988b). The toxic chemicals observed in East Waterway sediments included phenolic compounds, resin acids, PAHs, PCBs, and various metals. Many of the compounds observed are related to pulp industry discharges (PTI and Tetra Tech 1988b). The possible contributions from combined sewer overflows (CSOs) and private storm drains are discussed in Sections 2.3, 2.5, and 5.1.1 of this report.

Scott Paper Company--

The Scott Paper Company has been operating on this site on East Waterway since 1930 (see Figure 4). The company's operation extends the length of the eastern shore of East Waterway from 22nd Street south to Everett Avenue. The Scott Paper Company pulp and paper mills produce ammonia-based sulfite pulp, and towel and tissue paper. There are two auxiliary plants on the site: a steam plant and a WTP. Figure 5 is a diagram of the water flow through the plant.

Scott is a permitted discharger of treated and untreated wastewater to the East Waterway and offshore Port Gardner. The permit information is summarized in Table 1 (See Section 2.1) (Scott Paper Company 1979). The nearshore diffuser (S003) and the secondary treatment plant outfall (S008) discharge into the mouth and head, respectively, of the East Waterway. The deepwater diffuser (SW001) discharges untreated wastewater through an outfall 2,000 ft offshore. This outfall is discussed later in this section. Scott's NPDES permit, WA 000062-1, specifies monitoring and reporting biochemical oxygen demand (BOD), total suspended solids (TSS), total flow (Q), and total production of air-dried bleached pulp product on a daily basis (Scott Paper Company 1979). Priority-pollutant data available from the permit application and the U.S. EPA's STORET database are presented in

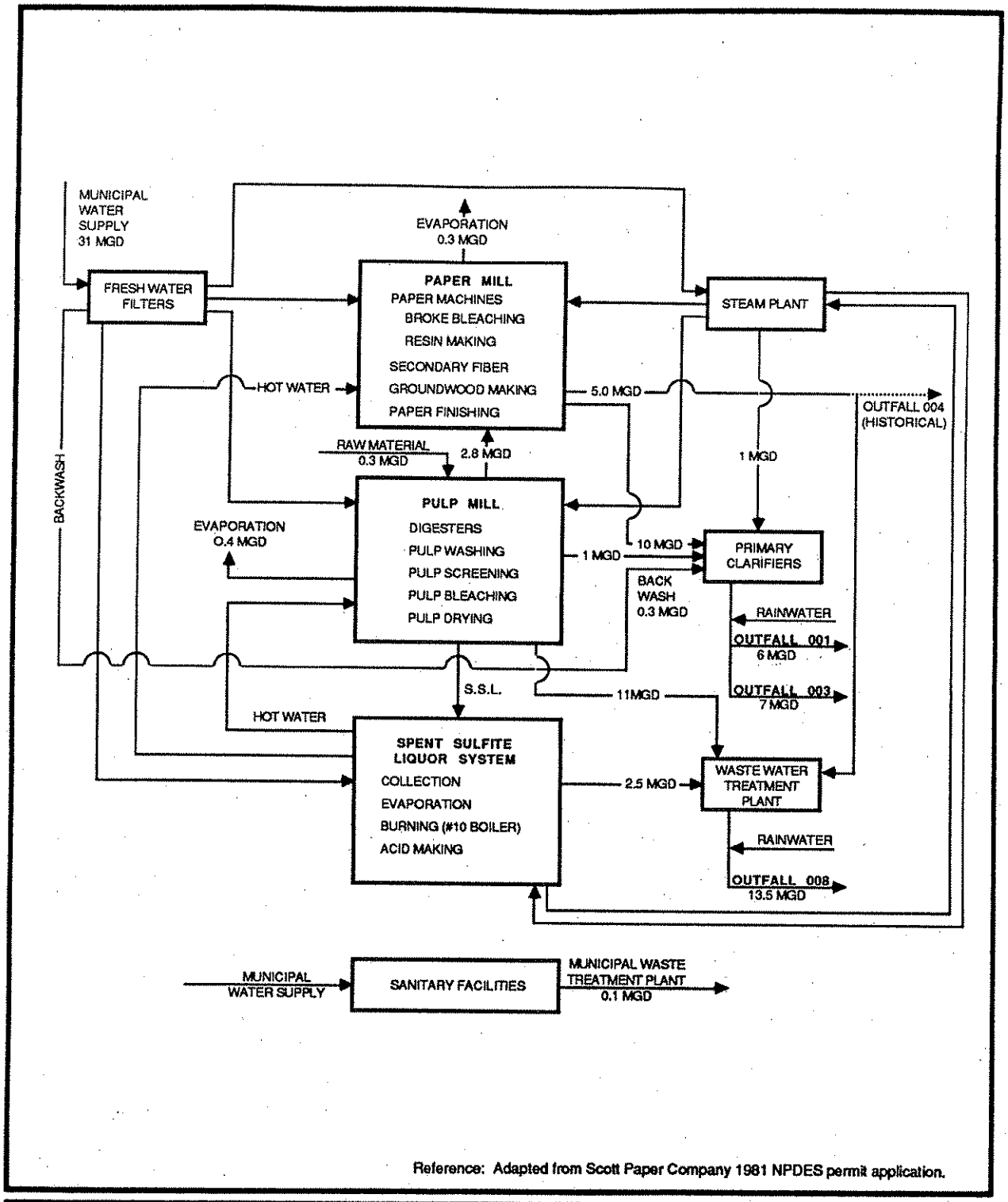


Figure 5. Schematic diagram of water flow through Scott Paper Company's East Waterway facility.

Tetra Tech (1985b). Discharge monitoring report worksheets provide a breakdown of total flow, BOD, and TSS by individual outfall. The worksheet information for 1985 through April 1988 is summarized in Tables 4, 5, and 6.

The wastewater flow to each outfall is determined by individual plant processes and is shown Figure 5 (Scott Paper Company 1979). Effluent from the two primary clarifiers is combined and discharged from Outfalls SW001 and S003 without further treatment. This discharge is separated at a weir under the pulp mill. Ideally, the flow to Outfall SW001 is maximized and Outfall S003 is used primarily as an overflow outfall. In practice, the flows to each outfall are separated such that the pH at Outfall S003 is maintained at permitted levels. Approximately one-half of the effluent is directed to each outfall. The clarifiers process water from the hog fuel boiler in the steam plant, water from three sumps used for fiber collection in the pulp mill, a continuous flow of machine sewer water, an intermittent flow of water from the color-change line in the paper mill, and backwash from the fresh water filters. This backwash is comprised of grit and other material that has been filtered from incoming unprocessed city water (Bechtel, T., 1 July 1988, personal communication).

The remainder of the wastewater from all of the processes is routed to the Scott industrial WTP. Effluent from the treatment plant is discharged at Outfall S008. The Scott WTP is designed to collect waste from streams with a high BOD content. The treatment plant processes wastewater from the spent sulfite liquor system, the acidified water used to regenerate the resins in the water deionizing columns, wastewater (brown "white water") from the pulp mill, sludge dewatering filtrate, bleach plant waste, and wastewater from the paper mill "bayline" floor trenches. Water from the floor trenches was formerly discharged at Outfall S004. Prior to construction of the WTP in 1980, untreated pulp bleaching wastewater effluent was discharged through Outfall S002, south of Outfall S003 (see Figure 4). The Scott pulp mill currently unloads liquid chlorine (pressurized chlorine gas) for its pulp bleaching process near the historic Outfall S002 (Bechtel, T., 1 July 1988, personal communication). The SW001 Outfall discharges into the offshore Port Gardner area and is discussed below.

TABLE 4. SCOTT MILL EFFLUENT DISCHARGE
MONITORING REPORTS (1985-APRIL 1988)
OUTFALL SW001

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1985					
J	7.3	77	4,668	51	3,114
F	8.0	62	4,088	56	3,764
M	7.9	65	4,235	48	3,146
A	6.9	54	3,136	58	3,356
M	8.1	57	3,824	58	3,878
J	9.4	54	4,243	67	5,205
J	9.5	64	4,712	63	4,668
A	10.4	97	8,607	76	6,483
S	10.9	98	9,192	105	9,790
O	8.5	64	4,495	66	4,668
N	8.8	94	6,870	92	6,697
D	8.8	96	7,064	97	7,148
Total	3,155 MG		987 ton		942 ton
1986					
J	8.8	78	5,698	80	5,876
F	8.4	84	5,838	99	6,897
M	8.1	92	6,135	104	6,793
A	7.7	81	5,230	84	5,390
M	7.8	96	6,276	75	4,877
J	8.3	77	5,288	74	5,123
J	8.1	75	5,088	85	5,774
A	7.7	69	4,374	62	3,913
S	7.8	65	4,217	73	4,745
O	7.5	67	4,193	76	4,734
N	6.5	85	4,673	104	5,667
D	6.9	70	3,956	78	4,511
Total	2,789 MG		908 ton		954 ton

TABLE 4. (Continued)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1987					
J	8.2	62	4,257	70	4,816
F	8.0	79	5,293	89	5,991
M	7.9	76	5,016	77	5,093
A	8.0	63	4,199	70	4,662
M	7.7	59	3,777	65	4,128
J	7.7	49	3,182	52	3,333
J	6.9	46	2,660	51	2,911
A	6.3	45	2,361	49	2,580
S	6.4	50	2,698	53	2,821
O	8.1	57	3,828	63	4,225
N	7.7	61	3,901	58	3,732
D	8.2	65	4,492	65	4,505
Total	2,727 MG		684 ton		730 ton
1988					
J	8.0	69	4,631	70	4,723
F	5.8	65	3,142	54	2,583
M	5.7	70	3,379	57	2,660
A	6.5	65	3,527	69	3,707
Total	752		212		198
3-1/3 Yr Average	7.9 $\pm$1.1[a]	70 $\pm$15	4,661 $\pm$1,460	71 $\pm$16	4,717 $\pm$1,500

[a] Average = $\bar{x} \pm 1s$ (s = standard deviation).

Reference: Scott Paper Company (1988).

TABLE 5. SCOTT MILL EFFLLUENT DISCHARGE
MONITORING REPORTS (1985-APRIL 1988)
OUTFALL S003

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1985					
J	7.6	69	4,460	48	3,001
F	4.5	55	2,075	44	1,667
M	3.9	54	1,744	44	1,425
A	4.2	45	1,581	49	1,770
M	6.0	46	2,224	45	2,218
J	7.5	35	2,298	49	3,170
J	8.6	30	1,988	34	2,221
A	5.9	44	2,167	43	2,166
S	3.8	71	2,194	67	1,994
O	5.1	41	1,864	47	2,185
N	6.7	72	3,922	65	3,525
D	4.7	76	2,974	58	2,310
Total	2,057 MG		448 ton		421 ton
1986					
J	5.4	50	2,364	60	2,978
F	3.5	67	1,872	65	1,800
M	5.0	102	3,898	74	3,419
A	4.2	91	3,154	43	1,552
M	4.1	116	3,875	48	1,615
J	5.5	67	2,926	34	1,485
J	7.1	44	2,515	30	1,672
A	8.6	30	2,157	18	1,330
S	6.9	23	1,329	20	1,134
O	9.2	39	2,949	35	2,727
N	7.5	95	5,614	76	5,118
D	5.8	99	4,686	50	2,454
Total	2,204 MG		567 ton		414 ton

TABLE 5. (Continued)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1987					
J	5.0	84	3,416	52	2,214
F	7.6	71	4,596	61	4,040
M	5.0	78	3,070	55	2,358
A	7.0	56	3,214	43	2,584
M	7.2	48	2,931	33	2,004
J	7.1	44	2,602	34	2,004
J	6.1	69	3,328	49	2,343
A	6.7	41	2,285	27	1,489
S	7.8	42	2,816	41	2,787
O	8.0	57	3,719	46	3,105
N	4.7	63	2,366	39	1,611
D	5.1	77	3,158	47	2,040
Total	2,330 MG		566 ton		430 ton
1988					
J	6.8	88	5,414	61	3,630
F	4.4	89	3,271	46	1,688
M	7.0	132	6,970	53	3,165
A	5.0	162	6,382	60	2,563
Total	706 MG		335 ton		168 ton
3-1/3 yr Average	6.0 $\pm$1.5[a]	67 $\pm$29	3,159 $\pm$1,296	47 $\pm$13	2,364 $\pm$832

[a] Average = $\bar{x} \pm 1s$ (s = standard deviation).

Reference: Scott Paper Company (1988).

TABLE 6. SCOTT MILL EFFLUENT DISCHARGE
MONITORING REPORTS (1985-APRIL 1988)
OUTFALL S008

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1985					
J	10.8	22	1,972	67	6,057
F	11.1	29	2,623	61	5,550
M	11.5	35	3,356	76	7,238
A	12.9	25	2,670	61	6,640
M	13.5	20	2,274	53	5,919
J	15.1	22	2,767	68	8,489
J	15.3	24	2,769	49	5,857
A	16.4	28	3,794	62	8,569
S	12.7	22	2,291	52	5,437
O	13.4	24	2,699	61	6,819
N	11.9	39	3,922	89	8,923
D	10.2	24	2,065	56	4,911
Total	4,654 MG		501 ton		1,218 ton
1986					
J	12.3	24	2,449	60	6,116
F	11.4	26	2,528	52	5,047
M	10.3	41	3,486	93	8,118
A	10.9	27	2,417	64	5,810
M	11.0	24	2,192	51	4,763
J	11.8	34	3,324	76	7,468
J	12.6	33	3,501	97	10,269
A	17.2	26	3,631	58	8,126
S	16.3	21	2,837	44	6,066
O	15.3	24	3,059	58	7,328
N	12.8	23	2,661	66	7,566
D	15.8	26	3,487	69	8,962
Total	4,776 MG		546 ton		1,289 ton

TABLE 6. (Continued)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1987					
J	14.4	18	2,174	54	6,433
F	13.1	15	1,665	38	4,186
M	15.3	14	1,775	44	5,698
A	14.2	18	2,169	42	4,906
M	13.9	16	1,846	37	4,387
J	14.2	21	2,389	51	5,939
J	15.6	23	2,526	50	5,793
A	19.1	28	4,387	53	8,297
S	15.8	32	4,430	58	7,748
O	15.9	28	3,794	63	8,354
N	17.1	23	3,264	57	8,103
D	16.5	19	2,608	39	5,419
Total	5,610 MG		501 ton		1,141 ton
1988					
J	15.2	21	2,675	55	6,582
F	19.6	16	2,708	48	7,905
M	13.9	22	2,791	63	7,826
A	17.9	17	2,524	43	6,248
Total	1,985 MG		162 ton		432 ton
3-1/3 yr Average	14.1 $\pm$2.4[a]	24 $\pm$6	2,812 $\pm$686	58 $\pm$14	6,747 $\pm$1,447

[a] Average = $\bar{x} \pm 1s$ (standard deviation).

Reference: Scott Paper Company (1988).

There is little additional information available on the Scott outfall discharges. The NPDES permit does not require additional monitoring of priority pollutants. Table 7 contains historical data on priority pollutant metals, volatile organic compounds, and resin acids in samples taken from the Scott outfalls in 1983 and 1985. This information is in addition to that presented in Tetra Tech (1985b). There are no recent data available on priority pollutants from the Scott outfall discharges. Formaldehyde, used in the papermaking process to improve paper strength, was replaced with a polyamide-polyamine wet strength resin in August 1985, thereby removing formaldehyde as a possible ongoing contaminant (Bailey, A., 7 November 1985, personal communication).

Port of Everett and Other Smaller Industries--

In addition to the Scott Paper Company, the East Waterway area contains the central terminals for the Port of Everett and several smaller industries. The Port of Everett consists of Hewitt Terminal, Pacific Terminal, and the South Terminal (formerly the Weyerhaeuser Sulfite/Thermomechanical Plant docks) (see Figure 4). Hewitt Terminal (Piers 1 and 3) at the mouth of the waterway has four deepwater berths for ships carrying heavy cargos such as logs, lumber, pulp, steel, alumina ore, ingots, autos, and agricultural products. The Pacific Terminal is located to the north, across the East Waterway from the Scott Paper Company. Piers B, D, and E at the Pacific Terminal are made from plank and piling and have both road and barge access. The Weyerhaeuser Sulfite/Thermomechanical Plant closed in 1980 and was located south of Pier 1 (Tetra Tech 1985b). The Pier 1 area is now called South Terminal and contains two berths (Gregoire, D., 1 June 1988, personal communication).

There are several other smaller industries surrounding the East Waterway (see Figure 4) that occupy space in the Port of Everett. Anaconda Aluminum, Everett Cold Storage (American Ice & Cold Storage), and Johnston Petroleum Products (Mobil Oil Co.) are located near the Hewitt Terminal. Foss Tug, Dunlap Towing, and other tug and tow boat businesses are located at Pacific Terminal. Because the U.S. Navy plans to establish its new homeport on the East Waterway, some companies have moved in order to

TABLE 7. ORGANIC CHEMICALS AND METALS FOUND IN SCOTT PULP AND PAPER MILL OUTFALLS (mg/L)

Contaminant	Date of Sample	Outfall SW001	Outfall S003	Outfall S008 Influent	Outfall S008 Effluent
Metals[a]					
Cadmium	6/5/85	0.0010	0.0010		0.0020
Chromium	6/5/85	0.0050	0.0050		0.0100
Copper	6/5/85	0.0040	ND		0.0020
Nickel	6/5/85	ND	ND		0.0070
Silver	6/5/85	ND	ND		0.0018
Zinc	6/5/85	0.0450	0.0170		0.440
Volatile Organics[b]					
Chloroform	7/9/85				0.049
	11/24/82	0.107			
	9/22/82		0.373		1.130
Ethyl benzene	11/24/82	0.021			
Carbon Tetrachloride	9/22/82				0.010
Resin Acids					
Isopimaric[c]	NA			0.140	ND
Isopimaric[d]	3/2/83			0.285	ND
Dehydroabietic[c]	NA		0.035	0.852	0.002
Dehydroabietic[d]	3/2/83			1.463	0.018
Abietic[c]	NA		0.004	0.010	ND
Retene[d]	3/2/83			0.0009	0.045

[a] Bechtel, T. (19 July 1985, personal communication).

[b] Bailey, A. (7 November 1985, personal communication).

[c] Archer, S. (9 September 1983, personal communication).

[d] Johnson, B. (9 August 1983, personal communication).

ND = Not detected.

NA = Information not available.

provide room for this new facility. Viking Wire Rope Company, formerly at this location, has moved to Marysville. Until recently, the Western Gear Company was located along the north end of Pacific Terminal, south of the Norton Terminal. This company, a former permitted discharger of noncontact cooling water through historical Outfalls WG002 and WG003, has been permanently closed at this location. There are no chemical data on these smaller companies.

2.1.2 Offshore Port Gardner

The only identified industrial source that might impact this problem station is the Scott-Weyerhaeuser deepwater diffuser.

Scott-Weyerhaeuser Deepwater Diffuser--

The Scott-Weyerhaeuser deepwater diffuser (SW001) is located southeast of the East Waterway, approximately 2,000 to 3,000 ft offshore of Port Gardner at a depth of approximately 300 ft, near offshore Station OG-01 (see Figure 4). This outfall, constructed in 1951, shared discharges with the Weyerhaeuser Sulfite/Thermomechanical plant until that plant closed in 1980. Prior to 1975, effluent discharged from the Weyerhaeuser plant at Outfall SW001 consisted of untreated sulfite waste liquor. When the plant was converted to the thermomechanical process in 1975, a secondary treatment plant was constructed, and all process wastewaters were treated prior to discharge. Information on the other outfalls from this plant is presented in Tetra Tech (1985b).

Outfall SW001 also discharges a portion of the effluent from the two primary sedimentation clarifiers at the Scott Paper Company. These clarifiers collect wastewater from the steam plant, fresh water filter backwash, the paper mill processes, and the pulp mill processes. The operations that supply influent to the clarifiers are described in more detail later in this section and are summarized in Table 3 (see Section 2.1.1.). The monthly average BOD, TSS, and flow for Outfall SW001 are provided in Table 4 (see Section 2.1.1). Additional chemical data are presented in Table 7 (see Section 2.1.1) and indicate that the concentration

of copper (0.0040 mg/L) at Outfall SW001 exceeded both U.S. EPA acute and chronic criteria for marine water (0.0029 mg/L) in June 1985. Other metals did not exceed the criteria, but the nickel concentration (0.0070 mg/L) was close to the chronic effects limit of 0.0083 mg/L. There are no other recent data available for the offshore outfall at SW001.

2.1.3 Nearshore Port Gardner

The Nearshore Port Gardner problem area includes nearly all of the NG stations and is located in the southwest corner of the study area (Figure 6). Potential industrial sources of contamination in this area are the Mukilteo Defense Fuel Supply Depot and the various industries in the Boeing/Paine Field area (Figure 6). Wastes from this area collect in the streams and gullies that flow into Port Gardner. Other potential contaminant sources, including the Mukilteo WTP and general surface runoff, are described in Sections 2.2 and 2.5.

Mukilteo Defense Fuel Supply Depot--

The Mukilteo Defense Fuel Supply Depot receives, stores, and transfers aviation gasoline and aviation turbine fuel (JP-4) (Tetra Tech 1985b). The facility consists of a transfer pier, a railroad tank car loading area, a fuel laboratory, and ten bulk fuel storage tanks. There are six outfalls from the fuel storage tank area that discharge directly into Port Gardner. Outfalls M001 through M005 are for storm water and fuel condensate, and Outfall M006 discharges storm water and wastewater from the fuels laboratory. These discharges are permitted under Ecology NPDES Permit No. WA 002523-2, and are monitored for oil and grease on a monthly basis (see Table 1). Outfall M006 is also monitored for flow. Discharge monitoring report data for this facility were not available for this report.

There have been two major leakages at the fuel storage facility; the first leakage occurred in 1982 and the second in 1986. In 1982, Tank 10 was found to have structural and seepage problems. In 1982 and 1983, groundwater studies were conducted at the Tank 10 site by the U.S. Army Environmental Hygiene Agency (AEHA) to determine if contamination had resulted from

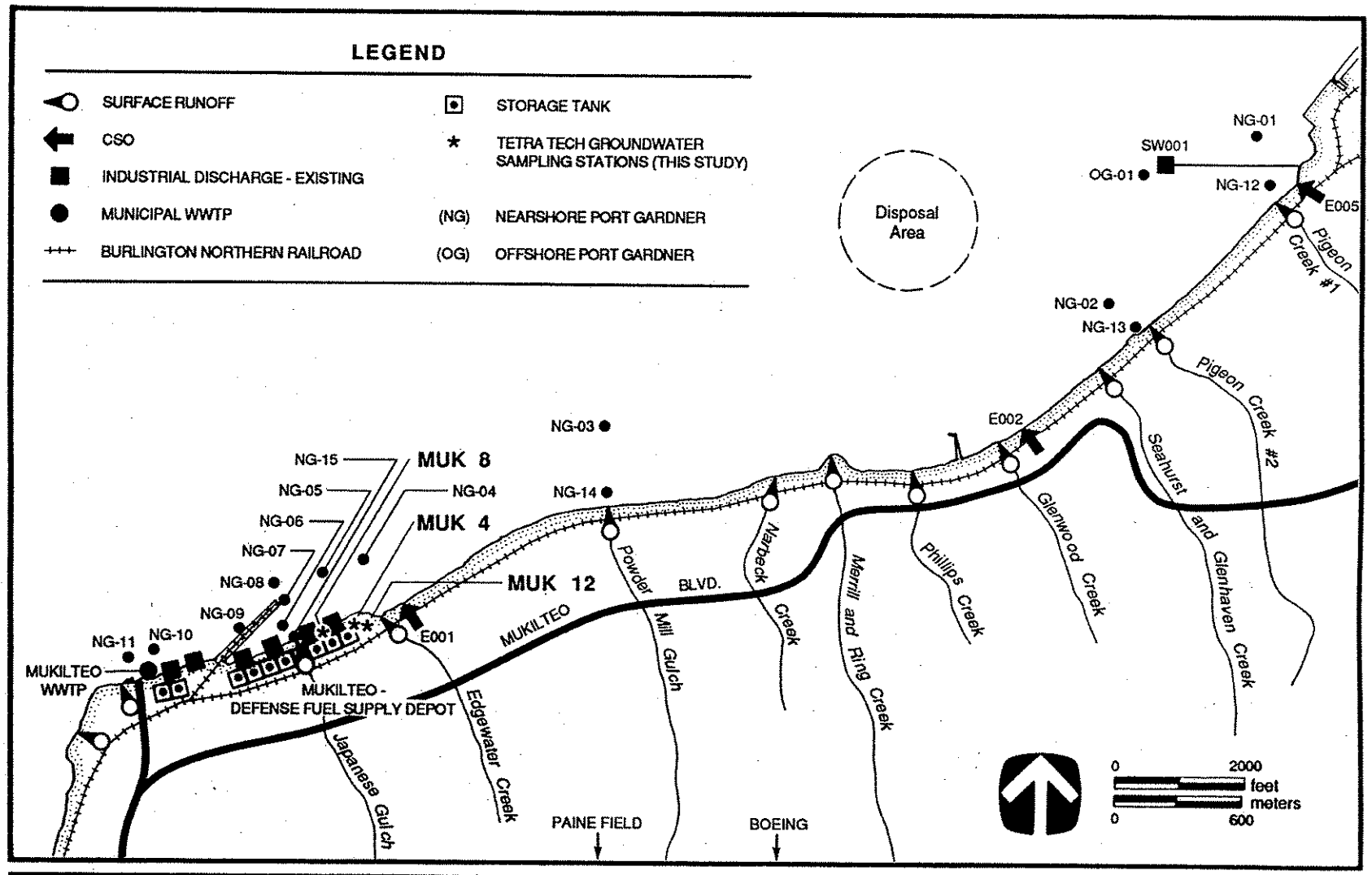


Figure 6. Locations of sampling stations, industrial and natural drainage outfalls, and other potential sources of contamination in the nearshore Fort Gardner study segment.

suspected storage tank leakage. Results of these studies are described in Tetra Tech (1985b). Tank 10 was drained prior to the AEHA study and is no longer in use. Samples taken in 1983 from monitoring wells near Tanks 9 and 10 contained JP-4 fuel in excess of 1,000 ppm and all other wells in the vicinity contained less than 10 ppb of benzene, ethylbenzene, toluene, or chloroform (Spencer and Rodgers 1987). A memo from the Snohomish County Environmental Health Office's files, dated 29 June 1987, contains data on the detection of HPAH (e.g., benzopyrenes, benzoanthracene, benzofluoranthene, chrysene) at the facility.

In 1986, leakage problems were discovered at Tank 9. A hydrogeologic survey was conducted to determine the effects on the groundwater of fuel leakage in the piping to Tank 9 and to propose remediation plans. The conclusions of this survey state that a substantial amount of JP-4 fuel is on the groundwater surface near Tank 9, but the more volatile additives to JP-4 fuel (benzene, toluene, and xylene) are not retained in the groundwater for any significant amount of time. The survey also concludes that leaching of residual concentrations of hydrocarbons into Puget Sound is the only path of environmental exposure (Spencer and Rodgers 1987).

Boeing/Paine Field and Related Industries--

The area south of the nearshore Port Gardner problem area and Mukilteo (see Figure 2) contains the Snohomish County Airport (Paine Field), several large industries, an automobile racing track, and unpermitted landfills. These sources may contribute to the contamination of surface water, groundwater, and the sewer system. Such contaminants could be transported to Port Gardner through Japanese Gulch and Powder Mill Gulch.

Information in the files at the Snohomish County Environmental Health Department describe several contamination problems in the Paine Field area. There is a long history of nonpermitted landfill sites at the western and southern ends of the airport, including an old Air Force dump. Poor hazardous waste storage practices at numerous places in and around the airport area were also documented in county inspection reports (Winters, T., 16 January 1987, personal communication). There is concern that leachate

from the landfills, dumping, and hazardous waste spills may enter the groundwater and surface water systems and, ultimately discharging near the nearshore Port Gardner area, through Japanese Gulch and Powder Mill Gulch. A Paine Field survey designed to analyze the toxic chemicals in sediment, groundwater, and surface water at Big Gulch, Japanese Gulch, Powder Mill Gulch, Stickney Lake, and Swamp Creek is currently being conducted and should be completed in June 1988 (Yake, B., 3 June 1988, personal communication). A summary of available organic chemical data from Ecology studies related to Paine Field is provided in Table 8. Volatile organic chemicals, chlorohydrocarbons, and Aroclor (PCB) 1254 were detected in ponds and drains around the area, particularly those that drain into the creeks mentioned above.

The event log of a Paine Field site inspection conducted by the Snohomish County Safety and Industrial Insurance Office on 16 January, 1987 (Winters, T., 16 January 1987, personal communication) lists several problems in the area. Examples of the problems listed in the log include the presence of hazardous waste containers (labeled "poison" and "corrosive"), an overturned rail car tanker, contaminated soil from the landfill and sumps, and asphalt and tar waste. Nine samples taken from material found in barrels, mud, and soil were analyzed in order to establish a waste profile. A variety of heavy metals (e.g., chromium, lead, copper, nickel, zinc, cadmium, barium), phenols, and xylene were detected (Laucks Testing Laboratories 1987).

The Paine Field Clean-up Committee, comprised mainly of various state and county government agency personnel and airport management, was formed to assess the airport waste problems and oversee their solutions. A survey was performed of all the approximately 120 underground storage tanks in the area and their contents. These tanks contained aviation fuel, kerosene, diesel fuel, used oil, heating oil, #5 black oil, and gasoline. Efforts are being made to clean up the site. For example, the old Air Force dump was capped and hydroseeded in April 1987 (Paine Field Clean-up Committee 1987-1988).

Boeing Commercial Aircraft is a participant in the City of Everett's pretreatment program. Although the company is listed in Table 2 as

TABLE 8. PAINE FIELD CHEMICAL DATA

Location	Concentrations in mg/L						
	Acetone	1,1-Di-chloroethane	Trans-1,2-chloroethane	Chloroform	1,1,1-Tri-chloroethane	Trichloroethene	PCB 1254
Boeing pond[a] 9/2/87				0.0015			
Drain at 100th SW[a] 9/3/87	0.036	0.0056	0.0011	0.0031	0.056	0.028	
Unknown source[b] suspended sediment 2/17/87							0.176
Japanese pond[c]							0.280
Boeing pond[c]							20.500
Powder mouth[c]							0.044
100th drain[c]							0.084

[a] Analytical Resources Inc. (1987).

[b] Carrell, B. (5 March 1987, personal communication).

[c] Carrell, B. (24 March 1987, personal communication).

participating in the industrial pretreatment program, a description of the discharges and permit requirements were not available for this report. A new City of Everett permit will be issued in July 1988 (Kerwin, J., 14 June 1988, personal communication). It is suspected that Boeing could be contributing to contamination in Japanese Gulch, but further studies are necessary to confirm this (Paine Field Clean-up Committee 1987-1988).

There are three other large industries in the Paine Field area (see Figure 2) that discharge to the Everett WTP and participate in the pretreatment program (see Table 2). John Fluke Mfg. Co., an electronics firm, has two locations in the area. The plant at Evergreen Way is monitored once per quarter for total oil and grease, and four times per year for total metals (i.e., the sum of copper, nickel, chromium, and zinc), individual metals (i.e., total metals plus lead and cadmium), cyanide, and the total toxic organics specified in 40 CFR 413.02 (John Fluke Mfg. Co. 1985). The Ecology permit monitoring report for metals at the Evergreen Way plant for February 1988 is summarized in Table 9. Copper and lead exceeded the permit limits (Dawson, L., 15 March 1988, personal communication). The plant at the Seaway Boulevard location is monitored monthly for nickel, total chromium, and total metals (John Fluke Mfg. Co. 1981). No monitoring data were available from this location.

Kohkoku (USA), Inc. produces polyvinyl chloride plastic films and sheeting. This company is a participant in the Everett pretreatment program and is required to monitor BOD, chemical oxygen demand (COD), and TSS on a monthly basis. Total oils are monitored twice per month [Kohkoku (USA) 1984]. Monitoring data from the plant were not available.

2.1.4 Snohomish River

There are three problem locations in the Snohomish River estuary. The first location consists of Stations SR-04 and SR-05 (see Figure 2) and is located near the Weyerhaeuser Kraft Mill, downstream from the Everett WTP. Chemicals found at Station SR-05 included benzoic acid, 4-methylphenol, and various resin acids. The second area is at Station SR-07, located in the Everett Marina, north of the Norton Terminal (see Figure 2). Benthic

TABLE 9. JOHN FLUKE MFG. CO., INC. - EVERGREEN WAY
MONITORING RESULTS - FEBRUARY 1988

Concentrations in mg/L

Metal	Date of Sample 2/2/88	2/10/88	2/18/88	2/26/88	Daily Limit	Monthly Average	Monthly Average Limit
Copper	0.0034	0.0037	0.0016	0.0013	0.00338	0.0025 ±0.0012	0.00207
Nickel	0.00032	0.00039	0.00048	0.00023	0.00398	0.00036 ±0.00011	0.00238
Chromium	<0.00005	<0.00005	<0.00005	<0.00005	0.00277	<0.00005	0.00171
Zinc	0.00004	0.00004	0.00007	0.00009	0.00261	0.00006 ±0.00002	0.00148
Lead	0.00077	0.00077	0.00022	0.00017	0.00069	0.00048 ±0.00033	0.00043
Cadmium	<0.00001	<0.00001	<0.00001	<0.00001	0.00069	<0.00001	0.00026
Total metals	0.0038	0.0042	0.0022	0.0017	0.0105	NA	NA

NA = Information not available.

Reference: Dawson, L. (15 March 1988, personal communication).

effects, elevated tributyl tin (TBT), and high sulfide concentrations are of concern at this station (PTI and Tetra Tech 1988b). There are other industries near the Snohomish River, particularly those that use paints, solvents, and wood treatment chemicals, that may contribute contaminants to the area. These industries include marinas, piers, boat building and repair companies, and lumber companies. Electroplating companies are a possible source of heavy metals.

Weyerhaeuser Kraft Mill--

Of the two original Weyerhaeuser plants on the Snohomish River (the Kraft pulp mill and the wood products plant), only the Weyerhaeuser Kraft Mill is still in operation. The wood products plant was closed in 1984; a short description of its operation is provided in Tetra Tech (1985b). The Kraft Mill produces market-bleached pulp. Wastewater from the plant is treated in an aerated lagoon on Smith Island north of the Snohomish River (see Figure 2). The effluent from this lagoon, consisting of waste from wood pulping, bleaching, drying, chemical recovery, and gas scrubbing, is discharged into Steamboat Slough at Outfall WK001. Additionally, there are three other discharges into the Snohomish River. The largest discharge is at Outfall WK004 and consists of backwash from the plant's water-filtration system. Outfall WK002 discharges noncontact cooling water and stormwater runoff. Outfall WK005 discharges surface runoff from Smith Island (Tetra Tech 1985b; Weyerhaeuser 1988).

The Weyerhaeuser Kraft Mill is a permitted discharger. The NPDES Waste Discharge Permit No. WA-000300-0, which will expire 25 June 1990, requires monitoring of the three outfalls mentioned above (Table 1). BOD and TSS are sampled daily with flow, temperature, and pH monitored on a continuous basis (Weyerhaeuser 1985). Monthly summaries from January 1985 through April 1988 are given in Table 10. BOD is measured only at Outfall WK001; TSS is measured prior to discharge Outfalls WK001 and WK004 (Weyerhaeuser 1988). Typically, one-fourth to one-third of the reported TSS is diverted to Outfall WK004 and the remainder is discharged from Outfall WK001 (Ruppert, H., 3 June 1988, personal communication).

TABLE 10. WEYERHAEUSER KRAFT MILL EFFLUENT DISCHARGE MONITORING REPORTS (1985-APRIL 1988)[a]

	Outfall WK001			Outfalls WK001 & WK004	
	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)
1985					
J	21.8	29.0	5,300	30	5,500
F	18.2	44.8	6,900	30	4,700
M	16.3	21.3	2,900	18.3	2,600
A	16.7	21.9	3,100	24.9	2,900
M	20.0	21.8	3,600	17.8	4,000
J	19.4	25.3	4,100	28.2	4,900
J	24.8	13.1	2,700	16.5	3,500
A	24.0	17.4	3,500	21.1	4,300
S	23.7	26.7	5,300	25.7	5,100
O	20.0	18.3	3,100	26.2	4,500
N	18.6	27.4	4,100	23.7	3,900
D	19.3	31.6	4,900	25.5	4,200
Total	7,394 MG		749 ton		761 ton
1986					
J	20.9	25	4,300	31.9	5,600
F	19.1	40.0	6,400	38.7	6,400
M	19.2	29.3	4,700	27.6	4,600
A	21.6	18.2	3,300	15.9	2,900
M	25.5	22.0	4,100	21.7	4,100
J	20.8	23.6	4,100	30.4	5,300
J	20.8	29.6	5,300	41.3	7,700
A	37.2	32.4	5,500	39.7	7,000
S	12.9	18.0	2,300	22.5	3,100
O	19.7	22.6	3,800	24.9	4,200
N	18.6	22.0	3,400	27.9	4,800
D	18.9	21.8	3,400	27.1	2,800
Total	8,548 MG		768 ton		889 ton

TABLE 10. (Continued)

	Q (MGD)	Outfall WK001 BOD (mg/L)	Outfall WK001 BOD (lb/day)	Outfalls WK001 & WK004 TSS (mg/L)	Outfalls WK001 & WK004 TSS (lb/day)
1987					
J	20.7	37.2	5,800	37.8	6,500
F	20.7	34.9	6,100	33.4	5,800
M	20.1	29.6	4,900	32.1	---
A	19.6	25.8	4,100	29.5	4,900
M	20.2	30.4	5,200	31.9	5,500
J	21.4	28.6	5,100	27.0	4,900
J	20.3	24.8	4,200	21.8	3,800
A	20.4	21.4	3,600	25.3	4,400
S	19.6	26.4	4,300	26.8	3,900
O	19.9	25.2	4,100	27.2	4,600
N	18.5	26.3	4,000	23.2	3,700
D	20.5	34.5	5,900	27.4	4,800
Total	7,358 MG		871 ton		801 ton
1988					
J	19.3	36.3	5,800	34.0	5,300
F	19.9	33.0	5,500	18.9	3,900
M	19.9	31.8	5,300	23.6	4,000
A	19.4	33.7	5,500	24.8	4,200
Total	2,354 MG		332 ton		262 ton
3 1/3-yr Average	20.5 ±3.5	27.1 ±6.7	4,488 ±1,097	27.1 ±6.1	4,585 ±1,134

[a] Flow and BOD reported for Outfall WK001. TSS reported for Outfalls WK001 and WK004 combined.

Reference: Weyerhaeuser (1988).

There are very few additional data available from contaminant studies conducted at the Weyerhaeuser Kraft Mill. The NPDES permit application and data from three effluent samples provided by the Weyerhaeuser Company provide limited information on pollutant and metals concentrations (Table 11). These data represent isolated examples from the plant effluent and are not adequate to provide a comprehensive analysis. The NPDES permit application reported values for some metals, none of which exceeded the U.S. EPA water quality criteria. Chlorobenzene was the only organic compound found in concentrations greater than the analytical detection limit (Weyerhaeuser 1983). In another sample, collected 1 April 1986, only chloroform was detected (Ruppert, H., 20 May 1988, personal communication). Data for metals found in effluent from Outfall WK001 are also presented in Table 11. Evaluation of these data suggests that the plant is occasionally discharging elevated concentrations of certain organic compounds and metals (e.g., chlorobenzene, chloroform, magnesium, chromium, copper) (Weyerhaeuser 1983; Ruppert, H., 20 May 1988, personal communication). Vanillin black liquor (VBL) used by the Weyerhaeuser Kraft Mill in its processes could be a source of copper. The amount of copper in the effluent due to VBL is reported to be much less currently than in the past (Ruppert, H., 12 May 1988, personal communication), but there are no data available to substantiate this statement.

The majority of the Weyerhaeuser Kraft Mill wastewater is routed to a lagoon treatment system on Smith Island. Effluent from this system is discharged at Outfall WK001 into Steamboat Slough. This effluent is sampled for organic compounds and metals more frequently than effluent from the other outfalls. There are very few data available on the effluent discharged at Outfalls WK002, WK004, and WK005.

Everett Marina and Related Industries--

The Everett Marina is located north of the East Waterway and the Norton Terminal, across the Snohomish River channel from Jetty Island (see Figure 2). It is the second largest marina on the West Coast and contains more than 2,000 boat slips. There are facilities for both pleasure craft and commercial fishing vessels. The activities in the marina area, such as boat

TABLE 11. WEYERHAEUSER KRAFT MILL POLLUTANT DATA

	Permit Application[a] 5/12/83 Outfalls				Monitoring Reports[b] 1/31/86 8/11/87 Outfalls	
	WK001 (mg/L)	WK002 (mg/L)	WK004 (mg/L)	WK005 (mg/L)	WK001 (mg/L)	WK001 (mg/L)
Total organic carbon	204	5	<10	144	NA	NA
Ammonia-Nitrogen	0.04	0.029	0.037	2.4	NA	NA
Fecal coliforms (No./100 mL)	<1	--	--	60	NA	NA
Oil and grease	2.0	2	--	3	NA	NA
Phosphorus	0.27	--	--	--	NA	NA
Sulfates SO_4^{2-}	185	--	<5	--	NA	NA
Sulfites SO_3^{2-}	<2	--	<2	--	NA	NA
Fluorine	0.051	0.032	0.028	--	NA	NA
Aluminum	0.31	--	0.33	1.0	0.52	0.26
Barium	0.073	--	0.009	--	0.07	0.07
Boron	0.24	--	0.018	--	NA	0.06
Cobalt	<0.001	--	<0.001	--	<0.005	<0.01
Iron	0.46	--	0.046	20	0.56	0.80
Magnesium	97	--	1.38	116	34	3.8
Molybdenum	<0.01	--	<0.01	--	<0.01	<0.01
Manganese	0.2	--	0.016	--	0.24	0.18
Tin	<0.01	--	<0.01	--	0.05	<0.05
Titanium	<0.5	--	<0.5	--	NA	NA
Beryllium	ND	--	--	--	<0.005	<0.005
Cadmium	ND	--	--	--	<0.005	<0.005
Chromium	ND	--	--	--	0.17	0.11
Copper	ND	--	--	--	0.22	0.02
Lead	ND	--	--	--	<0.05	<0.05
Mercury	ND	--	--	--	<0.0002	NA
Nickel	ND	--	--	--	<0.03	0.02
Silver	ND	--	--	--	<0.005	<0.01
Zinc	ND	--	--	--	0.03	0.04
Chlorobenzene	0.001	--	--	--	NA	NA
Asbestos	c	c	c	c	NA	NA
Cresols (methylphenols)	c	c	c	c	NA	NA

[a] Maximum daily value.

[b] Ruppert, H., (20 May 1988, personal communication). Data represent the average of two replicate samples for each date.

[c] Expected to be present - no measurements taken.

NA = Not analyzed.

ND = Not detected - detection limit not available.

-- = Value not provided in permit application - contaminant believed absent.

sandblasting and painting, are potential sources of contamination. Other possible sources of contamination in the marina, such as surface runoff and CSOs, are discussed in other sections of this report.

The location of the boat basin off the Snohomish River places the marina in a position to accumulate contaminated materials. A study conducted for the Port of Everett (Spadaro, P., 6 May 1986, personal communication) found high molecular weight polycyclic aromatic hydrocarbons (HPAH) and heavy metals in the sediments along the north end of the marina boat basin (Figure 7). A sample taken upstream of the marina in the Snohomish River near Jetty Island at historical Station SSB1 (Spadaro, P., 6 May 1986, personal communication) showed acceptable levels of chemicals similar to those found at acceptable levels in the marina. The criteria used to determine acceptability were the Interim Decision Criteria for Disposal of Dredged Material at the Port Gardner Open Water Disposal Site (Spadaro, P., 6 May 1986, personal communication). A summary of the relevant data from this study (Spadaro, P., 6 May 1986, personal communication) is provided in Table 12. HPAH concentrations were above the acceptable IDC limits at historical Stations SSB2 and SSB6. Elevated concentrations mercury were found in sediments from historical Stations SSB3 and SSB6. Elevated concentrations of arsenic, copper, lead, and zinc were found at Station SSB6. Mercury also exceeded the low AET criteria (Tetra Tech 1986g) at Station SSB6.

Nearby industries that could be sources of chemical contaminants in the Everett Marina area include boat building and repair facilities, the Marina Village, Steuart Seafoods, and other nonharbor-related businesses such as American Boiler Works, Tri-Coatings (Marpac), and Centrecon. Steuart Seafoods, Tri-Coatings, and Centrecon participate in the Everett pretreatment program. The permit requirements for these three industries are listed in Table 2. Information in Ecology files on the above mentioned industries states that Tri-Coatings (Marpac) was inspected for dangerous waste activities in March 1986 and 31 January 1987. Chromic acid, chlorides, and sulfates were used at Marpac but no analytical data were available on these potential problem chemicals during Ecology's inspection.

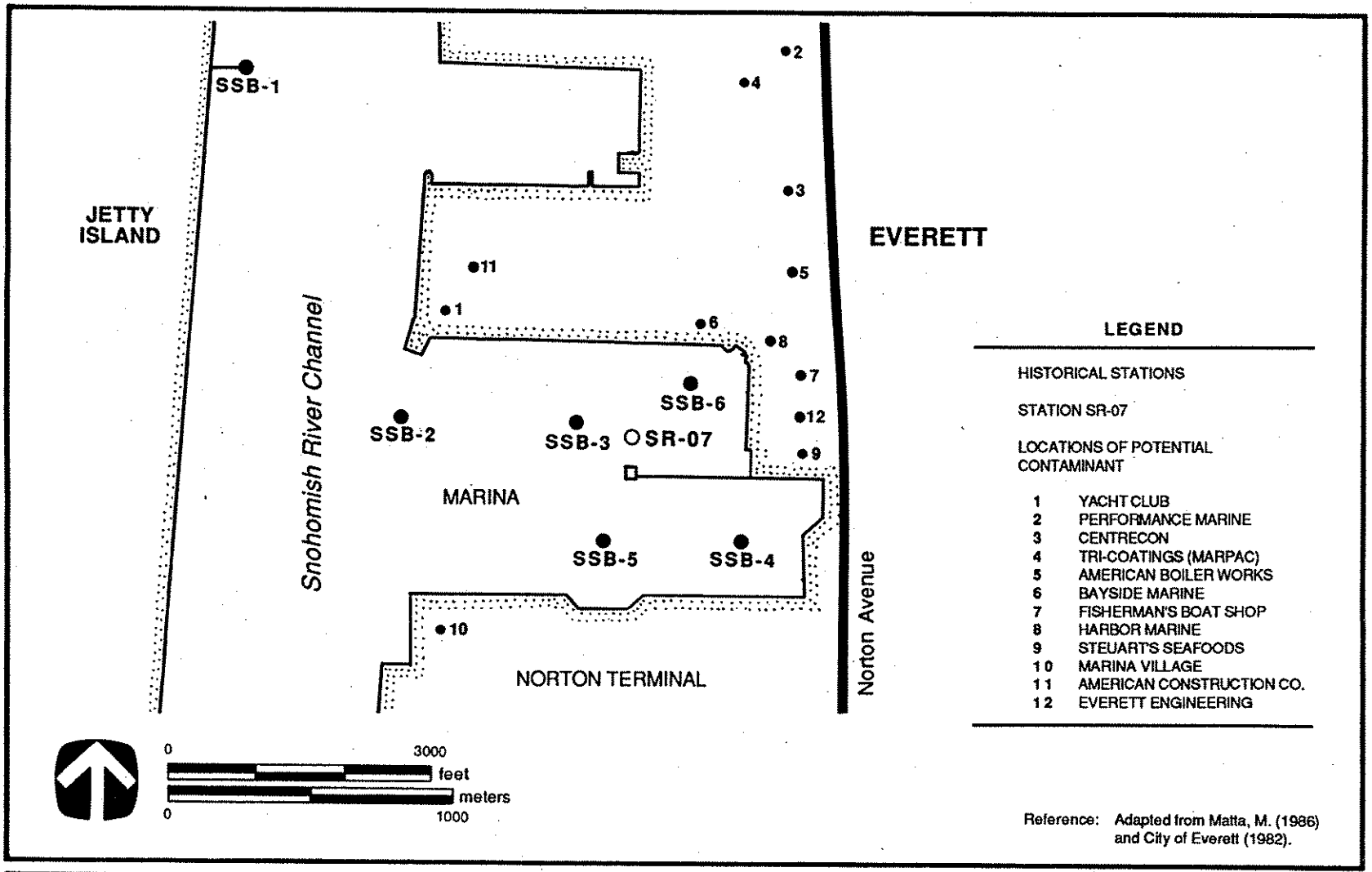


Figure 7. Sampling locations in the vicinity of the Everett Harbor Marina.

TABLE 12. HISTORICAL STATIONS IN THE EVEREETT MARINA WHERE POLLUTANT CONCENTRATIONS ARE ABOVE ACCEPTABLE CRITERIA

Contaminant	Stations SSB2 (mg/kg)	SSB3 (mg/kg)	SSB6 (mg/kg)	IDC[a] (mg/kg)	Puget Sound[b] Low AET (mg/kg)
Arsenic	7.8	11	29	12.5	85
Copper	47	59	110	68.0	310
Mercury	0.1	0.2	0.6	0.15	0.41
Lead	<10	11	45	33	300
Zinc	61	85	160	105	260
HPAH[c]	2.720	4.811	4.740	2.690	12.000

[a] Interim Decision Criteria for Disposal of Dredged Material at the Port Gardner Open Water Disposal Site, U.S. Environmental Protection Agency, 12 February 1986.

[b] Tetra Tech (1986).

[c] Summation of benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, fluoranthene, pyrene, and benzo(a)anthracene.

Reference: Adapted from Spadaro, P. (6 May 1986, personal communication).

Boat repair businesses and individual boat owners are reported to engage in sandblasting activities (Gregoire, D., 20 June 1988, personal communication). The Fisherman's Boat Shop, located on the water at the northeast corner of the marina, has been investigated recently by Ecology for possible hazardous waste activities. In a memo to the files at Ecology, the Fisherman's Boat Shop property is described as containing accumulated sandblast wastes consisting of copper smelter slag that is heavily contaminated with marine paint and antifouling marine biocides. Storm water forces the sandblast waste into the harbor through storm drains and sheet runoff (Murdock, D., 19 June 1987, personal communication).

Soil samples taken at Fisherman's Boat Shop were analyzed for specific metals (i.e., from sandblasting activities) and the results of these analyses are presented in Table 13. Although the samples were obtained from soil not marine sediment, the AET values for marine sediment are noted for reference. The soil samples contained a variety of metals with copper, lead, and zinc the most abundant metals in the samples.

Wood Treatment Facilities--

In 1986, the U.S. EPA sponsored studies to determine whether wood treatment chemicals were entering the soil and water surrounding certain lumber mills in Washington (Matta 1986). Buse Timber, located on Smith Island between the Snohomish River and Union Slough, and Canyon Lumber, located across the Snohomish River south of the Everett WTP (see Figure 2), were chosen as likely places in Everett where wood treatment chemicals might be found. Sediment and water samples were collected at these lumber companies, and the results of the analyses are provided in Table 14. Elevated levels of pentachlorophenol and tetrachlorophenol were found in all of the samples. These data suggest that the areas in and around wood treatment facilities are potential sources of chlorinated phenolic compounds in the Everett Harbor area.

TABLE 13. METALS CONCENTRATIONS IN SOIL SAMPLES FROM FISHERMAN'S BOAT SHOP, EVERETT MARINA

Contaminant	Soil Sample (mg/kg) 1	2	3	4	AET[a] Low/High (mg/kg)
Arsenic	480	590	720	1,370	85/700
Barium	315	435	666	142	
Cadmium	42	6	40	56	5.8/9.6
Chromium	130	71	131	114	27/59
Copper	4,950	4,380	4,610	4,540	310/800
Lead	2,520	1,190	2,330	2,660	300/700
Nickel	53	22	48	29	28/49
Silver	13	23	13	38	5.2/5.2
Zinc	8,880	7,140	9,550	28,600	260/1600
Selenium	0.8	0.1U	0.1	0.3	
Mercury	2.0	0.83	0.96	0.02	0.41/2.1

[a] Tetra Tech (1986g).

Reference: U.S. EPA Region X Lab Management System (1987).

TABLE 14. CANYON LUMBER AND BUSE TIMBER
WOOD TREATMENT CHEMICALS EXAMINATION

	Tetrachlorophenol (TCP) (mg/kg)	Pentachlorophenol (PCP) (mg/kg)
Canyon Lumber		
Near Hegeberg Boat Shop	0.290	0.390
Near railroad crossing	10.600	27.900
Near railroad crossing (water)	0.0068	0.041
Buse Timber		
Storm drain near dip tank	47.500	240.000
Near slough	0.890	1.970

Reference: Adapted from Matta (1986).

Electroplating Industries---

Pacific Plating and Custom Pacific Plating are located at the same address on Hewitt Avenue in Everett. Both companies participate in the Everett pretreatment program dischargers and are listed in Table 2 (see Section 2.1.1). Information in Ecology files pertaining to inspections of Pacific Plating and Custom Pacific Plating indicate that the potential exists for spills of toxic chemicals into the sanitary sewer system. Toxic chemicals at Pacific Plating that may be involved in such spills, include waste chromic acid, trichloroethylene, cadmium cyanide, zinc cyanide, copper cyanide, zinc oxide, nitric acid, and hydrochloric acid. Custom Pacific Plating generates cyanide, chromium, and nickel sludge. Further information is not available about suspected problems at these electroplating industries.

2.1.5 Ebey Slough

The main industrial facility in this area is the Boeing Test Facility. Its proximity to Quilceda Creek, which drains into Ebey Slough, and its current listing in CERCLIS (see Table 3) makes this facility a possible source of leachate contamination. Little additional information is available concerning possible industrial sources of contaminants in the Marysville area that could impact Ebey Slough.

The Boeing Test Facility--

The Boeing Test Facility is located on a 360-ac section of land at the eastern end of the Tulalip Indian Reservation. Boeing has operated the site since the 1950s as a fuel storage and testing area. The fuels stored here are reported to include hydrazine, peroxide, fluoride, JP-4 fuel, and PCB's (Tetra Tech 1985b). The Esperance sand aquifer beneath the site, where the watertable is at 4-5 ft, might receive leaks and spills from the test facility and provide a link to the drainage system, thereby contributing to possible contamination in Ebey Slough. There are no new data available concerning this CERCLIS site.

2.2 WASTEWATER TREATMENT PLANTS

Within or near the Everett Harbor study area there are five municipal WTPs: Mukilteo, Marysville, Everett, Lake Stevens, and Tulalip. Contamination from three of these plants (Mukilteo, Marysville, and Everett) may impact the stations and problem areas discussed in this report. The Mukilteo plant, located at the southwest corner of the study area (see Figure 2), discharges into the nearshore Port Gardner problem area. Located in the northeast corner of the study area (see Figure 2), the Marysville plant discharges into Ebey Slough. The Everett plant, situated on the east bank of the Snohomish River between Stations SR-01 and SR-02 (see Figure 2), has a history of overloads and leachate problems (Tetra Tech 1985b). This plant is not located near any problem area or station, but its location on the Snohomish River estuary may allow for effluent movement into some problem locations. The Lake Stevens plant discharges effluent into Ebey Slough near the northeast corner of Ebey Island. Although the Lake Stevens plant has had problems meeting its permit requirements in the past, it is well removed from the study area. The Tulalip plant is also located far from a problem area or station. Both the Lake Stevens and Tulalip WTPs are not discussed here.

2.2.1 Mukilteo WTP

The Mukilteo WTP is located at the intersection of Mukilteo Boulevard and Loveland Avenue and has been in operation since 1962. Primary treated effluent from this plant is discharged into the Port Gardner area through an 18-in concrete pipeline that extends approximately 125 ft offshore to a depth of 16 ft (Tetra Tech 1985b). This discharge is permitted under NPDES Permit No. WA 002329-9, which expired on 7 July 1988. Permit requirements include weekly monitoring of BOD, TSS, and fecal coliform bacteria in the plant effluent. Monitoring data from February 1987 through April 1988 are provided in Table 15 (City of Mukilteo 1988).

Although the plant has had a history of operational problems and plant overloads that resulted in the discharge of untreated wastewater to Port Gardner, the overflow problems have been corrected (Tetra Tech 1985b).

TABLE 15. MUKILTEO WTP DISCHARGE MONITORING REPORTS (FEBRUARY 1987-APRIL 1988)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)	Fecal[a] (#/100 mL)
Permit Requirements		165	300	150	280	700
1987						
J	b	b	b	b	b	b
F	1.8	191	293	87	144	333
M	1.7	203	294	131	192	186
A	1.4	241	261	77	83	146
M	1.4	289	322	77	84	150
J	1.2	257	282	228	270	417
J	b	b	b	b	b	b
A	1.2	354	333	100	96	467
S	1.7	335	292	117	101	1,669
O	1.1	315	276	55	51	957
N	1.2	355	316	83	71	113
D	1.6	254	308	109	144	363
Total	430 MG		45 ton		19 ton	
1988						
J	1.4	342	456	140	159	214
F	1.3	380	402	140	146	246
M	1.4	356	382	151	162	838
A	1.5	377	449	123	150	487
Total	170 MG		25 ton		9 ton	
Average	1.4±0.2[c]	304±64	333±64	116±43	132±57	470±427

[a] Fecal = Fecal coliform bacteria.

[b] Information not submitted for this report.

[c] Average = $\bar{x} \pm 1s$ (s= standard deviation).

However, enforcement actions by Ecology continue because the plant is often out of compliance with elevated BOD concentrations in the effluent discharge (Wright, D., 1 June 1988, personal communication). The City of Mukilteo's request for a Section 301(h) variance from secondary treatment requirements was denied by the U.S. EPA (Wright, D., 1 June 1988, personal communication). The plant is currently in the process of upgrading its treatment system. A new pump station and pressure line is being constructed that will connect to the Olympus Terrace treatment plant in south Mukilteo, west of Paine Field as soon as expansion of the Olympus Terrace plant is finished. Completion is scheduled for late Fall, 1989 (Adams, J., 23 May 1988, personal communication).

2.2.2 Marysville WTP

The Marysville WTP, located at Columbia Street and Ebey Slough, was built in 1959 and provides service to the City of Marysville and surrounding unincorporated areas. Effluent from the plant is discharged to Ebey Slough through a 150-ft long outfall (Tetra Tech 1985b). Precipitation results in occasional discharges from other outfalls, such as sanitary sewer overflows and sewage pumping station bypasses. These alternative outfalls are for emergency use only and therefore are not routinely sampled for contaminants. There are five of these emergency outfalls: two discharge into Ebey Slough, two into Quilceda Creek, and one into Allen Creek (City of Marysville 1988). Any of these discharges may possibly contribute to contamination in Ebey Slough or area creeks.

Monthly discharge data from the Marysville WTP for January 1986 through March 1988 are provided in Table 16. The overload is evident when the monthly averages of the variables are compared to the permit limits. The NPDES Permit No. WA-002249-7, which expired 1 July 1988, requires weekly monitoring of BOD, TSS, and fecal coliform bacteria in the effluent discharge. Flow and BOD averages have exceeded permit limits since 1986 (City of Marysville 1988). The city is currently adding eight influent aerators and three grinders to improve plant performance (Olsen, G., 20 May 1988, personal communication).

TABLE 16. MARYSVILLE WWTP DISCHARGE MONITORING REPORTS (1986-MARCH 1988)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)	Fecal[a] (#/100 mL)
Permit Requirements	1.2	30	300	75	751	200
1986						
J	2.4	35	290	36	320	760
F	2.7	31	259	40	330	420
M	2.0	25	208	24	200	130
A	2.1	26	218	32	266	130
M	2.3	35	291	32	266	150
J	b	b	b	b	b	b
J	1.3	50	542	62	670	130
A	1.1	50	460	125	1,250	200
S	2.3	b	490	b	642	76
O	1.5	b	650	b	600	180
N	2.0	48	760	40	635	620
D	1.9	32	507	32	507	311
Total	580 MG		71 ton		87 ton	
J	b	b	b	b	b	b
F	2.1	38	665	46	805	420
M	2.2	36	660	47	862	330
A	b	b	b	b	b	b
M	1.9	44	700	67	1,117	26
J	1.3	28	440	46	500	22
J	1.3	38	954	75	813	290
A	1.3	72	780	60	650	508
S	1.5	70	875	84	1,050	20
O	1.1	65	596	35	320	36
N	b	b	b	b	b	b
D	1.6	31	410	40	334	200
Total	430 MG		92 ton		98 ton	

TABLE 16. (Continued)

	Q (MGD)	BOD (mg/L)	BOD (lb/day)	TSS (mg/L)	TSS (lb/day)	Fecal[a] (#/100 mL)
1988						
J.8	32	493	27	416	495	
F.8	36	567	32	504	32	
M.9	31	509	31	542	33	
Total	170 MG		23 ton		22 ton	
Average	1.8±0.4[c]	41±14	536±204	47±25	591±286	240±211

[a] Fecal = Fecal coliform bacteria.

[b] Information not submitted for this report.

[c] Average = $\bar{x} \pm 1s$ (s = standard deviation).

2.2.3 Everett WTP

The Everett WTP was built in 1960 and is located east of the Snohomish River on Smith Island. The plant is subject to frequent hydraulic and organic overloading and is approaching maximum capacity (Determan 1987). The plant consists of a headworks, two 15-ac aeration ponds, two facultative stabilization ponds, and a 2-ac chlorine contact pond. The plant effluent flows from the chlorine contact pond through a 48-in line that discharges within a few feet of the surface near the east bank of the Snohomish River (see Figure 2). The outfall has no diffuser. Minimal dilution, estimated to be about 2.5:1, has been found at the point of discharge (Determan 1987). A flapper gate at the end of the outfall is designed to minimize discharge during peak tidal flows, but it does not operate properly. Incomplete closure of the gate allows effluent material to be carried both upstream and downstream from the outfall by tidal action. Alternative discharge methods and configurations are currently under consideration (Determan 1987).

The plant effluent is monitored daily for dissolved oxygen (DO), BOD, TSS, pH, fecal coliform bacteria and fecal streptococci bacteria according the requirements of their NPDES Permit No. WA 002449-0. Heavy metals, including chromium (total and hexavalent), copper, and zinc, are monitored quarterly. Monitoring data for May 1987 through April 1988 are given in Table 17 (effluent variables) and for April 1987 through April 1988 in Table 18 (heavy metals) (City of Everett 1988).

Both an Ecology water quality study (Determan 1987) and Class II inspection (Reif 1987) were reported by Determan in 1987. These studies assessed the characteristics of the effluent from the Everett plant and the sediments and receiving waters nearby. Dye studies were conducted to track the effluent discharge in the Snohomish River estuary. Chlorination practices were examined, and regulated discharge variables and metals concentrations in receiving water and sediment samples were studied. The results of the Ecology water quality study suggest that the flow of the effluent plume, incoming tides, outgoing tides, and river current each contributed to the net effect on the concentrations of the toxic chemicals at the discharge zone. For example, total residual chlorine, exceeded acute

TABLE 17. EVERETT WTP DISCHARGE
MONITORING REPORTS (MAY 1987-APRIL 1988) FOR EFFLUENT VARIABLES

	Q (MGD)	DO (mg/L)	BOD (mg/L)	TSS (mg/L)	Fecal[a] (#/100 mL)
1987					
M	11.94	6.8	34	54	8
J	11.15	13.3	26	56	10
J	11.53	8.0	20	53	5
A	11.91	11.3	24	53	NR[c]
S	11.50	9.8	18	55	NR
O	10.26	9.2	19	41	NR
N	11.17	3.1	27	42	41
D	14.68	2.8	20	23	NR
Total	2,874 MG				
1988					
J	13.85	1.8	33	27	10
F	12.97	5.3	34	34	3
M	18.06	9.6	23	39	4
A	16.04	12.1	19	32	5
Total	1,834 MG				
Average	12.92±2.32[b]	7.8±3.8	25±6	42±12	11±12

[a] Fecal = Fecal coliform bacteria.

[b] Average = $\bar{x} \pm 1s$ (s = standard deviation).

[c] NR = Not reported.

TABLE 18. EVERETT WTP DISCHARGE MONITORING REPORTS (APRIL 1987-APRIL 1988) FOR HEAVY METALS

	Total Chromium		Copper		Zinc		Lead	
	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)	(lb/day)	(mg/L)
Permit Requirements	8.8	0.1	2.65	0.03	37.1	0.42	8.8	0.1
1987								
4/3-4/30	0.27	0.0021	0.99	0.010	10.95	0.111	0.20	0.002
5/1-5/28	0.33	0.0037	1.92	0.018	5.97	0.056	1.49	0.014
5/29-6/25	0.47	0.0048	5.24	0.054	6.11	0.063	0.19	0.002
7/31-9/3	0.72	0.0072	1.80	0.018	4.68	0.047	0.40	0.004
7/31-9/4	0.66	0.0058	1.11	0.011	2.17	0.019	0.40	0.004
10/2-10/29	0.34	0.004	0.55	0.006	2.29	0.027	0.68	0.008
10/30-11/26	0.62	0.0063	1.46	0.015	4.0	0.041	0.7	0.008
11/27-12/31	1.33	0.0055	6.77	0.028	11.45	0.084	0.48	0.002
1988								
1/1-1/28	0.53	0.0055	2.87	0.030	5.27	0.055	0.57	0.006
1/29-2/25	0.42	0.0037	2.47	0.022	10.7	0.098	0.79	0.007
2/26-3/31	0.294	0.0028	3.16	0.031	11.3	0.111	0.509	0.005
4/1-4/28	1.5	0.0100	1.68	0.01	2.6	0.02	0.56	0.004
Average	0.6 ± 0.4[a]	0.005 ± 0.002	2.50 ± 1.83	0.02 ± 0.01	6.5 ± 3.7	0.06 ± 0.03	0.6 ± 0.3	0.006 ± 0.004

[a] Average = $\bar{x} \pm 1s$ (s = standard deviation).

TABLE 19. CALCULATED UP-FLOW AND PREDICTED THEORETICAL DOWN-FLOW CONCENTRATIONS OF METALS IN THE EFFLUENT DOWNSTREAM FROM THE EVERETT WTP DILUTION ZONE COMPARED TO OTHER STUDIES AND U.S. EPA CRITERIA

Metal	Determan 13 August 1986 Up-flow (mg/L)	Determan 13 August 1986 Down-flow (mg/L)	Reif (1987) (mg/L)	Singleton, et. al (1982) (mg/L)	U.S. EPA (1987) Chronic/Acute Saltwater Criteria (mg/L)
Copper	<0.001	<0.005	0.014	0.0027	0.0029/0.0029[a]
Zinc	<0.001	0.012	0.039	0.033	0.086/0.095[b]
Nickel	<0.001	0.006	0.020	0.004	0.0083/0.075[b]
Total Chromium	<0.001	0.001	<0.001	0.078	0.050/1.100[c]
Cadmium	0.0003	0.005	0.001	<0.001	0.0093/0.043[c]
Lead	<0.001	0.006	0.020	0.008	0.0056/0.140[c]
Mercury	<0.00004	<0.00004	<0.00005	<0.0002	0.000025/0.0021[c]
Silver	0.0002	0.0003	0.0011	0.002	--/0.0023[d]

[a] 1-hr average (not to be exceeded more than once in 3 yr).

[b] 24-hr average (maximum allowable at any time).

[c] 4-day average or 1-hr average (not to be exceeded more than once in 3 yr).

[d] Maximum allowable at any time.

Reference: Adapted from Determan (1987).

TABLE 20. CONCENTRATIONS OF METALS IN SEDIMENT AT THE EVERETT WTP COMPARED TO TWO OTHER SITES IN THE SNOHOMISH RIVER AND TO AET VALUES

Metal	Everett WWTP Chlorination Lagoon (mg/kg)	Snohomish River Dagmar's Marina (mg/kg)	Snohomish River Control Site (mg/kg)	AET[a] Low/High
Copper	107	17	19	310/800
Zinc	169	46	48	260/1,600
Nickel	42	24	23	28/49
Chromium	52	20	19	27/59
Cadmium	4.1	0.1	0.14	5.8/9.6
Lead	34	1.5	1.2	300/700

[a] From Tetra Tech (1986g).

Reference: Adapted from Determan (1987).

toxicity levels when stored effluent was released through the open tide gate (Determan 1987). Such data serve to emphasize the need for a flow-paced chlorination system and an adequate diffuser(s).

Metals concentration data from three different water quality studies (Determan 1987; Reif 1987; Singleton et al. 1982) of the Everett WTP discharge zone were reported by Determan (1987) and are presented in Table 19. Data vary substantially among the studies, which may be the result of different sampling locations or the effects of effluent flow and tidal conditions at the time the samples were collected. Lead concentrations exceeded the permit level of 0.0014 mg/L in each study. Elevated concentrations of copper and nickel were reported by Reif (1987). Although the copper and nickel concentrations reported by Determan (1987) did not exceed the U.S. EPA water quality criteria, they are close to criteria values, and concentrations of these two metals could be higher during slack tides when currents are slowest. The concentrations of metals in sediment samples from the Everett WTP and two locations in the Snohomish River are shown in Table 20. The values are all below the highest apparent effects threshold (HAET) Puget Sound. Nickel and chromium concentrations in samples from the Everett WTP chlorination lagoon exceeded the lowest apparent effects threshold (LAET).

2.3 COMBINED SEWER OVERFLOWS

The majority of the Everett Harbor project area is served by a combined sanitary and storm sewer system. In a combined system, both domestic waste and stormwater runoff enter the same sewerage system. Combined sewer systems overflow when the additional flow from stormwater runoff exceeds the hydraulic capacity of the collection system. The excess flow, a mixture of stormwater runoff and raw sewage, is discharged from planned overflow points in the system (i.e., CSOs).

Historically, the Everett sewer system discharged directly to Port Gardner and the Snohomish River through numerous outfalls. A complex system of gravity sewers, pump stations, regulators, and force mains was constructed in the 1960s to intercept most of these outfalls and convey the sewage to

treatment lagoons. Currently, within NESS there are 16 outfalls (2 of which are deactivated), 37 regulators, and 10 lift stations (see Figures 3, 8, 9).

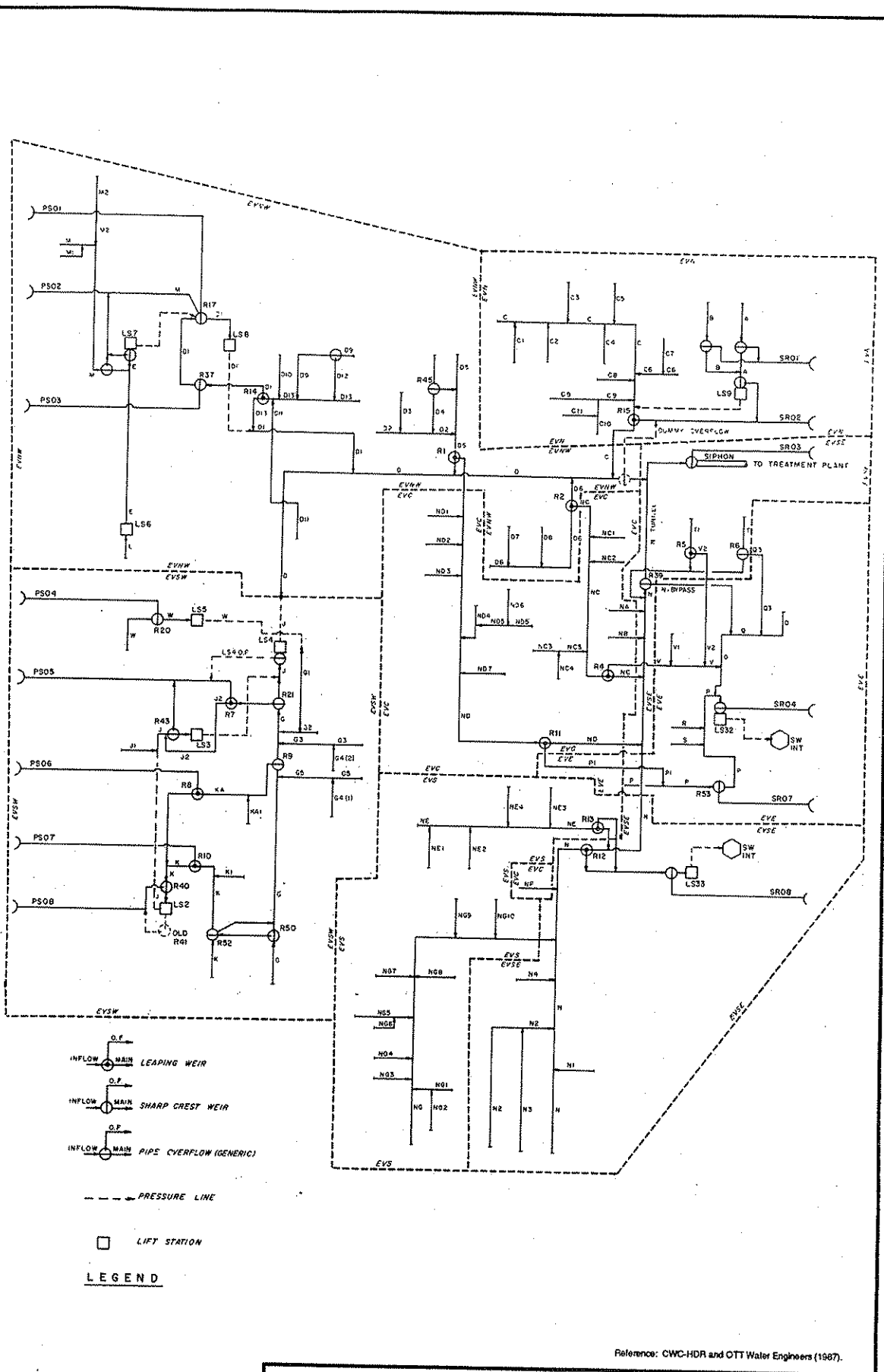
In 1987, Ecology adopted CSO control regulations under the Washington Administrative Code (WAC 173-245), that defined control of each site to denote "that an average of one untreated discharge may occur per year." A plan for the control of combined sewer overflows was developed for the City of Everett to comply with the new state regulations [Culp Wesner and Culp-Henningson, Durham and Richardson (CWC-HDR) and Ott Water Engineers 1987]. CWC-HDR and Ott Water Engineers classified the CSOs that discharge to Port Gardner into groups of outfalls (PS for Puget Sound and SR for Snohomish River), because the number of regulators made defining a single drainage basin for each outfall difficult. Outfalls to the Snohomish River were classified individually, but were given outfall group numbers for consistency. The individual outfalls and their associated groups were then modeled by CWC-HDR and Ott Water Engineers (Table 21). The purpose of modeling the CSO's was to determine the effects of alternative CSO control strategies on overflows in the Everett system. To evaluate alternative control facilities and strategies, CWC-HDR and Ott Water Engineers used a technical approach that involved Everett area rainfall data, CSO data, and an updated set of computer models.

Two basic types of models were used: 1) a detailed model based on the physical characteristics of the individual drainage basins, pipelines, pumping stations, and regulators (the HYDRA model); and 2) a model based on the hydrologic balance of rainfall, runoff, collection system capacity, and CSO spills (the PROVE model). Outfalls are modeled in PROVE by groups, which contain one or more outfalls. This grouping of outfalls was necessary because all overflow weirs are not the same and the proportion of diverted flow to nondiverted flow changes with total flow at each weir. This proportion is also dependent upon downstream conditions such as back-water surcharging. For this reason it is nearly impossible to define a single contributing basin for each outfall, especially in outfall Group 2 (PS04, 5, 6, 7, 8) (Figure 8).

TABLE 21. OUTFALLS AND THEIR ASSOCIATED GROUPS IN THE EVERETT HARBOR STUDY AREA

Outfall Group Number	Combined Sewer Overflows
Port Gardner	
1	PS01, 2, 3
2	PS04, 5, 6, 7, 8
Snohomish River	
3	SR01
4	SR02
5	SR03 (siphon to treatment plant)
6	SR04
7	SR05, 6 (deactivated)
8	SR07
9	SR08

Reference: CWC-HDR and Ott Water Engineers (1987).



Reference: CWC-HDR and OTT Water Engineers (1987).

Figure 8. City of Everett North End Sewer System (NESS) schematic diagram (1987 conditions).

The quality of water discharging from combined sewer overflows at a given location is a function of the land use in the tributary drainage basin and the relative proportions of baseflow and storm water. The quality can also vary substantially from one area to another even for identical land uses. Estimates of the various land-use characteristics in the NESS are summarized in Table 22.

Outfall sites PS01, PS02, PS03 (outfall Group 1) represent the overflows from the northwest part of Everett, between 9th and 21st Streets, and west of Wetmore Avenue. PS03 rarely overflows due to the overflow weir, which has a high elevation relative to the normal flow of the corresponding pipeline (CWC-HDR and Ott Water Engineers 1987).

Outfall PS04 is located near 25th Street on property owned by Scott Paper Company. The overflow from Lift Stations 3 and 4 is discharged at Outfall PS05. This CSO collects the majority of flow west of Colby Avenue between 26th and 60th Streets. Outfall PS06 has a large contributing area which encompasses southwest Everett outfall. PS07 is located off of Bond Street between Wall Street and Pacific Avenue. Regulation of flow upstream of Lift Station 2, combined with the new interceptor, allows infrequent overflows at Outfall PS08 (CWC-HDR and Ott Water Engineers 1987).

There are eight CSOs in the Snohomish River Group. Outfalls SR01 and SR02 serve the north and northwest residential areas (see Figure 3). Combined sewage collects near Lift Station 9, which pumps and regulates flow near these outfalls. Overflows occur infrequently at Outfall SR03 located at the Siphon Headworks. Instead, combined sewer flows that exceed the capacity of the system overflow (or back up) elsewhere. The peak capacity of the siphon headworks is approximately 55 MGD (CWC-HDR and Ott Water Engineers 1987). Outfall SR04 overflows when runoff from a small area east of I-5 does not flow into the main interceptor. Outfalls SR05 and SR06 were directly connected to the new river interceptor and have been deactivated. Overflows at Outfall SR07 are caused by runoff from the central area between 13th Street and 36th Avenue. Outfall SR08, a 60-in overflow pipe at 36th Street, services an area nearly a third of the NESS drainage. It is the largest contributary outfall to the Snohomish River (Table 23). The average

TABLE 22. SUMMARY OF LAND-USE CHARACTERISTICS IN THE SERVICE AREA FOR NESS

Land-Use Characteristics	Area
Total NESS	3,287 ac
Total impervious area[a]	1,123 ac
Total pervious area[b]	1,977 ac
Total NESS combined area	3,100 ac
Weighted percent impervious	36%

[a] Impervious areas are defined as areas incapable of being penetrated by moisture, such as parking lots and streets.

[b] Golf courses, lawns, parks, etc.

Reference: CWC-HDR and Ott Water Engineers (1987).

TABLE 23. OUTFALL GROUP OVERFLOW SUMMARY

Outfall Group No.	Outfalls	Approximate CSO Discharge Points	Service Area (ac)	Stormwater Capacity (MGD)	Average Annual Volume of Overflow (MG)	Annual Number of Events	Estimated 1-yr Return CSO Event Volume (MG)
1	PS01, 2, 3	PS01 13th Street PS02 14th Street PS03 16th Street	183	4.8	4.4	25	0.8
2	PS04, 5, 6 7, 8	PS04 25th Street PS05 Everett Avenue PS06 Hewitt Avenue PS07 Bond Street (between Wall Street and Pacific Avenue) PS08 Bond Street (between Wall Street and Pacific Avenue)	397	4.8	48.9	69	4.5
3	SR01	17th Street and Marine View Drive	61	0.4	5.4	79	0.5
4	SR02	17th Street and Marine View Drive	563	0.1	84.8	111	5.8
5	SR03	17th Street and Marine View Drive	Siphon Headworks - All basins contribute - Overflows are negligible	-----Negligible-----			
6	SR04	California Street and Railway Avenue	518	7.0	35.3	58	4.1
7	SR05, 6	SR05 Railway Avenue between Hewitt Avenue and California Street SR06 Railroad crossing between Hewitt Avenue and Pacific Avenue	Deactivated with the construction of the riverside interceptor	--------None--------			
8	SR07	Pacific Avenue and Railroad	488	6.0	36.3	58	3.7
9	SR08	36th Street and Railroad	890	5.0	269.9	101	18.9
		NESS COMBINED:	3,100	28.1	485.0	72[a]	38.3
ALL SYSTEM-WIDE		**NESS TOTAL:**	3,287	28.0	442	79	38

[a] Average.

Reference: Numbers taken from CWC-HDR and Ott Water Engineers (1987).

flow from Outfall SR08 is 5 times greater than the combined flow of all eight Port Gardner outfalls. On a system-wide basis, Outfall SR08 contributes more than one-half of all the overflow volume. This CSO network and its drainage system is presented in Figure 9. This figure obtained from the City of Everett's Drainage Facilities (201 Plan) outlines the seven subbasins and their contributing areas (Table 24).

The City of Everett has recently sampled storm water from four CSOs during seven storm events (Mathias, D. 27 May 1988, personal communication). Table 25 lists the CSO locations and events. Water quality samples were obtained by flow-activated automatic water quality samplers (Model No. 2700, manufactured by ISCO Inc.) at 15-min increments. Flow volume was recorded in the same manhole with flowloggers (Model WDFM-8, manufactured by the Montedoro-Whitney Corporation). Flow recordings were not available at the time of this report, thus loading values were not calculated. A summary of the results from the chemical analysis of the storm water is presented in Table 26. Also presented in Table 26 are U.S. EPA freshwater quality criteria. Seven metals (i.e., cadmium, chromium, copper, lead, mercury, silver, and zinc) exceeded either chronic or acute U.S. EPA freshwater quality criteria. Copper exceeded acute criteria at all four locations (Outfalls PS05, PS06, SR07, and SR08).

CWC-HDR and Ott Water Engineers (1987) reported pollutant loadings based on typical concentrations reported in the literature and technical reports from the 1984 Toxicant Pretreatment Planning Study. CWC-HDR and Ott Water Engineers (1987) used baseflow and runoff ratios and weighted land-use ratios for CSO components. Weighted concentrations were then computed for each outfall group and each pollutant (Table 27). The average annual CSO volume was then multiplied by the final concentrations to yield estimated annual mass discharge (Table 28).

2.4 LANDFILLS

Two landfills (Everett and Tulalip) are located in the Everett Harbor study area. Contaminants contained within each landfill can be transported to the Snohomish River and its sloughs via surface runoff or leachate.

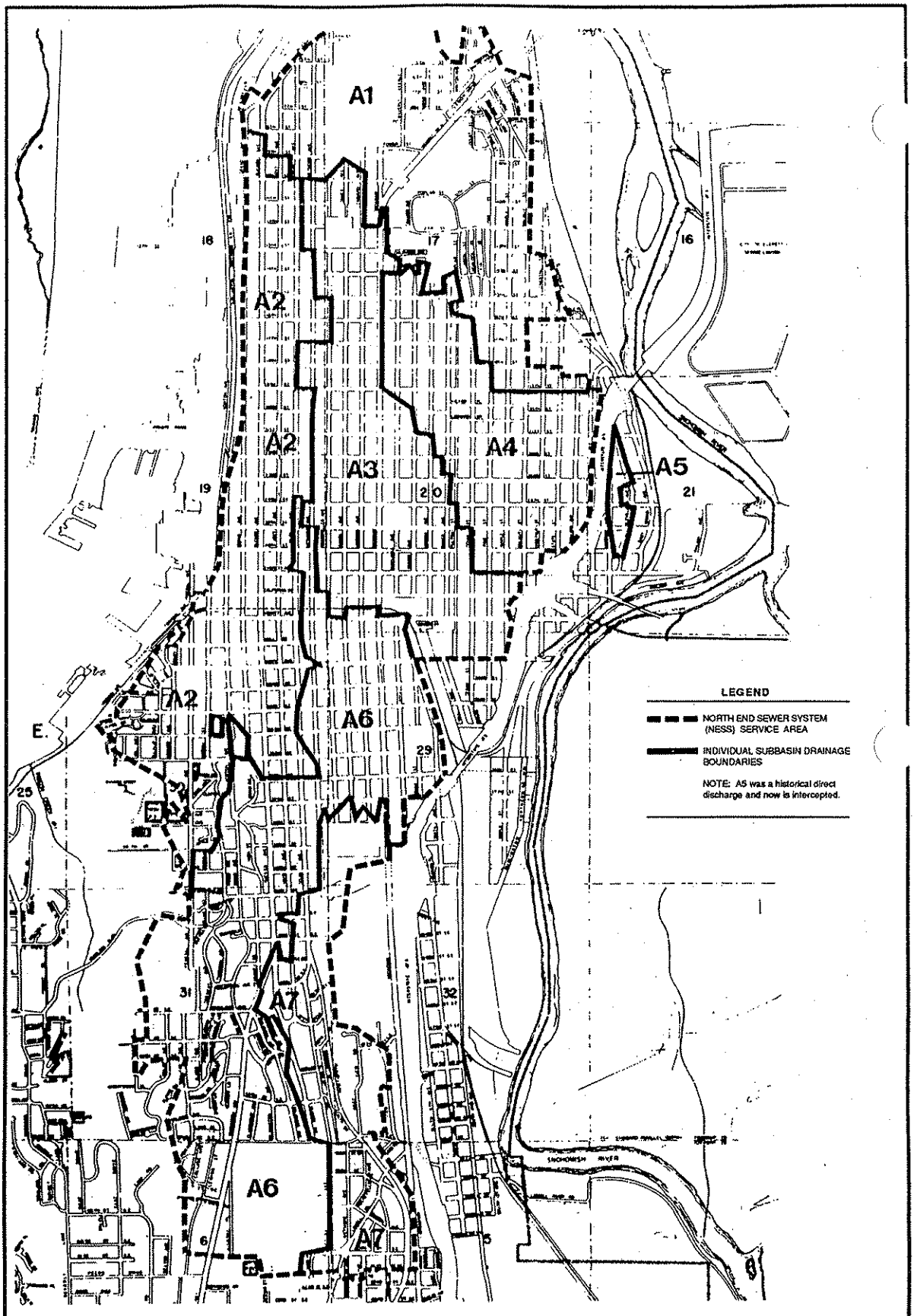


Figure 9. Individual drainage subbasin boundaries for City of Everett North End CSOs.

TABLE 24. APPROXIMATE DRAINAGE AREAS FOR THE SEVEN SUBBASINS SHOWN IN FIGURE 9

Subbasins	Area (ac)
A1	590
A2	560
A3	490
A4	340
A5	15
A6	640[a]
A7	320[a]

[a] Includes area south of 52nd Street.

TABLE 25. SUMMARY OF STORMWATER SAMPLES COLLECTED (1987-1988) BY THE CITY OF EVERETT[a]

Date	CSO			
	PS05[b]	PS06[c]	SR07[d]	SR08[e]
09/25/87				X
10/31/87	X[f]			
11/13/87		X	X	
01/20/88			X	
03/02/88				X
03/24/88		X		
03/26/88	X			

[a] For geographical reference, see Figure 3.

[b] PS05 = Lift Station #3 (Railroad) (E009).

[c] PS06 = Hewitt and Bond (E008).

[d] SR07 = Pacific and Chestnut (E026).

[e] SR08 = 36th Street (Upstream of LS33) (E028).

[f] Represents a sample collected.

TABLE 26. SUMMARY OF EVERETT CSO STORMWATER CONTAMINANT DATA

Detected Analytes	Mean Concentration (ug/L) PS05 (E009)	PS06 (E008)	SR07 (E026)	SR08 (E028)	U.S. EPA (1986) Freshwater Quality Criteria (Aquatic Life) (ug/L) Acute	Chronic
Arsenic	5.0	3.5	5.5	4.0	360	190
Antimony	5.0	5.0	5.0	5.0	9,000[d]	1,600[d]
Beryllium	5.5	3.0	5.0	5.0	130[d]	5.3[d]
Cadmium	5.0[a]	1.0	2.0[b]	1.75[b]	3.9[f]	1.1[f]
Chromium	10.9	10.0	15.5[b]	12.5[b]	1700[f]/16[e]	210[f]/11[e]
Copper	51.0[a]	36.0[a]	78.0[a]	121.5[a]	18[f]	12[f]
Lead	32.0[b]	35.5[b]	55.0[b]	125.0[a]	82[f]	3.2[f]
Mercury	0.9[b]	0.2[b]	0.2[b]	0.7[b]	2.4	0.012
Nickel	28.0	5.0	11.5	21.0	1,400[f]	160[f]
Selenium	2.5	1.5	1.5	2.5	260	35
Silver	35.5[a]	1.0[b]	1.0[b]	9.0[a]	4.1[f]	0.12
Thallium	1.0	2.0	1.0	1.5	1,400[d]	40[d]
Zinc	230.0[a]	1,115.0[a]	290.0[a]	365.0[a]	120[f]	110[f]
Phenol				53.6[c]	10,200[d]	2,560[d]
4-Methylphenol		6.0[c]			g	g
gamma-BHC				0.17[c]	2.0	0.014
Diethyl phthalate	1.8[c]	2.8[c]		7.7[c]	g	g
Di-n-butyl phthalate		2.0[c]		26.7[c]	g	g
Benzyl butyl phthalate		2.4[c]			g	g
Bis(2-ethylhexyl) phthalate	228.0	9.8[c]	5.2	37.8	g	g
Methylene chloride		1.8[c]	17.0[c]	8.35	g	g
Chloroform		2.9[c]		7.0[c]	28,900[d]	1,240[d]
Tetrachloroethane				8.4[c]	9,320[d]	g
Trichlorofluoromethane				3.2[c]	g	g
Trichloroethylene				59.0[c]	45,000[d]	21,900[d]
Trans-1,2-dichloroethylene				55.6[c]	g	g
Toluene	63.2[c]			34.8[c]	17,500[d]	g
Xylene		5.0[c]			g	g
Acetone		95.0[c]			g	g
Benzoic acid	17.0[c]				g	g

[a] Concentration exceeds U.S. EPA acute criteria.

[b] Concentration exceeds U.S. EPA chronic criteria.

[c] Single concentration obtained from one sample. All other values represent means obtained from two samples collected from each CSO, each during different storm events (see Table 25, Section 2.3).

[d] Insufficient data to develop criteria. Value presented is the U.S. EPA lowest observed effect level (LOEL).

[e] The first value is for trivalent chromium (III) and the second value is for hexavalent chromium (VI).

[f] Hardness dependent criteria (100 mg/L used).

[g] No criteria or toxicity thresholds are presented in the water quality criteria documents.

Note: Other analytes were undetected at reasonable detection limits (see Table 42).

Reference: Data compiled from Mathias, D. (23 May 1988, personal communciation).

TABLE 27. OUTFALL SPECIFIC POLLUTANT CONCENTRATIONS FOR NESS

Outfall Group	Final Weighted Concentration (mg/L) BOD	TSS	Lead	Cadmium	Zinc
1	29.1	66.1	0.23	0.002	0.23
2	59.5	79.7	0.26	0.003	0.25
3	31.8	69.9	0.21	0.003	0.26
4	31.5	70.8	0.21	0.001	0.22
6	30.5	65.5	0.23	0.003	0.26
8	27.5	55.5	0.28	0.001	0.26
9	50.0	77.6	0.24	0.002	0.25

Reference: Data from CWC-HDR and Ott Water Engineers (1987).

TABLE 28. ESTIMATED POLLUTANT LOADINGS FOR NESS

Outfall Group	Average Annual Volume MG	Mass Loading (lbs/yr) BOD	TSS	Lead	Cadmium	Zinc
1	4.4	1,066	2,422	8.4	0.10	8.4
2	48.9	24,225	32,449	105.9	1.20	101.8
3	5.4	1,430	3,143	9.4	0.10	11.7
4	84.4	22,240	49,988	148.3	0.70	155.3
6	35.3	8,964	19,251	67.6	0.90	76.4
8	36.3	8,311	16,774	84.6	0.30	78.6
9	267.9	111,527	173,090	535.3	4.50	557.6

Reference: Data from CWC-HDR and Ott Water Engineers (1987).

2.4.1 Everett Landfill

The old Everett landfill covered an area of about 70 ac adjacent to the Snohomish River, near 40th Street in south Everett (see Figure 2). It was operated by Snohomish County between 1917 and 1974. Prior to 1966, the site was operated as a burning dump. The landfill primarily accepted wastes from the Everett area, but unknown quantities of unspecified acids and bases were disposed of at the site. The site has been closed since 1974, but is still operated as a solid waste transfer station. The Snohomish County Public Works Department compacts solid waste prior to transport to the Cathcart sanitary landfill.

Because the landfill is unlined and leachate is not collected, there is a high potential for leachate to contaminate groundwater in the area. The water table beneath the site is shallow, with depths varying between 0 and 15 ft. Groundwater in the area generally flows toward the Snohomish River and potential contamination could eventually reach the river. The tire fire at the facility in September 1984 renewed interest in the site as a potential pollutant problem area.

In December 1984, Ecology collected nine samples (i.e., two surface water, five soil/ash, and two oil residue) to determine the chemical composition of surface runoff and soils around the landfill (Tetra Tech 1985b). The largest concentrations of PAHs were found in samples of oil floating on top of the ditch (Table 29). Dikes were installed in the drainage ditch to prevent oil from reaching the Snohomish River. It is not known how much oil discharged into the river before the dikes were installed.

A soil sample collected from the banks of the drainage ditch exhibited the highest PAH content of all the soil samples. The LPAH concentration from this drainage ditch soil sample was 4.18 mg/kg and the HPAH concentration was 15.4 mg/kg. These concentrations are higher than those found in street dust samples from residential areas in Bellevue and industrial areas in Seattle (Galvin and Moore 1982).

TABLE 29. SUMMARY OF EVERETT TIRE FIRE DATA

	Oil Samples[a] (mg/kg)		Water Samples[b] (ug/L)		Soil Samples (mg/kg)				
					c	d	d	d	d
LPAH	1,352	1,315	-	-	4.18	0.283	2.642	1.280	0.170
HPAH	891	760	-	-	15.4	3.33	3.81	0.610	3.62
2-Methyl-naphthalene	380	230	-	-	ND[e]	ND	0.190	0.420	ND
Dibenzofuran	--	ND	--	--	ND	0.018	0.250	0.060	ND
Zinc	--	--	89	125	196	129,800	61,200	22,200	80,000
Copper	--	--	31	28	108	140	230	84	164
Lead	--	--	<1	<1	116	705	128	56	204
Arsenic	--	--	10	3	12.7	31.4	11.0	7.4	13
Silver	--	--	<0.1	<0.1	0.3	1.1	0.4	0.1	0.4
Chromium	--	--	40	10	32.1	32.9	328	28.5	20.2
Cyanide	<10 ug/L	<10 ug/L	--	--	0.37	1.36	0.85	<0.41	<0.41

[a] Oil residue floating in drainage ditch.

[b] Surface water samples.

[c] Soil scraped from side of drainage ditch.

[d] Surface soils at site.

[e] ND = Not detected.

Reference: Huntamer (1985).

Zinc was the predominant metal detected in both the soils and surface runoff samples from the site. Zinc concentrations ranged from 89 to 125 ug/L in the water samples and from 196 to 129,800 mg/kg in the soil samples.

Under U.S. EPA Technical Directive Document F10-8704-04, a file review and site inspection were conducted on the landfill by Ecology & Environment (1988) to evaluate its status within U.S. EPA Uncontrolled Hazardous Waste Site Program. Four water samples (three surface and one leachate), one sediment, and three soil samples were collected on 22 July 1987 to determine if contaminants from the landfill were migrating towards the Snohomish River. The samples were analyzed for all the compounds on U.S. EPA's Target Compound List, including inorganics, volatile organic compounds, acid and base/neutral extractable organic compounds (ABN), pesticides, and PCBs.

Results of the analyses showed that PCBs were detected in the four sediment samples (94-920 ug/kg). These compounds are thought to have been carried into the landfill with unauthorized dumping of oil. PAH compounds were detected in samples obtained in the ditch along the eastern railroad track (south and north locations). These compounds may have originated from the creosote-preserved railroad ties, in addition to pyrolytic oil produced from the intense heat of the 1984 tire fire. No immediate explanation could be given for the presence of other compounds such as chlorobenzene or 1,4-dichlorobenzene found in site water samples.

Ecology & Environment (1988) made the following conclusions regarding the City of Everett Landfill site:

- Low levels of contaminants detected in sediment, surface water, and leachate samples indicate contaminant migration from the landfill toward the river via the drainage ditch

- No evidence of pesticide contamination was found at the site

- The potential exists for long-term, chronic contamination of the Snohomish River as a result of landfill leachate and runoff.

Currently, a chain-link fence surrounds the tire burn area at the landfill surface. No method of containment has been implemented to prevent the zinc-laden ash from becoming airborne or transported offsite by surface runoff.

2.4.2 Tulalip Landfill

The 150-ac landfill is located about 0.5 mi southwest of Marysville on an island in the Snohomish River delta (see Figure 2). It was operated by the Seattle Disposal Company between 1975 and 1979. The site was originally excavated to a maximum depth of approximately 10 ft below mean sea level. The excavated material was used to construct a dike around the perimeter of the site. A canal was built, extending into the fill area, to provide barge access for garbage originating in Seattle. There is no provision for disposal of leachate collected at the landfill.

Although there are no records of quantity or type of material disposed of at the site, it has been estimated that about 95 percent of the material was from commercial and industrial companies in Seattle (Ecology & Environment 1984). The landfill was closed in October 1979 under order from U.S. EPA because of concern over wetland destruction, water contamination, and complaints from Marysville residents of odor problems.

Bacterial Contamination--Because this report focuses on chemical contaminants, biological contaminants such as bacteria are not evaluated. However, because the landfill accepted wastes from hospitals in the Seattle area, there was some concern over the possibility of bacterial contamination from the site, particularly with respect to antibiotic resistant bacteria. While the landfill was in operation, U.S. EPA collected samples of water and sediment from various locations along the landfill's barge canal and in Ebey Slough on three separate occasions: 6 August 1974, 7 October 1974, and 8 June 1976 (Vasconcelos 1974a,b; 1976). The range of bacterial concentrations found in the samples is summarized in Table 30.

TABLE 30. SUMMARY OF BACTERIOLOGICAL DATA FOR TULALIP LANDFILL[a]

Location	Total Coliform Bacteria	Fecal Coliform Bacteria	Fecal Streptococcus Bacteria	*Pseudomonas aeruginosa*	*Staphylococcus aureus*
Mouth of Barge Canal					
Surface water (No./100 mL)	3,300->16,000	170-450	330-1,300	20-34	320-330
Bottom water (No./100 mL)	24,000-92,000	180-1,700	4,900-35,000	0-220	600-4,500
Sediment (No./100 g)	24,000-130,000	450-4,900	-	-	-
Head Barge Canal					
Surface water (No./100 mL)	24,000-92,000	780-1,700	130-7,000	66-370	330-1,400
Bottom water (No./100 mL)	92,000-240,000	840-92,000	54,000-240,000	10-230	3,700-12,000
Sediment (No./100 g)	170,000-540,000	7,900-35,000	-	-	-
Ebey Slough (Reference)					
Surface water (No./100 mL)	950->16,000	310-2,400	140-180	2-60	40-170
Bottom water (No./100 mL)	330-16,000	20-170	45-<180	0-17	50-280
Sediment (No./100 g)	680-95,000	<180-7,000	-	-	-

[a] Samples taken at high and low tide.

Reference: Vasconcelos (1974a,b; 1976).

Pseudomonas aeruginosa and Staphylococcus aureus, both human pathogens, were found in all water samples taken near the landfill, and in Ebey Slough samples. The pathogen Clostridium perfringens was also found in the sediment samples and is an organism associated with food poisoning and therefore is a significant concern in fishable waters.

Chemical Contamination--Sampling has been conducted at the Tulalip landfill on two separate occasions since it was closed in 1979. A leachate sample was collected by the Tulalip Fisheries Department on 23 February 1983. The sample was analyzed for conventional pollutants and selected metals by Ecology. The total organic carbon content was 180 mg/L and the concentration of zinc was 13 mg/L. Ecology & Environment and Ecology inspected the site on 11 September 1984. During the inspection, two leachate samples were collected and analyzed for priority pollutants. The metals data are reported in Table 31.

Ecology & Environment (1984) estimated that between 50 and 100 million gal of leachate are generated at the site each year. Due to the location of the landfill, leachate from the site could enter both Steamboat and Ebey Sloughs. Based on the leachate production estimates, daily metal loadings would range between 0.02 and 0.1 lb/day for arsenic, 0.24 and 0.95 lb/day for chromium, 0.05 and 0.66 lb/day for lead, and 0.16 and 0.76 lb/day for zinc.

U.S. EPA completed a field investigation of the Tulalip landfill in February 1988. The following samples were collected:

- Groundwater from existing monitoring wells
- Surface water from pooling areas onsite and from neighboring sloughs
- Groundwater from offsite domestic wells
- Leachate-stained sediment samples throughout the site.

TABLE 31. SUMMARY OF AVAILABLE LEACHATE DATA FROM TULALIP LANDFILL

	Banks Seeps at Barge Canal Entrance (ug/L)	Puddle by Entrance Road (ug/L)
Arsenic	15	49
Chromium	206	415
Copper	-	758
Lead	289	48
Nickel	-	457
Zinc	138	333

These samples were analyzed for the compounds on U.S. EPA's Target Compound List. The chemical data are currently undergoing internal quality assurance review. The report is expected to be completed by early July 1988 (Glasser, B., 31 May 1988, personal communication).

2.5 SURFACE RUNOFF PATHWAYS

Most surface water runoff from the study area is discharged into Everett Harbor via natural drainages (e.g., streams and creeks). The primary sources of surface water runoff include the Snohomish River and its sloughs. Discharge from small creeks draining the portion of the basin between Mukilteo and Everett, constitute only a small fraction of the areas surface runoff. Because of the rural agricultural nature of most of the study area, there are few developed storm sewer networks.

2.5.1 Rivers and Creeks

Snohomish River Area--

Most surface runoff in the study area enters the main stem and sloughs (Ebey, Steamboat, and Union) of the Snohomish River (see Figure 2). The Snohomish River's annual flow, measured by the U.S. Geological Survey about 20 mi upstream of the mouth (near Monroe), averages 6,400 MGD. Metals data obtained during 1985-1986 at this station are presented in Table 32.

Another major carrier of surface runoff is the Marshland Drainage District Canal (see Figure 2). The canal flows into the Snohomish River above the Everett landfill and provides drainage to about 13,000 ac of agricultural land on the west side of the river and about 1,500 ac of urban land in the southeast end of Everett. Chemical contaminant data were not available for this potential surface water discharge source.

The Tulalip Tribes contracted with the Snohomish County Conservation District in May 1987 to monitor water quality associated with commercial agricultural areas in the Snohomish River Basin. Four rivers and six creeks are currently being sampled (i.e., Snohomish, Skykomish, Snoqualmie, and

TABLE 32. WATER QUALITY DATA COLLECTED AT USGS STATION 12150800 ON THE SNOHOMISH RIVER NEAR MONROE, WASHINGTON

	20 November 1985 (ug/L)	20 February 1986 (ug/L)	20 May 1986 (ug/L)
Arsenic	<1	<1	<1
Beryllium	<0.5	<0.5	<0.5
Cadmium	<1	<1	<1
Chromium	<1	<1	<1
Copper	4	4	6
Lead	<1	6	5
Mercury	<0.1	<0.1	0.4
Nickel	2	1	<1
Selenium	<1	<1	<1
Silver	<1	<1	1
Zinc	16	10	9

Reference: Williams, R. (22 March 1988, personal communication).

Pilchuck Rivers; and Cherry, Patterson, Woods, French, Allen, and Quilceda Creeks). Only conventional variables are being monitored (i.e., fecal bacteria, nitrate, ammonia, temperature, dissolved oxygen, and water height).

South Port Gardner Area--

The South Port Gardner drainage basin extends from Elliott Point at Mukilteo on the west side to near Federal Avenue in Everett on the east side. The area is drained by 10 separate creeks (see Figure 2). Japanese Gulch and Powder Mill Gulch drain the largest industrial areas around Paine Field.

Drainage area and estimated discharges for the 1-yr storm (24-h storm event with a 1-yr recurrence interval) for major streams and storm drains in the South Port Gardner area are shown in Table 33. Water quality data for these drainages are either unavailable or are limited to analyses of a single base flow sample. The pollutant loadings were calculated from estimated flows and the available chemical data and are shown in Table 34.

In August 1987, Ecology collected water and sediment samples from the five major drainages serving Paine Field and analyzed for priority pollutants and hazardous substances. The five drainages included Big Gulch, Japanese Gulch, Powder Mill Gulch, Stickney Lake, and Swamp Creek. The laboratory results were not available to be included in this report. The final report on the characterization of runoff from the Paine Field Survey will be completed by early July 1988 (Yake, B., 3 June 1988, personal communication).

2.5.2 Storm Drains

The South Port Gardner area is drained by numerous small storm drains along Mukilteo Boulevard in southwest Everett. Within the City of Mukilteo there are only two storm drains that discharge directly into Port Gardner, both located in the northwest corner of Mukilteo. Most of the areas contributing to these Mukilteo Boulevard storm drains are small; consequent-

TABLE 33. DRAINAGE BASIN AREAS AND FLOW ESTIMATES FOR SURFACE RUNOFF DISCHARGES IN SOUTH PORT GARDNER

	Area (ac)	Flow (MGD)
Powder Mill Gulch	1,280	9.4
Pigeon Creek #1	973	6.4
Japanese Gulch	935	5.6
Pigeon Creek #2	900	4.2
Merrill and Ring Creek	800	2.4
Narbeck Creek	450	1.9
Glenwood Creek	400	0.6
Mukilteo Storm Drain #2	326	0.9
Edgewater Creek	200	0.3
Seahurst-Glenhaven Creek	185	1.3
Phillips Creek	105	0.003
Mukilteo Storm Drain #1	47	0.3

Reference: Tetra Tech (1985b).

TABLE 34. LOADING ESTIMATES FOR CONVENTIONAL POLLUTANTS AND SELECTED METALS FROM SURFACE RUNOFF DISCHARGES BASED ON A 1-YR STORM[a]

Source	TSS (lb)	BOD (lb)	Lead+Copper+Zinc (lb)
South Port Gardner			
Powder Mill Gulch	15,000	940	31
Pigeon Creek #1	--	1,470	6
Japanese Gulch	8,400	560	20
Pigeon Creek #2	6,300	420	15
Merrill and Ring Creek	3,600	240	8
Narbeck Creek	2,850	190	7
Glenwood Creek	2,800	60	2
Mukilteo Storm Drain #2	1,350	90	2
Edgewater Creek	450	30	1
Seahurst-Glenhaven Creek	1,950	130	5
Phillips Creek	5	3	<1
Mukilteo Storm Drain #1	450	3	1
Ebey Slough			
Quilceda Creek	--	2,460	--
Allen Creek	--	820	--
Ebey Slough Storm Drain	5,700	380	14
Snohomish River			
Marshland Canal	--	3,520	--
Tidegates	--	3,570	--
Snohomish River near Monroe	--	--	1,100

[a] 1-yr storm is defined as a 24-h storm event with a 1-yr recurrence interval.

ly, discharge would be significantly less than the previously mentioned major creek flows in the area.

Within Marysville there are six storm drain outfalls. Two discharge into Allen Creek near 6th Street and three discharge into Quilceda Creek at 80th Street, 88th Street, and 100th Street. The sixth storm drain, serving an area of about 500 ac on the southwest section of Marysville, discharges into Ebey Slough, west of the Highway 509 bridge (Figure 10). Loading estimates for these drains are presented in Tetra Tech (1985b).

In addition, there are several city and private storm drains that discharge into the Snohomish River, downstream of Preston Point (see Figure 10). However, the size of the areas contributing flows to these storm drains is small, generally less than about 40 ac. Consequently, pollutant loadings are not expected to be significant. Other storm drains discharging to Port Gardner include three main groups (i.e., Port of Everett, City of Everett, and private industries).

Port of Everett storm drains serve facilities at Hewitt Terminal, Norton Terminal, and the North Marina. There are approximately nine small drains that serve the North Marina parking area. Although not shown in Figure 2 (see Section 2.0), all of these storm drains discharge off the southern end of the marina. The city storm drains in the area generally provide drainage only for Norton Avenue and adjacent areas.

Surface runoff drainage from the Scott Paper Mill is discharged via six different outfalls (Figure 11). The north end of the property drains to the Port of Everett storm drain at the head of the East Waterway. Runoff from areas around the paper mill is routed through the primary clarifiers before being discharged from Outfalls SW001 and S003. Runoff from the pulp mill area is discharged directly from Outfall S003. The rest of the property is served by three storm drains.

All runoff from the Weyerhaeuser Kraft Mill area is now routed through the lagoon system and discharged to Steamboat Slough via Outfall WK001. However, runoff from the wood products kraft mill plant is still discharged

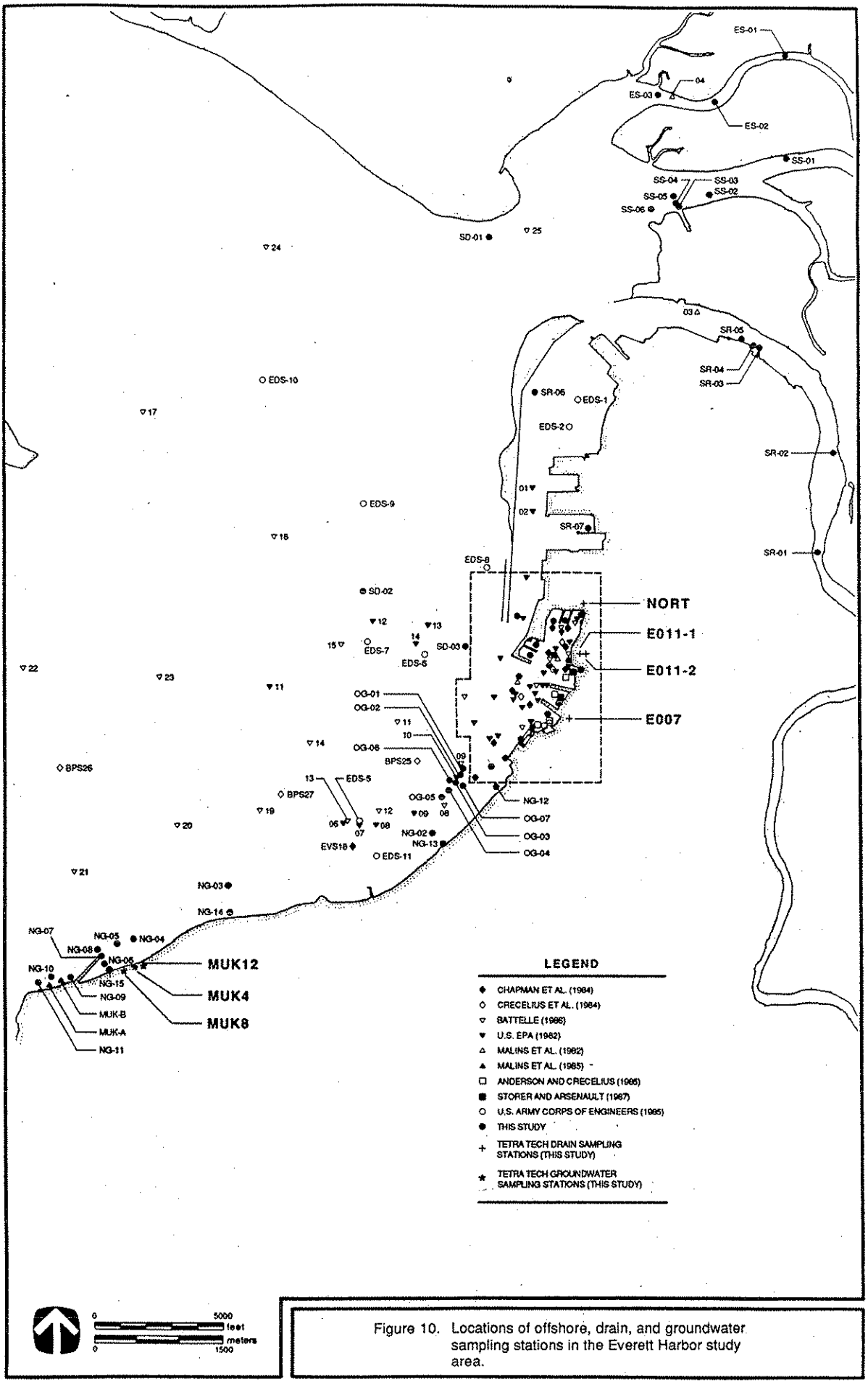


Figure 10. Locations of offshore, drain, and groundwater sampling stations in the Everett Harbor study area.

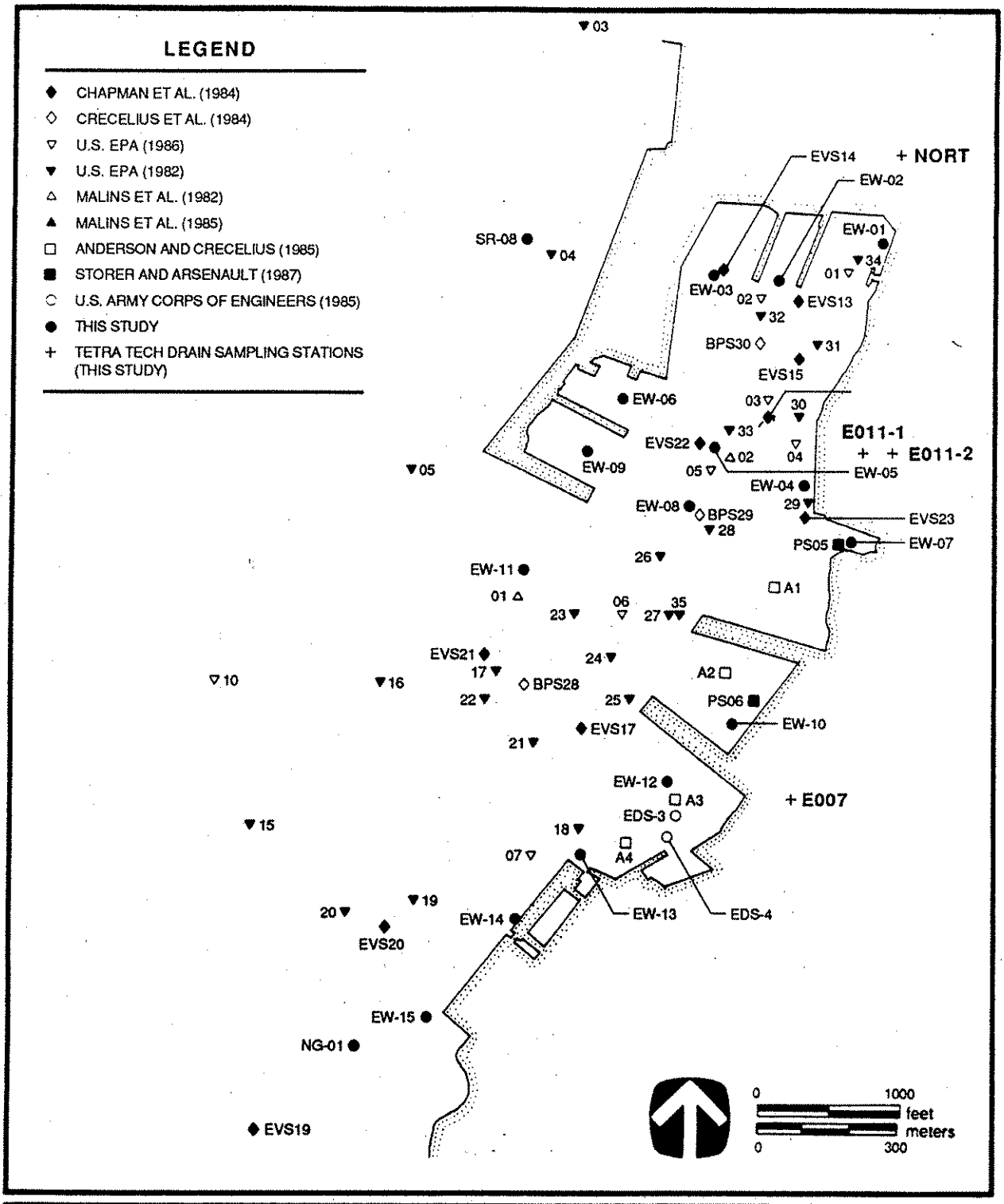


Figure 11. Locations of offshore and drain sampling stations in the East Waterway study segment.

into the Snohomish River. The plant area is reportedly served by 21 separate storm drains (Tetra Tech 1985b).

Data are generally unavailable for all of the aforementioned storm drains. Since the area they serve is minimal and the majority of flow discharged from these drains is mostly dependent upon storm events, the pollutant loading is thought to be insignificant. Further monitoring and sampling programs are needed to confirm this conclusion.

2.6 GROUNDWATER

Groundwater contamination may occur as a result of improper waste disposal practices and accidental spills of chemicals or petroleum products. Although data are limited, available information indicates that the following specific areas have potential for groundwater contamination:

- Tulalip landfill
- Everett landfill
- Mukilteo Defense Fuel Supply Depot
- Boeing Test Facility.

The two landfills are discussed in Section 2.4. Potential groundwater contamination from the remaining two facilities is discussed below.

Mukilteo Defense Fuel Supply Depot--

The Mukilteo Defense Fuel Supply Depot is located in the southwest corner of the study area (see Figure 2). The facility consists of a marine fuel transfer pier, a railroad tank car loading area, and 10 bulk fuel storage tanks that hold aviation gasoline and aviation turbine fuel (JP-4).

The facility conducted a groundwater study in 1982 and 1983 to determine if groundwater contamination is a problem. Results of this study are

presented in Tetra Tech (1985) and are summarized below. Initially, five monitoring wells were installed along the northern boundary of the site, with one additional well placed upgradient of the tanks at the southwest corner of the property. After JP-4 was detected in Wells 4 and 6 in the northeast corner of the facility, near Tanks 9 and 10, an additional six monitoring wells were installed around these tanks to determine the extent of the contamination.

Well 4 contained the greatest contamination, with JP-4 concentrations rapidly increasing from a low of <1 mg/L in September 1982 to a high of 450,000 mg/L in July 1983 (Table 35). Because the monitoring program was discontinued after July 1983, it is not known whether the 450,000 mg/L represents the maximum JP-4 concentration in the plume. There are no data defining the volume of groundwater discharged from the site to Possession Sound. Consequently, pollutant loadings cannot be evaluated.

Tank 10, located at the eastern end of the facility and suspected of leaking JP-4 into the groundwater, was empty at the time of the study and has subsequently remained empty. Although the source of the contamination from this tank was thereby eliminated, cleanup has not occurred at the site. Therefore, the site will be an ongoing source of JP-4 contamination. The Defense Fuel Supply Depot has performed structural repairs on Tank 10, and plans additional adjustments before putting the tank back into use (Randall, B., 9 August 1985, personal communication). Recent activities at this facility, including a more thorough discussion of this leak and a 1987 Hydrogeologic Survey and Remedial Action Planning report, are discussed in Section 2.1.

On 23 October 1986, during fuel barge loading operations, a leak was detected and traced to a section of distribution line, north of the containment wall for Tank 9. Four groundwater samples were collected from three monitoring wells at the Mukilteo Defense Fuel Supply Depot in October 1986 during the Everett Harbor Action Program source investigation (this study). Results from the chemical analysis of these groundwater samples are discussed in Sections 4.0 and 5.0 of this report.

TABLE 35. SUMMARY OF DATA FROM MONITORING WELLS AT THE MUKILTEO DEFENSE FUEL SUPPLY DEPOT

	Well 4	Well 6	Well 9
Benzene (ug/L) (9/82)	100-200	2,000-4,000	NA[a]
Ethyl benzene (ug/L) (9/82)	400-500	200-300	NA
Toluene (ug/L) (9/82)	<10	100-150	NA
Chloroform (ug/L) (9/82)	<10	<10	NA
JP-4 (mg/L) (9/82)	<1	1.1	NA
(5/83)	8,400	72	--
(6/83)	200,000	22	4
(7/83)	450,000	27	--

[a] NA = Not analyzed.

Boeing Test Facility--

The 360-ac Boeing Test Facility is located in the eastern end of the Tulalip Indian Reservation (see Figure 10). A complete discussion of this facility is provided in Section 2.1 (Industrial Facilities).

2.7 ATMOSPHERIC DEPOSITION

Atmospheric deposition of contaminants occurs on land and water surfaces in the Everett Harbor study area. Contaminants contained in the fraction deposited on the land are transported to the waterways via surface water runoff, and are therefore associated with storm drain and CSO discharges in the project area.

According to the Puget Sound Air Pollution Control Agency (PSPCA) records for 1987 (Anderson, J., 8 June 1988, personal communication), total suspended particulates emissions from 13 sources monitored in the study area were 1,615 ton/yr (Table 36). Some of the more commonly found Toxic Air Contaminants (TAC) Emissions in the Everett Harbor study area are summarized in Table 37 (see Appendix G for a complete listing of TAC emissions in the study area).

The Everett tire fire that occurred in 1984-1985 produced a large amount of contamination in the form of atmospheric deposition. The ash (see Section 2.4) contained an average of 5 mg/kg of polycyclic aromatic hydrocarbons (PAHs) and 7 percent heavy metal (zinc) concentrations by weight (SAIC 1985). With the exception of the tire fire, metal loadings to the Everett Harbor study area, by atmospheric deposition are negligible compared with other source inputs.

2.8 SPILLS

Information on accidental spills on land and water in the area is limited. Ecology maintains a file on spill complaints reported by private citizens. These reports usually contain information on the date and location of the spill, a description of what and how much was spilled, and

TABLE 36. SUMMARY OF SOURCE EMISSIONS IN THE EVERETT HARBOR STUDY AREA.

Registration Number	Source	Emission in Tons for 1987						
		SOX[a]	TSP[b]	NOX[c]	PM10[d]	CO[e]	VOC[f]	TAC
21400	Snohomish Co. (Paine Field) Airport	7	9	36	9	730	35	0
13120	Boeing Commercial Airplane (Everett)	55	14	222	13	6,423	860	622
10169	Associated Sand and Gravel Co., Inc.		224	9	38	2	0	3
16000	U.S. Defense Fuel Supply Agency DLA						20	
16338	TIZ's Door Sales, Inc.						12	11
16006	Providence Hospital							1
12164	Scott Paper Co. Northwest Operations	405	455	1,319	371	3,404	223	68
14024	Everett Port Facilities		185		7			
14121	Sound Casket Mfg., Co., Inc.						2	2
11271	Centrecon, Inc.		12		1			
10663	Nord/Jeld-Wen of Everett, Inc.	0	167	10	113	94	5	13
12425	Alpine Retreaders (J&V Investments)						2	2
12754	Weyerhaeuser Co., Kraft Mill	840	549	147	287	993	3	22
	Totals	1,307	1,615	1,743	839	11,646	1,162	744

[a] SOX = Any sulfur oxides.

[b] TSP = Total suspended particulates.

[c] NOX = Any nitrogen oxides.

[d] PM10 = Particulate matter <10 microns in size.

[e] CO = Carbon monoxide.

[f] VOC = Volatile organic compounds.

Reference: Anderson, J. (8 June 1988, personal communication).

TABLE 37. COMMONLY FOUND TAC EMISSIONS IN THE EVERETT HARBOR STUDY AREA

Contaminant	Emission (Tons/day)
Toluene	116.5
Xylene	104.00
Chloroform	43.00
Acetone	12.16
Phenol	7.00
Formaldehyde	5.09
Manganese	4.01
Ammonia	0.80
Nickel	0.34
Chromium	0.016

Reference: Anderson, J. (8 June 1988, personal communication).

the cleanup measures taken. Typically, there is insufficient information available to calculate contaminant loadings.

The U.S. Coast Guard maintains a file on marine spills. Spills were recorded for the study area beginning in 1972 (Linch, Lt. Commander, 14 June 1988, personal communication). Spill information includes the date, location, type of material, and estimated quantity spilled. The reported spills consisted primarily of petroleum products (i.e., gasoline, diesel, fuel oil, jet fuel, and waste oil). However, because the location is given by latitude and longitude to the nearest minute, it is impossible to determine the exact location of the spill. Also, because there is no information on the amount of spilled material recovered from cleanup operations, it is not possible to evaluate total loading of contaminants to the Everett Harbor study area. The Mukilteo Defense Fuel Supply Depot has had a number of fuel spills (see Section 2.1).

3.0 METHODS

The approach used to identify problem sources and link potential sources to offshore problem areas, as well as the techniques used to collect drain sediment and groundwater samples, are described below.

3.1 SOURCE EVALUATION APPROACH

Potential problem sources were identified based on the contaminant concentrations measured in the sediments collected from a limited number of drains (i.e., CSOs and storm drains), and in water collected from monitoring wells. Comparisons between the contaminants found in these onshore samples and the contaminants that were found in sediments from the offshore problem areas were also used to identify sources (PTI and Tetra Tech 1988b). The evaluation of onshore chemical contamination was conducted using data from the Everett Harbor Action Program sampling effort, which focused on three monitoring wells, two combined sewer overflows and one storm drain. Comparisons between potential sources and the receiving environment were based on the Everett Harbor Action Program onshore and receiving environment data, historical data, and additional information obtained from agency files (see Section 2.0).

The identification of problem drains in this report is consistent with the approach used to identify problem areas in the receiving environment of Port Gardner and the lower Snohomish River (PTI and Tetra Tech 1988b). Problem chemicals in each drain have been selected based on either of the following criteria:

- Exceedance of a highest Apparent Effects Threshold (AET) value for chemicals where AETs have been derived
- Elevation above reference (EAR) values greater than 1,000 for chemicals where there are no available AET values.

The EAR technique is a comparison of drain sediment data with offshore receiving environment sediment data collected from reference areas (i.e., noncontaminated areas). EAR values are calculated by dividing the concentration of a contaminant measured in the drain sediments by the concentration of that same contaminant measured in the reference area sediments.

The focus of the AET approach is to identify concentrations of chemical contaminants in sediments that are associated with statistically significant biological effects (relative to reference conditions). Biological indicators used to develop AET values include:

- Depression in abundances of major taxonomic groups of benthic infauna (e.g., Crustacea, Mollusca, Polychaeta)
- Amphipod mortality bioassay using Rhepoxynius abronius
- Oyster larvae abnormality bioassay using Crassostrea gigas
- Microtox bioluminescence bioassay using Photobacterium phosphoreum.

For a given chemical and a specific biological indicator, the AET is the concentration above which statistically significant biological effects occurred in all samples of sediments analyzed.

AET values have been proposed for 64 organic and inorganic toxic chemicals using synoptic chemical and biological data from 200 stations in Puget Sound (Tetra Tech 1987). For each chemical, a separate AET was developed for each biological indicator listed above, resulting in four sets of AET values. A list of the highest (HAET) and lowest AET (LAET) for each chemical is provided in Table 38.

Contaminants for which HAET values are unavailable were selected as problem chemicals if elevated above reference concentrations were more than

TABLE 38. PUGET SOUND AET VALUES
(ug/kg dry weight = ppb for organic compounds;
mg/kg dry weight = ppm for metals)

	Lowest AET	Highest AET
LPAH[a]	5,200	6,100
Naphthalene	2,100	2,400
Acenaphthylene	560	640
Acenaphthene	500	980
Fluorene	540	1,800
Phenanthrene	1,500	5,400
Anthracene	960	1,900
HPAH[b]	12,000	38,000
Fluoranthene	1,700	9,800
Pyrene	2,600	11,000
Benzo(a)anthracene	1,300	4,500
Chrysene	1,400	6,700
Benzofluoranthenes	3,200	8,000
Benzo(a)pyrene	1,600	6,800
Indeno(1,2,3-c,d)pyrene	600	880
Dibenzo(a,h)anthracene	230	1,200
Benzo(g,h,i)perylene	670	5,400
Total PCBs	130	2,500
Total Chlorinated Benzenes	170	680
1,3-Dichlorobenzene	--	--
1,4-Dichlorobenzene	110	260
1,2-Dichlorobenzene	35	50
1,2,4-Trichlorobenzene	31	64
Hexachlorobenzene	70	230
Total Phthalates	3,300	3,400
Dimethyl phthalate	71	160
Diethyl phthalate	--	200
Di-n-butyl phthalate	1,400	1,400
Butyl benzyl phthalate	63	470
Bis(2-ethylhexyl) phthalate	1,900	1,900
Pesticides		
4,4'-DDE	9	15
4,4'-DDD	2	43
4,4'-DDT	3.9	11

TABLE 38. (Continued)

	Lowest AET	Highest AET
Phenols		
Phenol	420	1,200
2-Methylphenol	63	63
4-Methylphenol	670	1,200
2,4-Dimethyl phenol	29	29
Pentachlorophenol	--	--
2-Methoxyphenol	930	930
Miscellaneous Extractables		
Hexachlorobutadiene	120	290
1-Methylphenanthrene	310	370
2-Methylnaphthalene	670	670
Biphenyl	260	270
Dibenzothiophene	240	250
Dibenzofuran	540	540
Benzyl alcohol	57	73
Benzoic acid	650	650
n-Nitrosodiphenylamine	40	220
Volatile Organic Compounds		
Tetrachloroethene	140	140
Ethyl benzene	33	37
Total xylenes	100	120
Metals		
Antimony	3.2	26
Arsenic	85	700
Cadmium	5.8	9.6
Copper	310	800
Lead	300	700
Mercury	0.41	2.1
Nickel	28	49
Silver	5.2	5.2
Zinc	260	1,600

[a] LPAH = Low molecular weight polynuclear aromatic hydrocarbons.

[b] HPAH = High molecular weight polynuclear aromatic hydrocarbons.

Reference: Tetra Tech (1987).

1,000-fold. Drains whose sediments exceeded an HAET value or an EAR of 1,000 for at least one chemical were identified as potential problem sources.

Contaminant concentrations measured in the groundwater samples were compared with available water quality criteria to identify problem chemicals. Available freshwater and saltwater criteria (U.S. EPA 1986) are summarized in Table 39. These values are based on acute and chronic toxicity to aquatic life. Although these ambient water quality criteria are not enforceable standards, they are general guidelines for interpreting water quality data. A groundwater sample that exceeds ambient water quality criteria or standards for a problem chemical may indicate that the area warrants further investigation of potential sources and possible source control actions.

The approach used to link potential contaminant sources to contamination found in the receiving environment sediments was based on the following information:

- Proximity of sources to the problem area in the receiving environment
- Comparison of the available source sediment chemistry and stormwater data from the Everett Harbor initial screening program and the City of Everett's CSO investigation (Mathias, D., 23 May 1988, personal communication) with available offshore sediment data
- Spatial distribution of contaminants in the offshore sediments
- Past or ongoing practices that may have contributed to the contamination observed in the receiving environment.

Contaminant sources (i.e., CSOs, storm drains, spills, groundwater inflow, and waterfront land-use activities) are expected to have greater effects on the areas immediately offshore than on deeper sites. Therefore, the proximity of drain outfalls and waterfront facilities to the problem

TABLE 39. SUMMARY OF U.S. EPA WATER QUALITY CRITERIA (UG/L)

	Freshwater Aquatic Life[a]		Saltwater Aquatic Life[a]	
	Acute Toxicity	Chronic Toxicity	Acute Toxicity	Chronic Toxicity
Metals				
Antimony	(9,000)	(1,600)	[b]	[b]
Arsenic	360	190	69	36
Beryllium	(130)	(5.3)	[b]	[b]
Cadmium	3.9[c]	1.1[c]	43	9.3
Chromium	1,700[c]/16[d]	210[c]/11[d]	(10,300)/1,100[d]	50
Copper	18[c]	12[c]	2.9	2.9
Lead	82[c]	3.2[c]	140	5.6
Mercury	2.4	0.012	2.1	0.025
Nickel	1,400[c]	160[c]	75	8.3
Selenium	260	35	410	54
Silver	4.1[c]	0.12	2.3	[b]
Thallium	(1,400)	(40)	(2,130)	[b]
Zinc	120[c]	110[c]	95	86
Cyanide	22	5.2	1	1
LPAH				
Naphthalene	(2,300)	(620)	(2,350)	[b]
Acenaphthylene	[b]	[b]	[b]	[b]
Acenaphthene	(1,700)	(520)	(970)	(710)
Fluorene	[b]	[b]	[b]	[b]
Phenanthrene	[b]	[b]	[b]	[b]
Anthracene	[b]	[b]	[b]	[b]
HPAH	[b]	[b]	[b]	[b]
Fluoranthene	(3,980)	[b]	(40)	(16)
Pyrene	[b]	[b]	[b]	[b]
Benzo(a)anthracene	[b]	[b]	[b]	[b]
Chrysene	[b]	[b]	[b]	[b]
Total benzofluoranthenes	[b]	[b]	[b]	[b]
Benzo(a)pyrene	[b]	[b]	[b]	[b]
Indeno(1,2,3-c,d)pyrene	[b]	[b]	[b]	[b]
Dibenzo(a,h)anthracene	[b]	[b]	[b]	[b]
Benzo(g,h,i)perylene	[b]	[b]	[b]	[b]
PAH Total	[b]	[b]	(300)	[b]

TABLE 39. (Continued)

	Freshwater Aquatic Life[a]		Saltwater Aquatic Life[a]	
	Acute Toxicity	Chronic Toxicity	Acute Toxicity	Chronic Toxicity
Phenols				
Phenol	(10,200)	(2,560)	(5,800)	b
2,4-Dichlorophenol	(2,020)	(365)	b	b
4-Chloro-3-methyl phenol	(30)	b	b	b
2,4-Dimethylphenol	(2,120)	b	b	b
Pentachlorophenol	20[e]	13[e]	13	(7.9)
2,3,5,6-Tetrachloro-phenol	b	b	b	(440)
2,4,5-Trichlorophenol	b	b	b	b
2,4,6-Trichlorophenol	b	(970)	b	b
Nitrophenols	(230)	(150)	(4,850)	b
2-Chlorophenol	(4,380)	(2,000)	b	b
4-Chlorophenol	b	b	(29,700)	b
Phthalate esters	(940)	(3)	(2,944)	(3.4)
Pesticides				
Aldrin	3.0	b	1.3	b
DDT	1.1	0.001	0.13	0.001
DDE	(1,050)	b	(14)	b
TDE	(0.06)	b	(3.6)	b
Demeton	b	0.1	b	0.1
Dieldrin	2.5	0.0019	0.71	0.0019
Endosulfan	0.22	0.056	0.034	0.0087
Endrin	0.18	0.0023	0.037	0.0023
Guthion	b	0.01	b	0.01
Heptachlor	0.52	0.0038	0.053	0.0036
Hexachlorocyclohexane (Lindane)	2.0	0.06	0.16	b
Malathion	b	0.1	b	0.1
Methoxychlor	b	0.03	b	0.03
Mirex	b	0.001	b	0.001
Parathion	0.065	0.013	b	b
Toxaphene	0.73	0.0002	0.21	0.0002
PCBs	2.0	0.014	10	0.03

TABLE 39. (Continued)

	Freshwater Aquatic Life[a]		Saltwater Aquatic Life[a]	
	Acute Toxicity	Chronic Toxicity	Acute Toxicity	Chronic Toxicity
Volatiles				
Acrylonitrile	(7,550)	(2,600)	b	b
Acrolein	(68)	(21)	(55)	b
Benzene	(5,300)	b	(5,100)	(700)
Trichloromethane (chloroform)	(28,900)	(1,240)	b	b
Tetrachloromethane (carbon tetrachloride)	(35,200)	b	(50,000)	b
1,2-dichloroethane	(118,000)	(20,000)	(113,000)	b
Dichloroethylenes	(11,600)	b	(224,000)	b
Dichloropropanes	(23,000)	(5,700)	(10,300)	(3,040)
Dichloropropenes	(6,060)	(244)	(790)	b
Ethyl benzene	(32,000)	b	(430)	b
Halomethanes	(11,000)	b	(12,000)	(6,400)
Pentachlorinated ethanes	(7,240)	(1,100)	(390)	(281)
Tetrachloroethanes	(9,320)	b	b	b
1,1,2,2-Tetrachloroethane	b	(2,400)	(9,020)	b
Tetrachloroethylene	(5,280)	(840)	(10,200)	(450)
Toluene	(17,500)	b	(6,300)	(5,000)
Trichloroethanes	(18,000)	b	b	b
1,1,1-Trichloroethane	b	b	(31,200)	b
1,1,2-Trichloroethane	b	(9,400)	b	b
Trichloroethylene	(45,000)	(21,900)	(2,000)	b
Miscellaneous Oxygenated Compounds				
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	(0.01)	(0.00001)	b	b
Isophorone	(117,000)	b	(12,900)	b
Organonitrogen Compounds				
Benzidine	(2,500)	b	b	b
Dinitrotoluene	(330)	(230)	(590)	(370)
Nitrobenzene	(27,000)	b	(6,680)	b
Nitrosamines	(5,850)	b	(3,300,000)	b
1,2-Diphenylhydrazine	(270)	b	b	b

TABLE 39. (Continued)

	Freshwater Aquatic Life[a]		Saltwater Aquatic Life[a]	
	Acute Toxicity	Chronic Toxicity	Acute Toxicity	Chronic Toxicity
Chlorinated Aliphatic Hydrocarbons				
Hexachloroethane	(980)	(540)	(940)	[b]
Hexachlorobutadiene	(90)	(9.3)	(32)	[b]
Hexachlorocyclopentadiene	(7)	(5.2)	(7)	[b]
Ethers				
Chloroalkyl ethers	(238,000)	[b]	[b]	[b]
Haloethers	(360)	(122)	[b]	[b]
Chlorinated Aromatic Hydrocarbons				
Chlorinated benzenes	(250)	(50)	(160)	(129)
Chlorinated naphthalenes	(1,600)	[b]	(7.5)	[b]
Dichlorobenzenes	(1,120)	(763)	(1970)	[b]

[a] ( ) = Insufficient data to develop criteria. Value presented is the lowest observed effect level.

[b] No criteria or toxicity thresholds are presented in the water quality criteria documents.

[c] Freshwater quality criteria for some chemicals are a function of hardness. For this table, a criteria concentration based on a hardness value of 100 mg/L calcium carbonate is provided.

[d] The first value is for trivalent chromium (III) and the second value is for hexavalent chromium (VI).

[e] Freshwater quality criteria for some chemicals are a function of pH. For this table, a criteria concentration based on a pH value of 7.8 is provided.

Reference: U.S. EPA (1986).

stations identified in the receiving environment was a major factor in the source evaluations.

The problem chemicals identified in the sources were also compared with the problem chemicals identified in the offshore sediments. If the problem chemicals differed between the source and the offshore sediments, it is unlikely that the source was a major contributor to the contamination problem.

To further evaluate the extent of contaminant contribution from drains or waterfront activities, the relative percent distributions of chemical concentrations were used to compare the offshore sediment samples with the drain sediments. A relative distribution was obtained by calculating the percentage contribution (by concentration) of a particular chemical or compound within a related group of chemicals (e.g., HPAH, LPAH, or metals). Plots of the relative percent distributions were used to compare source sediment samples with offshore sediment samples. If the relative percent distributions of chemicals differed between the source and offshore sediments, it is unlikely that the source was a major contributor to the contamination problem.

Evaluation of the spatial distribution of contaminants in the offshore sediments aids in the identification of sources. For example, widespread contamination in the offshore sediments suggests that there may be multiple sources contributing to the contamination. In addition, concentration gradients, which are frequently apparent in the offshore sediments, can help identify a particular source or sources.

Information obtained from agencies familiar with an area's past or ongoing industrial practices can be used to link sources to problem areas in the receiving environment. Information on industrial practices in the study area has been obtained from Ecology, U.S. EPA, the City of Everett, the Snohomish County Health Department, and the Port of Everett.

Dredging can affect the distributions of contaminants in offshore sediments. Therefore, dredging was considered in the evaluation of the

spatial distribution of contaminants in the problem areas identified in the receiving environment sediment samples. Dredging information compiled for the Everett Harbor study area is presented in Appendix F.

3.2 SOURCE SAMPLING APPROACH

The techniques used to collect and analyze the source samples for this investigation are described below.

3.2.1 Station Locations

Four sediment samples were collected from two CSOs and one storm drain that discharge into the project area (see Figure 10). With the exception of Lift Station #5 CSO (E011), all drains were sampled at a single station located near the mouth of the drain. CSO E011 was sampled at two locations: Manhole 1, the last manhole before the outfall (Sample E011-1) and Manhole 2, the next manhole upstream from Manhole 1 (Sample E011-2).

In addition, four groundwater samples (including one field replicate) were collected from three monitoring wells at the Mukilteo Defense Fuel Supply Depot. The locations of these three monitoring wells are shown in Figure 6 (see Section 2.1.3).

3.2.2 Sample Collection

The Everett Harbor onshore sampling program was conducted between 15 and 29 October 1986. Rainfall for October (2.93 in) was 0.26 in below normal. Rainfall for the preceding month (2.40 in) was 0.34 in above normal. Rainfall data are from the National Climatic Data Center in Asheville, North Carolina (Hughes, J., 15 June 1988, personal communication). Below normal rainfall during the sampling program aided the sampling effort by allowing access to the drains for sediment sample collection and by minimizing disturbances of drain sediment deposits.

Four drains were sampled during the Everett Harbor source sampling effort. A summary of the drain sampling locations and a description of the

sediment samples collected are presented in Table 40. The original sampling plan called for the sampling of six drains. However, Lift Station #2 CSO (E006) and the West Hewitt and Bond Street CSO (E008) were not sampled because 1) of difficulties in reaching manholes at log storage facilities, 2) several manholes were inundated by tidal water (the lowest tide during the study was 2 ft mean lower low water (MLLW), and 3) CSO discharge volumes were expected to be negligible (Tetra Tech 1986d).

Drain sediment samples were collected, using stainless steel scoops and spoons, from sediment deposits in the manhole and/or the drain line at each sampling location (Tetra Tech 1986f). Sampling personnel collected separate duplicate subsamples for volatile organic analyses. These subsamples were placed in 40-cm^3 glass vials while personnel were still in the manhole. Samples for the remaining chemical and physical analyses were placed in a precleaned stainless steel bucket and brought to the surface of the manhole prior to filling sample containers. This procedure minimized the time that the sampling personnel were in the manhole. Samples were homogenized (except those intended for volatile organic analyses) and placed in the following containers for analyses:

- For extractable organic compound analysis, 500 cm^3 of sample were transferred to a precleaned glass jar, equipped with a polytetrafluoroethane-cap liner.
- For metals analysis, 125 cm^3 of sample were transferred to a precleaned glass jar.
- For grain size analysis, 100 cm^3 of sample were transferred to a resealable plastic bag.

In addition to the four sediment samples, four groundwater samples (including one field replicate) were collected from three monitoring wells at the Mukilteo Defense Fuel Supply Depot. A summary of the monitoring wells investigated, the depth at which samples were taken, and observations noted during the sampling effort are presented in Table 41.

TABLE 40. EVERETT HARBOR COMBINED SEWER OVERFLOW AND STORM DRAIN SAMPLING LOCATIONS AND SAMPLE DESCRIPTIONS

Station Name	Sample Location	Date	Type	Sediment Depth	Color	Water Depth	Comments
24 S. Bond St. CSO E007	Manhole off of Bond St., SE of RR bridge	10/15/86	sandy	2 in	brown	-	Sample from ledge above leaping weir
Norton terminal storm drain	Manhole inside fenceline in SE corner of terminal	10/15/86	silt	3-4 in	black	1 in	Strong H_2S smell, very fine-grained oily sediment
Lift Station #5 CSO E011 - Manhole 1	Last manhole before outfall - on Scott Paper Co. property near steam plant	10/29/86	sandy	3 in	brown	1 in	Small trickle of hot water in line
- Manhole 2	Next manhole upstream of Manhole 1, near fuel sinter storage area	10/29/86	fine	4-5 in	black	-	Sediment looked like hog fuel sinter material

TABLE 41. MUKILTEO DEFENSE FUEL SUPPLY DEPOT MONITORING WELLS SAMPLED

Monitoring Well	Sample I.D.	Sample Collection Date	Water Table (Depth Below Surface, ft)	Comments
MW-4[a]	MUK4 MUK4D	10/16/86	8	Strong fuel smell, black greasy sediment at bottom of well, sheen on water.
MW-8	MUK8	10/16/86	8.3	Water clear, no odor, no sheen.
MW-12	MUK12	10/16/86	9.8	Water tan-colored, lots of sediment in sample.

[a] Field duplicate collected from this well.

Originally, four additional monitoring wells (MW-6, MW-7, MW-9, and MW-10) at the fuel depot were scheduled for sampling, but samples could not be collected because the wells had bent casings or were either dry or buried. At least three well volumes were hand-bailed from all sampled wells prior to collecting the samples.

Metals--

The following 11 of the 13 U.S. EPA-priority pollutant metals were analyzed in the four sediment samples and four groundwater samples collected for the source study: antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. The remaining two priority pollutant metals, beryllium, and thallium, were not analyzed because historical data did not suggest that these metals were of concern in the study area. Iron and manganese were also analyzed in the sediment samples.

Upon arrival at the analytical laboratory, the sediment samples were frozen in accordance with PSEP protocols. Sediment samples were prepared by thawing the frozen sediment, and then homogenizing, freeze-drying, and grinding each sample. The sample was then either subjected to a total acid digestion for atomic absorption (AA) analysis, or pressed into a pellet for x-ray fluorescence (XRF) analysis.

Water samples were prepared according to procedures specified in PSEP (Tetra Tech 1986e). Antimony, cadmium, mercury, selenium, and silver were quantified by AA. Arsenic, chromium, copper, iron, lead, manganese, nickel, and zinc were quantified using XRF analysis.

Extractable (Semivolatile) and Volatile Organic Compounds--

An isotope dilution gas chromatography/mass spectrometry (GC/MS) procedure derived from Tetra Tech (1986a) was used to analyze acid and base/neutral extractable compounds. As specified by this procedure, each 80-g homogenized sediment sample was spiked with the stable isotope-labeled analogs of the target compounds. Target compounds without labeled analogs were quantified using the nearest eluting, most chemically similar labeled

compound as a recovery standard. All reported concentrations were corrected for recovery using the isotope dilution technique. Recoveries of isotope-labeled standards were determined by the internal standard technique.

Analyses for 34 volatile organic compounds were performed on all four sediment source samples and on the four groundwater samples. The samples were analyzed for volatile organics using the purge-and-trap GC/MS technique specified in the U.S. EPA Contract Laboratory Program (CLP) protocols.

Six miscellaneous extractable compounds were analyzed in the source samples. Several of these are PAH compounds (2-methylnaphthalene, 1-methylpyrene, dibenzofuran, and dibenzothiophene). In addition, 15 TIO compounds were measured in the source sediment samples (Table 42). These compounds are found during GC/MS analysis and are tentatively identified by searching for a match between the compound's mass spectrum and one of the thousands of mass spectra contained in a computer database. Generally, the largest peaks in the sample chromatograms that do not correspond to target compounds are selected for tentative identification.

Pesticides and PCBs--

Nineteen pesticides (Table 42) were analyzed by gas chromatography/electron capture detection (GC/ECD). The analytical method originally specified to the laboratory is described in Tetra Tech (1986a). This procedure calls for extraction of a 100-g (wet-weight) sample with removal of 20 percent of the extract for GC/ECD analysis of pesticides and PCBs. For this project, a pesticide/PCB sample was extracted separately from the acid and base/neutral sample that was to be analyzed by GC/MS. A 40-g (wet-weight) aliquot was extracted and processed according to the protocol. Both quantitation and confirmation were performed using packed columns and U.S. EPA CLP protocols, rather than the capillary columns originally specified in Tetra Tech (1986a). Most of the sample extracts were diluted to minimize interference from nontarget compounds.

Sediment samples were analyzed for total PCBs, while the groundwater samples were analyzed for individual Aroclor mixtures. Analyses of PCBs in

TABLE 42. LIST OF CONTAMINANTS AND CONVENTIONAL VARIABLES MEASURED DURING THE EVERETT HARBOR STUDY

Low Molecular Weight PAH
- naphthalene[a]
- acenaphthylene[a]
- acenaphthene[a]
- fluorene[a]
- phenanthrene[a]
- anthracene[a]

High Molecular Weight PAH
- fluoranthene[a]
- pyrene[a]
- benzo(a)anthracene[a]
- chrysene[a]
- benzofluoranthenes (b and k)[a]
- benzo(a)pyrene[a]
- indeno(1,2,3-c,d)pyrene[a]
- dibenzo(a,h)anthracene[a]
- benzo(g,h,i)perylene[a]

Total PCBs[a]

Neutral Halogenated Compounds
- 1,2-dichlorobenzene[a]
- 1,3-dichlorobenzene[a]
- 1,4-dichlorobenzene[a]
- 1,2,4-trichlorobenzene[a]
- hexachlorobenzene (HCB)[a]
- 2-chloronaphthalene[a]
- hexachlorobutadiene[a]
- hexachloroethane[a]

Phthalate Esters
- dimethyl phthalate[a]
- diethyl phthalate[a]
- di-n-butyl phthalate[a]
- butyl benzyl phthalate[a]
- bis(2-ethylhexyl)phthalate[a]
- di-n-octyl phthalate[a]

Pesticides
- p,p'-DDE[a]
- p,p'-DDD[a]
- p,p'-DDT[a]
- aldrin[a]
- chlordane[a]
- dieldrin[a]
- endrin[a]
- endosulfan I[a]
- endosulfan II[a]
- endosulfan sulfate[a]
- endrin ketone
- heptachlor[a]
- hepachlor epoxide[a]
- alpha-HCH[a]
- beta-HCH[a]
- delta-HCH[a]
- gamma-HCH[a] (lindane)
- methoxychlor[b]
- toxaphene[a]

Phenol and Alkyl-Substituted Phenols
- phenol[a]
- 2-methylphenol
- 4-methylphenol
- 2,4-dimethylphenol[a]
- 4-chloro-3-methylphenol

Chlorinated Phenols/Guaiacols
- 2-chlorophenol[a]
- 2,4-dichlorophenol[a]
- 2,4,6-trichlorophenol[a]
- 2,4,5-trichlorophenol[b]
- 2,3,4,6-tetrachlorophenol[b]
- pentachlorophenol[a]
- 3,4,5-trichloroguaiacol
- 4,5,6-trichloroguaiacol
- tetrachloroguaiacol

Resin Acids
- abietic acid
- dehydroabietic acid
- 12-chlorodehydroabietic acid
- 14-chlorodehydroabietic acid
- dichlorodehydroabietic acid
- isopimaric acid
- neoabietic acid
- sandaracopimaric acid

Nitrogen-Containing Compounds
- N-nitrosodi-n-propylamine[a]
- N-nitrosodiphenylamine[a]
- nitrobenzene[a]
- 2-nitrophenol[a]
- 4-nitrophenol[a]

TABLE 42. (Continued)

- 2,4-dinitrophenol[a]
- 4,6-dinitro-2-methylphenol
- 4-chloroaniline[b]
- 2-nitroaniline
- 3-nitroaniline
- 4-nitroaniline
- 2,4-dinitrotoluene[a]
- 2,6-dinitrotoluene[a]
- 3,3'-dichlorobenzidine[a]

Halogenated Ethers
- bis(2-chloroethyl)ether[a]
- bis(2-chloroisopropyl)ether[a]
- bis(2-chloroethoxy)methane[a]
- 4-chlorophenyl phenyl ether[a]
- 4-bromophenyl phenyl ether[a]

Miscellaneous Extractables and Tentatively Identified Organic Compounds
- benzyl alcohol
- benzoic acid[b]
- dibenzofuran
- 2-methylnaphthalene
- isophorone[a]
- hexachlorocyclopentadiene[a]
- 1-methylpyrene[c]
- retene[c]
- cymene (unspecified isomer)[c]
- dibenzothiophene[c]
- 1,2,4-trithiolane[c]
- diterpenoid hydrocarbon[c] (base peak 255)
- diterpenoid alcohol[c] (base peak 271)
- hexadecanoic acid[c]
- hexadecanoic acid methyl ester[c]
- hexadecenoic acid methyl ester[c]
- cholesterol[c]
- campesterol[c]
- alkanol (unidentified)[c]
- base peak 181, isomer #1[c]
- base peak 181, isomer #2[c]

Volatile Organic Compounds
- acetone
- benzene
- bromodichloromethane
- bromoform
- bromomethane
- 2-butanone
- carbon disulfidecarbon tetrachloride
- chlorobenzene
- chloroethane
- 2-chloroethylvinyl ether
- chloroform
- chloromethane
- dibromochloromethane
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1-dichloroethene
- trans-1,2-dichloroethene
- 1,2-dichloropropane
- cis-1,3-dichloropropene
- trans-1,3-dichloropropene
- ethylbenzene
- 4-methyl-2-pentanone
- 2-hexanone
- styrene
- 1,1,2,2-tetrachloroethane
- tetrachloroethene
- 1,1,1-trichloroethane
- 1,1,2-trichloroethane
- trichloroethene
- toluene
- total xylenes
- vinyl acetate
- vinyl chloride

Metals
- antimony[a]
- arsenic[a]
- cadmium[a]
- chromium[a]
- copper[a]
- iron
- lead[a]
- manganese
- mercury[a]
- nickel[a]
- selenium[a]
- silver[a]
- zinc[a]

Conventional Variables
- total solids
- percent fine-grained material

[a] U.S. EPA priority pollutant.
[b] U.S. EPA hazardous substance list compound.
[c] Tentatively identified organic compound.

extracts were performed using two instrumental methods: GC/ECD, and GC/MS with limited mass scanning. Only GC/ECD analyses were originally scheduled for these samples. However, a review of the GC/ECD data indicated that sample interferences detracted from the reliability of the qualitative and quantitative results. The instrumentation and quantification methods for GC/ECD analysis described in Tetra Tech (1986a) were followed with several exceptions. Most notably, external standard quantification was used, rather than the recommended internal standard method; peak heights were used rather than peak areas; and a single-point calibration was used, rather than a 5-point calibration. A peak-by-peak, modified Webb-McCall technique was used to quantify PCBs. GC/MS analyses were performed with a 30-m DB-5 fused silica capillary column. The congener standard containing representative compounds differed slightly from the recommendations of Tetra Tech (1986a) and U.S. EPA Method 680. 2,4-Dichlorobiphenyl was used rather than 2,3-dichlorobiphenyl; 2,4,6-trichlorobiphenyl was used rather than 2,4,5-trichlorobiphenyl; 2,2',3,4',5,6'-hexachlorobiphenyl was used rather than 2,2',4,4',5,6'-hexachlorobiphenyl; 2,2',3,4,5,6,6'-heptachlorobiphenyl was used rather than 2,2',3,4',5,6,6'-heptachlorobiphenyl; and 2,2',3,3',5,5'-,6,6',-octachlorobiphenyl was used rather than 2,2',3,3',4,5',6,6'-octachlorobiphenyl. A separate standard was used to establish retention time windows for selected ion monitoring.

Pulp Mill Compounds--

The four source sediment samples were analyzed for selected compounds related to pulp mill processes (i.e., resin acids and chlorinated phenols/guaiacols). However, standard procedures for analysis of resin acids and chlorinated phenols/guaiacols in sediments were not available. Therefore, analytical methods for these compound classes were developed and validated in conjunction with Laucks Testing Laboratory in Seattle, WA (PTI and Tetra Tech 1988b). Resin acids were analyzed by full-scan GC/MS and chlorinated phenolic compounds were analyzed by GC/MS-SIM (Selected Ion Monitoring).

Ancillary Analyses--

Total solids and grain size were the only conventional variables measured in the source sediment samples. The procedures used for grain size and total solids determinations were in accordance with PSEP recommendations (Tetra Tech 1986e).

3.2.3 Chemical Analyses

The contaminants measured during the onshore source investigation were generally identical to those contaminants analyzed in the offshore sediments (PTI and Tetra Tech 1988b). This facilitated comparisons between variables measured in the two sampling efforts.

Data for 143 analytes, including 80 U.S. EPA priority pollutants and 5 additional organic compounds listed in the hazardous substance list were reported for the source sediment samples collected during the Everett Harbor Action Program (see Table 42). In addition, 2 conventional sediment quality variables (grain size and total solids) and 15 tentatively identified organic (TIO) compounds were measured.

The groundwater samples were analyzed for the same compounds as the sediment samples, with the exception of the conventional variables, iron, manganese, resin acids, chlorinated phenols and guaiacols, and the TIOs.

Most of the analytes of interest mentioned above have at least one of the following two properties: 1) they bioaccumulate, possibly with adverse biological effects in the food chain, or 2) they produce adverse biological effects even when not bioaccumulated. U.S. EPA-priority pollutants discharged into the study area are identified in Table 42 (see Section 3.2.2). Certain compounds that are not U.S. EPA-priority pollutants have been measured because of their local significance. For example, of particular interest are those substances that may be associated specifically with pulp mills, such as resin acids and chlorinated phenolic compounds.

Analytical procedures specified in Puget Sound Estuary Program (PSEP) protocols (Tetra Tech 1986e) were used to analyze both the source and offshore sediments. The PSEP protocols were developed to promote the use of acceptable and comparable methods when measuring contaminants in Puget Sound. In addition, the protocols provide guidelines to assess the quality of data obtained from different laboratories or determined by different analytical techniques.

3.2.4 Quality Assurance/Quality Control

Reviews of source sediment chemical data were performed in accordance with PSEP guidelines (Tetra Tech 1986e). Quality assurance/quality control (QA/QC) reviews of analytical results included assessments of accuracy [using standard reference materials (SRM), matrix spike, and/or surrogate recovery data] and precision (using data from analytical replicates). QA/QC reviews also evaluated initial and ongoing calibration and tuning, blank results, sample holding times, and tests of initial performance or other validation data for certain non-CLP procedures.

Detailed QA/QC reports concerning the chemical analyses were prepared and compiled in Tetra Tech (1988a). These reports are not reproduced in this section, but are summarized below. A complete description of the qualifiers used in this study is provided in Appendix A.

Metals--

The metals data are considered acceptable as qualified. Because laboratory control limits for precision were exceeded for antimony, all positive antimony data are considered to be estimated and were assigned an "E" qualifier. Because the SRM analyzed was not certified for silver or selenium, an accuracy assessment could not be made for these two analytes in the sediment samples.

Assessment of the Effect of Analytical Procedures on Metals Results--

The analytical methods used to determine metals in this study were designed to measure the total concentrations of metals in sediments, in contrast to methods that involve partial digestion. A small study was conducted to examine the implications of using the "total metals" methods (per PSEP protocols), especially when comparing results to reference area data (e.g., reference data from Carr Inlet) generated by "strong acid" methods, per U.S. EPA CLP. Two archived Carr Inlet samples collected during the Commencement Bay Remedial Investigation (Tetra Tech 1985a) were analyzed in triplicate using the "total metals" method from the present study, and the "strong acid" method used during the Commencement Bay study. In addition, selected samples collected during the Elliott Bay sampling effort (PTI and Tetra Tech 1988a) were analyzed by the "total metals" and "strong acid" methods for comparison purposes. The results of that comparison are presented in PTI and Tetra Tech (1988a) and are summarized below.

Differences were observed for a number of metals analyzed by both methods. However, the largest and most consistent differences were observed for chromium. In both Carr Inlet samples, mean chromium concentrations by "total metals" methods (in this case, XRF) were more than 4 times the mean concentrations determined by the "strong acid" technique. Results from samples from Port Susan and Elliott Bay/Duwamish River, with higher overall chromium concentrations, were generally a factor of 2 greater when analyzed by "total metals" methods than when "strong acid" methods were used.

Differences between antimony results by "total metals" vs. "strong acid" methods could not be determined for Carr Inlet samples because antimony was consistently undetected by the "strong acid" procedure. However, concentrations of antimony reported for Samples CR-11 and CR-13 using "strong acid" methods during the Commencement Bay Remedial Investigation were approximately 15 times lower than the "total metals" values. Similarly, for Duwamish River offshore sediment samples WW-12 and EW-15 collected during the Elliott Bay study (PTI and Tetra Tech 1988a), the "total metals" procedure [including hydrogen fluoride digestion and analysis by gas furnace atomic absorption (GFAA)] resulted in concentrations 10-20 times

higher than concentrations determined by the "strong acid" procedure. This marked discrepancy prompted reanalysis of the Elliott Bay samples by an independent and more reliable technique for antimony (i.e., XRF). Comparisons between XRF and the "total metals" procedure used in the Elliott Bay study (PTI and Tetra Tech 1988a) suggest that antimony concentrations observed during that study could be considerable overestimates (e.g., by a factor of 5).

The XRF analysis of antimony aroused sufficient uncertainty about the "total metals" antimony concentrations reported in this study that antimony data were not used to define or rank problem areas in the receiving environment. However, antimony distributions are described in PTI and Tetra Tech (1988b) and are used in the evaluation of sources because of their potential value in assessing relative antimony contamination in Everett Harbor.

Extractable (Semivolatile) and Volatile Organic Compounds--

The data for extractable organic compounds are considered acceptable as qualified. The analytical laboratory followed PSEP-specified protocols (Tetra Tech 1986e) with the following exception:

- Benzoic acid levels in one of four blanks exceeded the PSEP control limit of 2.5 ug total (Tetra Tech 1986e). Benzoic acid values for the source sample associated with this blank were qualified with an "E" after blank correction.

The data for volatile organic compounds are acceptable with the exception of data for methylene chloride. Methylene chloride values were rejected because of excessive blank contamination.

Pesticides and PCBs--

Many samples analyzed for chlorinated pesticides required dilution because of interferences. This resulted in higher detection limits than those specified in Tetra Tech (1986d). In addition, because of sample

dilutions, no precision and accuracy data were obtained for the pesticide/PCB analyses. However, the review of calibration data suggested that the analytical instrument was operating within acceptable limits. Data qualifiers were not assigned to positive pesticide results.

Source sediment samples were analyzed for total PCBs and groundwater samples were analyzed for individual Aroclor mixtures. All sample data for total PCBs are considered acceptable when qualified as estimates. Qualification was necessary because only single-point calibration was used for quantification. All concentrations greater than 50 ug/kg were determined by GC/MS analyses, because of interferences encountered during GC/ECD analyses. Extracts for GC/MS analysis were held longer than the 40-day holding time specified in U.S. EPA CLP protocols. The extended extract holding time might have resulted in either an underestimate or an overestimate of original sample concentrations. An underestimate may have resulted from degradation of PCBs, but such degradation would not be expected because of the well-documented stability of this class of compounds (Hutzinger et al. 1974). However, an overestimate of the PCB concentration may have resulted from loss of solvent volume in the extract to evaporation.

Pulp Mill Compounds--

Overall, data for resin acids and chlorinated phenols/guaiacols are considered acceptable. Palustric acid data were rejected based on 0 percent recoveries in both matrix spikes. Data were qualified with an E for several possible reasons: 1) data were reported at a concentration corresponding to less than half the lowest calibration standard; 2) data were associated with an ongoing calibration that was outside PSEP limits; or 3) the interpretation of the mass spectrum was questionable.

Ancillary Analyses--

The overall quality of the total solids and grain size data is acceptable. The accuracy of the method for sediment grain size analysis (Tetra Tech 1986e) has not been assessed by the use of SRMs. Recovery is examined by comparing the sum of the fraction weights with the calculated

total weight of the sample prior to fractionation. This initial weight is calculated using a percent solids value obtained from a separate solids determination. Recoveries for the onshore samples are acceptable. Precision was also acceptable for the samples.

4.0 CHARACTERIZATION OF ONSHORE SAMPLES

The results from the analyses of the Everett Harbor Action Program onshore samples are presented in Appendix A. For sediment samples, analytical concentrations of metals are in mg/kg dry weight and organic compounds are reported in ug/kg dry weight. Unless otherwise noted, all sediment concentrations are reported in dry weight. For groundwater samples, all units are ug/L. Data qualifiers are included with concentrations throughout this report. A complete description of data qualifiers is presented in Appendix A.

4.1 DRAIN SEDIMENTS

Four drain sediment samples were collected during the onshore sampling effort. One sample (E007) was taken from CSO E007, two samples (E011-1 and E011-2) were taken from Manholes 1 and 2, respectively, on CSO E011, and one sample (NORT) was taken from the Norton Terminal SD. The locations of these drain sampling points, as well as the approximate locations of the drain outfalls, are shown in Figure 4 (see Section 2.1).

4.1.1 Conventional Sediment Characteristics

The grain size characteristics of the drain sediment samples are presented in Appendix A. Three of the four drains contained sediments that were primarily sand. The fourth drain, the Norton Terminal SD, contained sediment that was sandy silty clay. Drain sediments typically contain more coarse-grained materials than fine-grained materials because the fine-grained particles are flushed out of the drain rather than deposited. In general, the sediments from the drains were more coarse-grained than the sediments from nearby offshore stations (Appendix D).

Total organic carbon, total nitrogen, and total sulfide contents of the drain sediments were not measured in this study. Data for total solids content are presented in Appendix A.

Because contaminants are frequently associated with the fine-grained materials (i.e., silts, clays) and organic matter contained in sediments, normalization to grain size and total organic carbon content is commonly used to compare data from different stations. Alternatively, the relative percent distribution of contaminants within a group of related chemicals can be used to compare sediments from different stations. This latter approach has been used in Section 5.1 of this report to compare the relative distributions of metals, LPAH compounds, and HPAH compounds in various sediments. Direct comparisons of contaminant concentrations between sediments from different stations have generally not been made. For contaminants other than metals, LPAH, and HPAH, the comparisons between drain sediments and offshore sediments have been based on the problem chemicals in both sediments.

4.1.2 Problem Chemicals in Drain Sediments

HAET values were used to identify problem chemicals in the drain sediments. For chemicals without established AET values, an EAR of 1,000 was used to identify a problem chemical. Such an approach was used to identify problem chemicals in the receiving environment sediments (PTI and Tetra Tech 1988b). However, of the chemicals found in the drain sediments for which an AET had not been established, none had an EAR greater than 1,000. In fact, no chemical in any of the four drain sediments had an EAR greater than 1,000, and only one chemical (zinc in the sediment from Manhole 2 of CSO E011) had an EAR of greater than 500 (Appendix E).

The use of HAET to identify nickel, chromium, and antimony as problem metals in drain sediments merits further discussion. AET values for nickel have been established using a database that contains a relatively limited range of concentrations (PTI and Tetra Tech 1988a). Therefore, past analyses of data relating to Elliott Bay and Everett Harbor have used 90th percentile concentrations to identify nickel as a problem chemical. Such an

approach is not possible for the Everett Harbor drain sediments because of the limited number of samples, so HAET values have been used instead.

As discussed in Section 3.2.4 of this report, comparisons of chromium and antimony data from this study with similar data from past studies is difficult because of differences in laboratory analytical procedures. The concentrations of chromium reported in the Everett Harbor drain sediments may be overestimated by a factor of 2 to 4 when compared to the data reported for the Carr Inlet reference area (see Section 3.2.4). However, the concentrations of chromium in all four of the Everett Harbor drain sediments exceeded the HAET concentration by a factor of 2 to 4, and chromium was therefore considered a potential problem chemical in all four sediments. Similarly, the concentrations of antimony in the four Everett Harbor drain sediments may be overestimated by a factor of 5 or more when compared to the data reported for Carr Inlet. However, antimony was not found at concentrations exceeding HAET in any of the four Everett Harbor drain sediments, and was consequently not identified as a problem chemical in those sediments.

Table 43 lists the problem chemicals found in the four Everett Harbor study area drain sediments. Chromium was the only problem chemical identified in all four drain sediments. Nickel was a problem chemical in three of the drain sediments. Dibenzofuran was a problem chemical in two of the drain sediments. All other problem chemicals were identified in only one of the drain sediments.

Sediment samples E011-1 and E011-2 were collected from two manholes approximately 200 ft apart on CSO E011. (Manhole 2 is upstream of Manhole 1). Similarities between the two samples are not as great as might be expected, given their proximity to each other. Both samples contained a greater number of problem chemicals than the samples from the other drains. Chromium and dibenzofuran were problem chemicals in both the samples. However, there were some noteworthy differences between the two samples. The sediment from Manhole 1 (E011-1) was brown in color (Tetra Tech 1986b) and coarse-grained (93 percent sand; see Appendix A). In contrast, the sediment from Manhole 2 (E011-2) was black (Tetra Tech 1986b) and fine-grained (57 percent sand, 30 percent clay; see Appendix A). Both sediments

TABLE 43. PROBLEM CHEMICALS IDENTIFIED IN EVERETT HARBOR STUDY AREA DRAIN SEDIMENTS[a]

Drain Sediment	Number of Problem Chemicals	Problem Chemicals Identified
E007	3	Chromium[b], nickel[c], DDT[d]
E011-1	6	Chromium[b], acenaphthene[d], LPAH[d,e], 4-methylphenol[d], benzoic acid[d], dibenzofuran[d]
E011-2	8	Chromium[b], nickel[c], cadmium[d], zinc[d], naphthalene[d], dibenzofuran, dimethyl phthalate[d], acenaphthylene[d],
NORT	2	Chromium[b], nickel[c]

[a] Defined by exceedance of HAET concentration.

[b] Concentrations of chromium may be overestimated by a factor of 2 to 4. See Section 4.1.2 and Section 3.2.4.

[c] The HAET for nickel has been established using a relatively limited range of concentrations. See Section 4.1.2.

[d] The concentration of this chemical was the highest measured in the four drain sediments.

[e] LPAH is defined as the sum of naphthalene, acenaphthylene, acenaphthene, flourene, phenanthrene, and anthracene.

contained LPAH compounds, but at dissimilar concentrations, which resulted in the identification of different LPAH compounds as problem chemicals in the two sediments. Problem chemicals that were identified in Sample E011-1 and not Sample E011-2 included acenaphthene, total LPAH, 4-methylphenol, and benzoic acid. However, benzoic acid was undetected in the E011-2 sediment at a detection limit that exceeded HAET. Problem chemicals that were found in Sample E011-2 and not Sample E011-1 include nickel, cadmium, zinc, naphthalene, acenaphthylene and dimethyl phthalate. These differences may be the result of multiple contaminant sources within the drainage basin, or may be attributable to the differences in the grain sizes of the two samples.

Table 44 contains the list of chemicals that were undetected in the four drain sediments, but had detection limits greater than or equal to the HAET concentration. These chemicals could have been present in the sediments at levels exceeding the HAET, but it is impossible to determine if they actually were. Consequently, they have not been listed as problem chemicals.

4.2 GROUNDWATER SAMPLES

As part of the onshore sampling effort for this study, four groundwater samples were collected from three monitoring wells at the Mulkilteo Defense Fuel Supply Depot. A sample and field duplicate (MUK 4 and MUK 4D) were collected from monitoring Well 4. The third sample (MUK8) was collected from monitoring Well 8, and the fourth sample (MUK12) was collected from monitoring Well 12. The locations of these sampling points are shown in Figure 6 (see Section 2.1.3). These four samples were collected because of suspected leakage of JP-4 jet fuel from Tank 10 at the depot (Tetra Tech 1986b).

The results from the analysis of these samples are presented in Table 45, along with the U.S. EPA freshwater quality criteria for aquatic life. The criteria do not represent enforceable standards, which are instead established by the State of Washington in WAC 173-201-047. Additionally, the criteria presented in Table 45 apply to surface waters, not groundwater. They are presented for comparison purposes only, to provide a general, qualitative description of acceptable water quality.

TABLE 44. CHEMICALS UNDETECTED IN THE EVERETT HARBOR STUDY AREA DRAIN SEDIMENTS WITH DETECTION LIMITS ≥ HAET CONCENTRATIONS

Drain Sediment	Undetected Chemicals With Detection Limits ≥ HAET
E007	None
E011-1	2-Methylphenol; 2,4-dimethylphenol; 1,2-dichlorobenzene; 1,2,4-trichlorobenzene; benzyl alcohol
E011-2	2-Methylphenol; 2,4-dimethylphenol; 1,2-dichlorobenzene; benzoic acid; benzyl alcohol
NORT	2-Methylphenol; 2,4-dimethylphenol; 1,2,4-trichlorobenzene; benzyl alcohol

TABLE 45. SUMMARY OF RESULTS FROM ANALYSIS OF GROUNDWATER AT MUKILTEO DEFENSE FUEL SUPPLY DEPOT OCTOBER 1986[a]

	Wells (ug/L)				U.S. EPA (1986) Freshwater Quality Criteria (AquaticLife) (ug/L)	
	MUK 4	MUK 4D[b]	MUK 8	MUK 12	Acute	Chronic
Antimony	2.7	4.1	8.1	5.4	9,000[d]	1,600[d]
Arsenic	3.04	2.35	5.79	1.00	360	190
Cadmium	0.144	0.098	0.0808	0.0284	3.9[e]	1.1[e]
Chromium	6.13	6.07	7.65	1.66	1,700[e]/16[f]	210[e]/11[f]
Copper	E10.2	E6.69	E14.7[c]	E2.18	18[e]	12[e]
Lead	12.3[c]	1.23	7.08[c]	1.83	82[e]	3.2[e]
Mercury	E0.03[c]	E0.004	E0.0003	E0.0008	2.4	0.012
Nickel	7.24	6.82	14.5	1.21	1,400[e]	160[e]
Silver	0.0655	0.125[c]	0.0198	0.0083	4.1[e]	0.12
Zinc	18.0	19.6	22.7	3.60	120[e]	110[e]
Acenaphthene	30	21	U10	U10	1,700[d]	520[d]
Fluorene	26	15	U10	U10	[g]	[g]
Phenanthrene	27	11	U10	U10	[g]	[g]
Anthracene	E4	E2	U10	U10	[g]	[g]
Fluoranthene	16	10	U10	U10	3,980[c]	[g]
Pyrene	12	E7	U10	U10	[g]	[g]
Benzo(a)anthracene	U10	E2	U10	U10	[g]	[g]
Chrysene	U10	E2	U10	U10	[g]	[g]
Benzo(b+k)fluoranthenes	U10	2	U10	U10	[g]	[g]
Benzo(a)pyrene	U10	2	U10	U10	[g]	[g]
Dibenzofuran	17	11	U10	U10	[g]	[g]
Benzene	E7	E4	U5	U5	5,300[d]	[g]
2-Methylnaphthalene	14	U10	U10	U10	[g]	[g]
LPAH	E110	E69	U60	U60	[g]	[g]
HPAH	L98	E55	U90	U90	[g]	[g]

[a] This table lists only contaminants that were detected. All other analyzed contaminants were undetected at relatively low detection limits (see Appendix A).

[b] D = field duplicate.

[c] Concentration exceeds chronic criteria.

[d] Insufficient data to develop criteria. Value presented is the lowest observed effect level (LOEL).

[e] Hardness dependent criteria (100 mg/L used).

[f] The first value is for trivalent chromium (III) and the second value is for hexavalent chromium (VI).

[g] No criteria or toxicity thresholds are presented in the water quality documents.

E = Concentration listed is an estimated value.

L = Concentration is less than the maximum shown.

U = Chemical was undetected. Number shown is the analytical detection limit for the chemical.

In the water from monitoring Well 8, the concentration of copper exceeded the U.S. EPA chronic criterion. Water from monitoring Wells 4 and 8 contained concentrations of lead which exceeded the chronic criterion. Concentrations of mercury and silver in the water from monitoring Well 4 exceeded the chronic criterion (Table 45).

Freshwater criteria are not available for many of the organic compounds found in the four groundwater samples, but the samples typically contained low concentrations of organic compounds. The chemicals not listed in Table RS11 were undetected at relatively low detection limits (Appendix A). However, the results presented in Table 45 should not be used to infer that the groundwater in the area is uncontaminated. Monitoring Well 4 contained water (Samples MUK 4 and MUK 4D) with a strong fuel odor and a visible surface sheen, and monitoring Well 7 contained a tan-colored oily substance that leaked out of the sampling bailer and could not be sampled (Tetra Tech 1986b).

Fuels such as those stored at the Mulkilteo facility contain varying amounts of PAH compounds. Although certain PAHs were found in the groundwater samples, laboratory analyses for lighter hydrocarbons (e.g., alkanes) or specific fuels were not conducted. Therefore, the presence of fuels or petroleum-related materials in the groundwater samples may not be reflected in the results presented in Table 45.

5.0 SOURCE EVALUATIONS

Problem area identification and prioritization in the Everett Harbor study area was based on a series of chemical and biological indices (PTI and Tetra Tech 1988b). These indices were used to relate conditions at stations within the study area to reference conditions in relatively uncontaminated embayments of Puget Sound. Study areas with sediments that contained high concentrations of chemicals and exhibited adverse biological effects received a ranking of "high priority" for evaluation of contaminant sources and remedial actions.

In the following sections, available information on potential sources of contamination (e.g., CSOs, SDs, groundwater, industrial facilities, wastewater treatment plants, etc.) and offshore sediment data were evaluated in order to link sources to problem areas in the receiving environment. Evaluations of potential sources were completed for the two problem areas (East Waterway and nearshore Port Gardner; Figure 12) identified in PTI and Tetra Tech (1988b). Evaluations of potential sources of contamination were also performed for the six individual problem stations (SR-05, SD-03, ES-03, OG-01, SD-01, and SR-07; Figure 12) that were located outside the two problem areas (PTI and Tetra Tech 1988b). Five main factors were considered in the evaluations:

- Proximity of the potential source to the problem station offshore
- Similarity of problem chemicals in onshore samples and offshore sediments (where chemical data for potential sources were available)
- Similarity of the relative percent distribution of chemicals within the drain and receiving environment sediments (where drain sediment data were available)

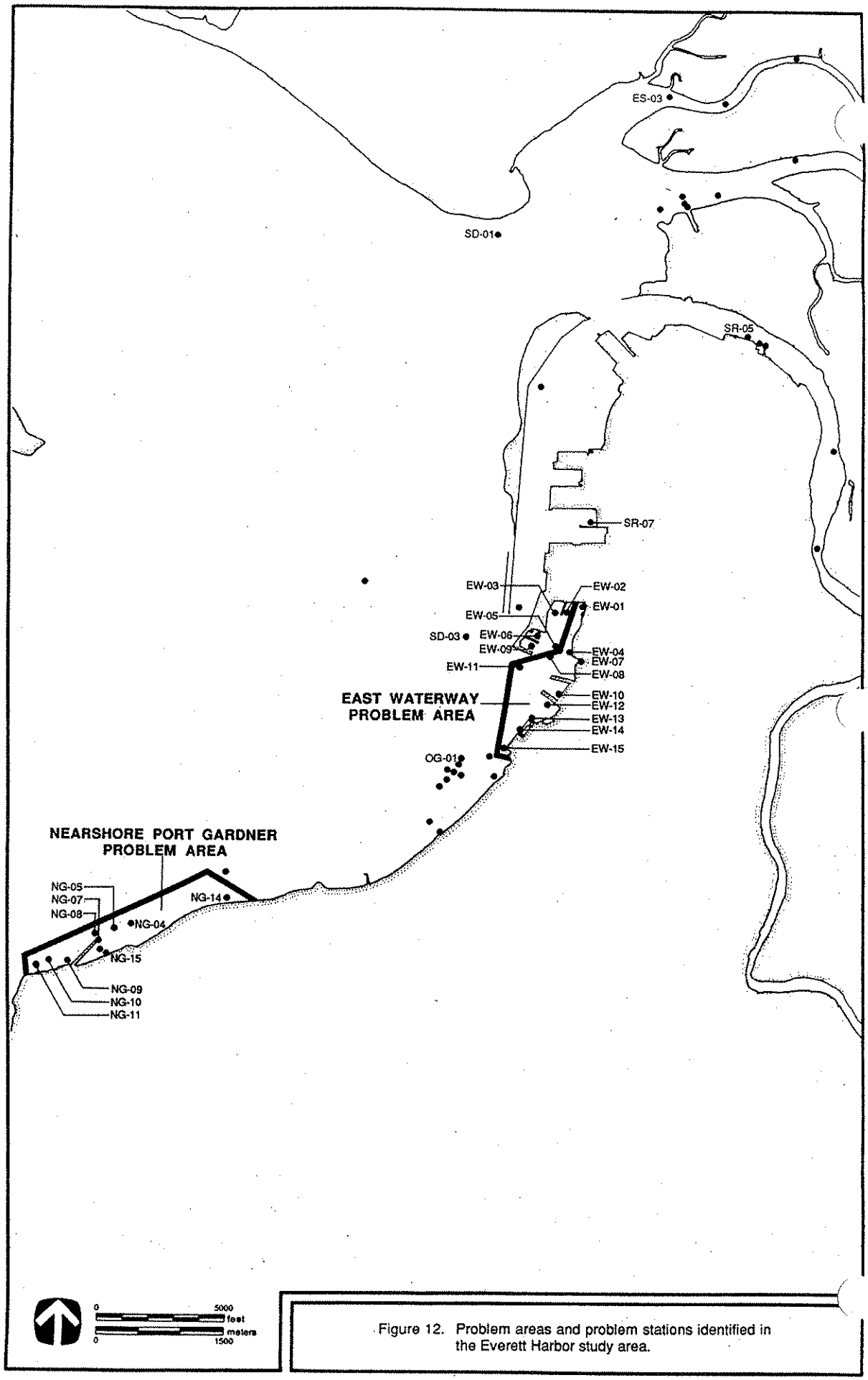


Figure 12. Problem areas and problem stations identified in the Everett Harbor study area.

- The spatial distribution of contaminants in the offshore sediments

- Available information on past or ongoing practices that may have contributed to the contamination observed in the receiving environment.

5.1 PROBLEM AREAS

5.1.1 East Waterway Problem Area

The East Waterway (Figure 13) was designated as a problem area primarily because of its scores for sediment chemistry, which averaged 58 percent of the maximum possible (PTI and Tetra Tech 1988b). The average score for biological indicators of contamination in the East Waterway was 20 percent of the maximum possible. The highest concentrations of most of the chemicals measured in the receiving environment study occurred at stations in this problem area, and the most severe sediment contamination was along the eastern shore (PTI and Tetra Tech 1988b).

The two chemicals that exceeded HAET concentrations most frequently in the East Waterway sediments were 4-methylphenol and LPAH. Other phenolic compounds, as well as HPAH, also exceeded HAET at certain East Waterway stations. The concentration of 4-methylphenol was highest at Station EW-07 (Figure 13), and elevated at all stations in the waterway. LPAH concentrations were highest at Stations EW-04, EW-07, EW-13 and EW-14, but were also elevated at most of the East Waterway stations. Naphthalene was the predominant PAH compound in the problem area (PTI and Tetra Tech 1988b).

Many compounds historically related to the pulp industry (e.g., resin acids, chlorinated phenols, chlorinated guaiacols) were found at elevated concentrations in the sediments of the East Waterway. Unchlorinated resin acids, which occur naturally in the resins and tissues of certain plants, are highly concentrated by pulping processes. Chlorinated resin acids, as well as chlorinated guaiacols, are useful geochemical tracers of pulp mill

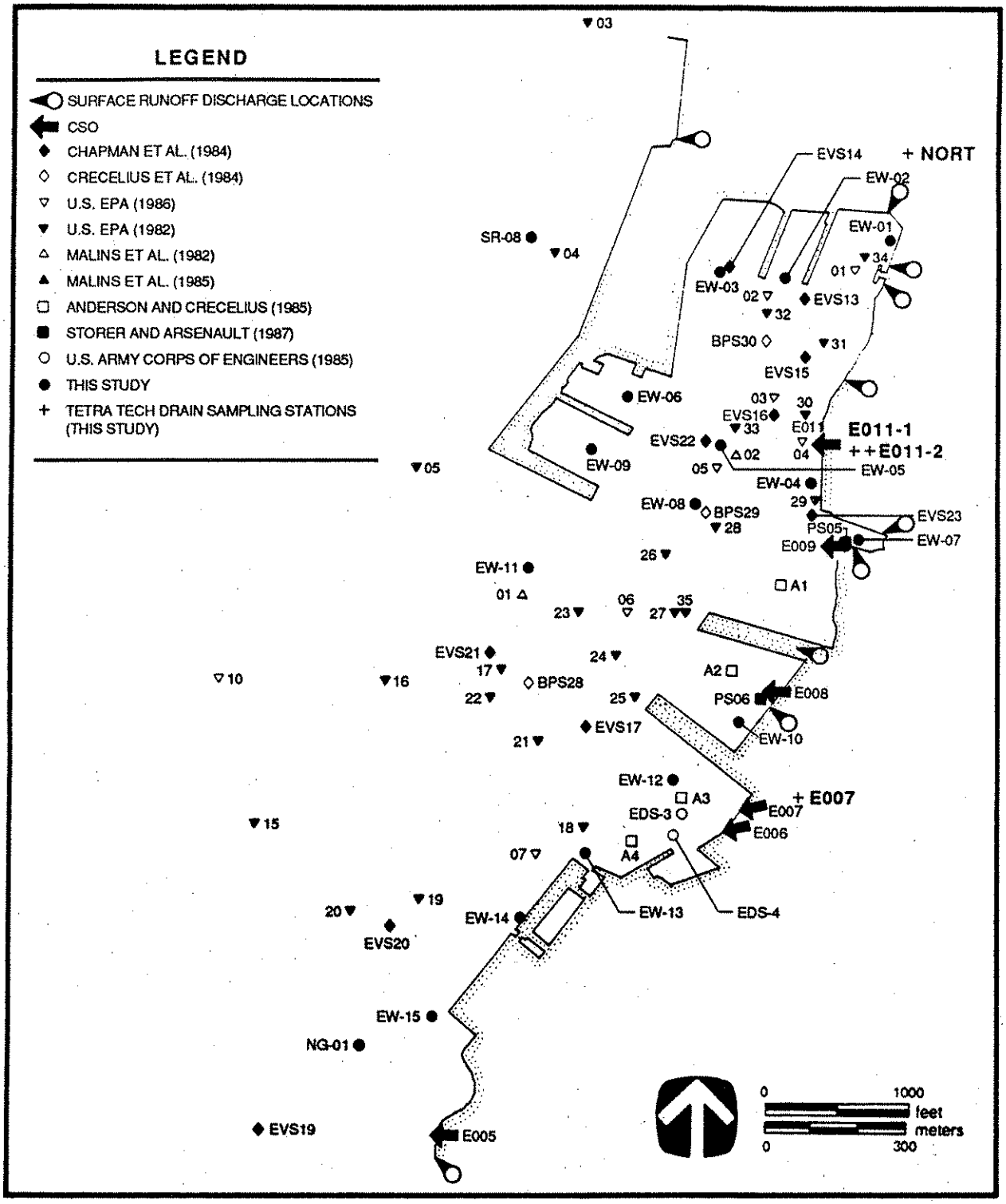


Figure 13. Locations of offshore and drain sampling stations, CSOs, and storm drains in the East Waterway study segment.

activities because they are generated during the chlorine bleaching process (PTI and Tetra Tech 1988b).

The two most prevalent resin acids in the study area, dehydroabietic acid (DHA) and abietic acid, were found at their highest observed concentrations at Stations EW-04 and EW-13 (Figure 13), respectively. The spatial distribution patterns of resin acid concentrations suggested that contamination at Stations EW-04 and EW-13 derived from distinct sources of a similar nature; however, chlorinated compounds were more prevalent at Station EW-04 than at Station EW-13. Concentrations of chlorinated resin acids, 2-chlorophenol, pentachlorophenol, 2-methyphenol, 2,4-dimethylphenol and several other compounds maximized at Station EW-04. Chlorinated phenols and chlorinated guaiacols had pronounced concentration maxima at Stations EW-01 and EW-02 (PTI and Tetra Tech 1988b).

Metals were not identified as problem chemicals in the sediments from the East Waterway as frequently as organic compounds. Copper and zinc were the only metals with concentrations that exceeded HAET, and both metals exceeded HAET concentration only at Station EW-14 (Figure 13). Zinc exceeded LAET concentration at several historical stations in the area [e.g., Stations BPS30 (Crecelius et al. 1984); E-04 (Battelle 1986); and PS05 (Storer and Arsenault 1987)]. Mercury exceeded LAET concentration at Station EW-10. Arsenic, cadmium, lead and mercury exceeded LAET concentrations at Station EW-14.

Drains as Potential Contaminant Sources--

During the onshore sampling effort for this study, four sediment samples were collected from three drains that discharge into the East Waterway problem area. Results from the chemical and physical analysis of these sediments appear in Appendix A, and are discussed in Section 4.0 of this report. The discussion below evaluates those drains, as well as other onshore facilities and activities, for their potential contributions to the chemical contamination measured in the sediments from the East Waterway.

Norton Terminal SD-- The outfall for the Norton Terminal SD is located approximately 200 ft north of offshore Station EW-01, at the head of the East Waterway (see Figure 13). In the sediment from Station EW-01, phenol (Z1,600 ug/kg) and 4-methyl phenol (6,000 ug/kg) were found at concentrations that exceeded HAET, and butylbenzyl phthalate (70 ug/kg) and n-nitrosodiphenylamine (57 ug/kg) exceeded LAET concentrations. Several chlorinated phenols, chlorinated guaiacols and one resin acid (sandarocopimaric acid, 14,000 ug/kg) exceeded 90th percentile concentrations at Station EW-01 (PTI and Tetra Tech 1988b). None of these contaminants were identified as problem chemicals in the Norton Terminal SD sediment.

Sediments from the storm drain contained only chromium (133 mg/kg) and nickel (67.2 mg/kg) at concentrations that exceeded HAET, and antimony (E6.0 mg/kg) at a concentration that exceeded LAET. Concentrations of chlorinated phenols in the drain sediment were less than 100 ug/kg, except for pentachlorophenol (330 ug/kg), which was undetected in the sediment from offshore Station EW-01. Chlorinated guaiacols were not detected in the drain sediment (at detection limits of 20 ug/kg), and sandaracopimaric acid was measured at E390 ug/kg. DHA, which was found in the sediment from Station EW-01 at a concentration of 10,000 ug/kg, was measured in the drain sediment at a concentration of 4,800 ug/kg.

The general dissimilarity between the organic compounds found in the sediment from the Norton Terminal SD and those found in the sediment from Station EW-01 is further demonstrated by comparing the relative percent distribution of selected contaminants found in each sediment. Relative distribution (see Section 3.1) was obtained by calculating the percentage contribution (by concentration) of a particular chemical or compound within a group of related chemicals (e.g., LPAH, HPAH, or metals). The relative distributions of LPAH and HPAH compounds measured in the sediments from Station EW-01 and the Norton Terminal SD are presented in Figure 14, and the relative distributions of selected pulp industry compounds measured in the two sediments are presented in Figure 15.

The relative distributions of LPAH compounds in the two sediments (Figure 14) do not match each other well, primarily because of the limited

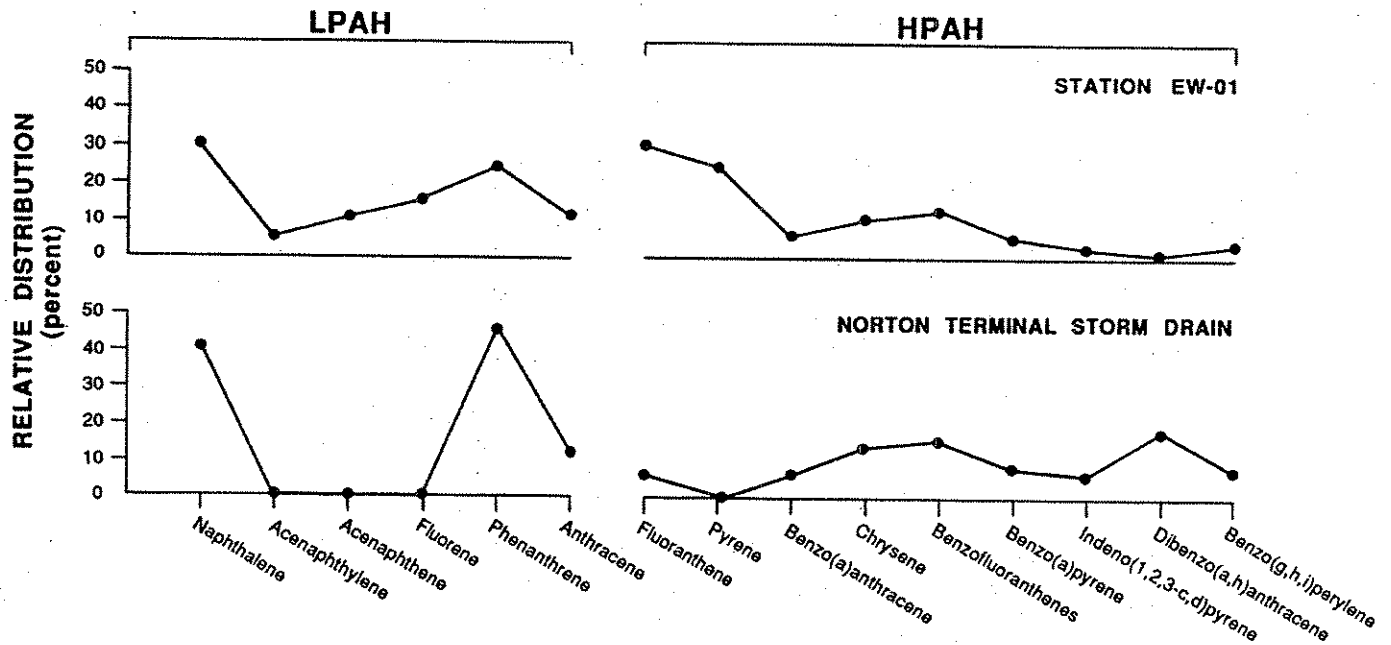


Figure 14. Comparison of relative percent distribution of PAH compounds in sediment from Station EW-01 and sediment from the Norton Terminal Storm Drain.

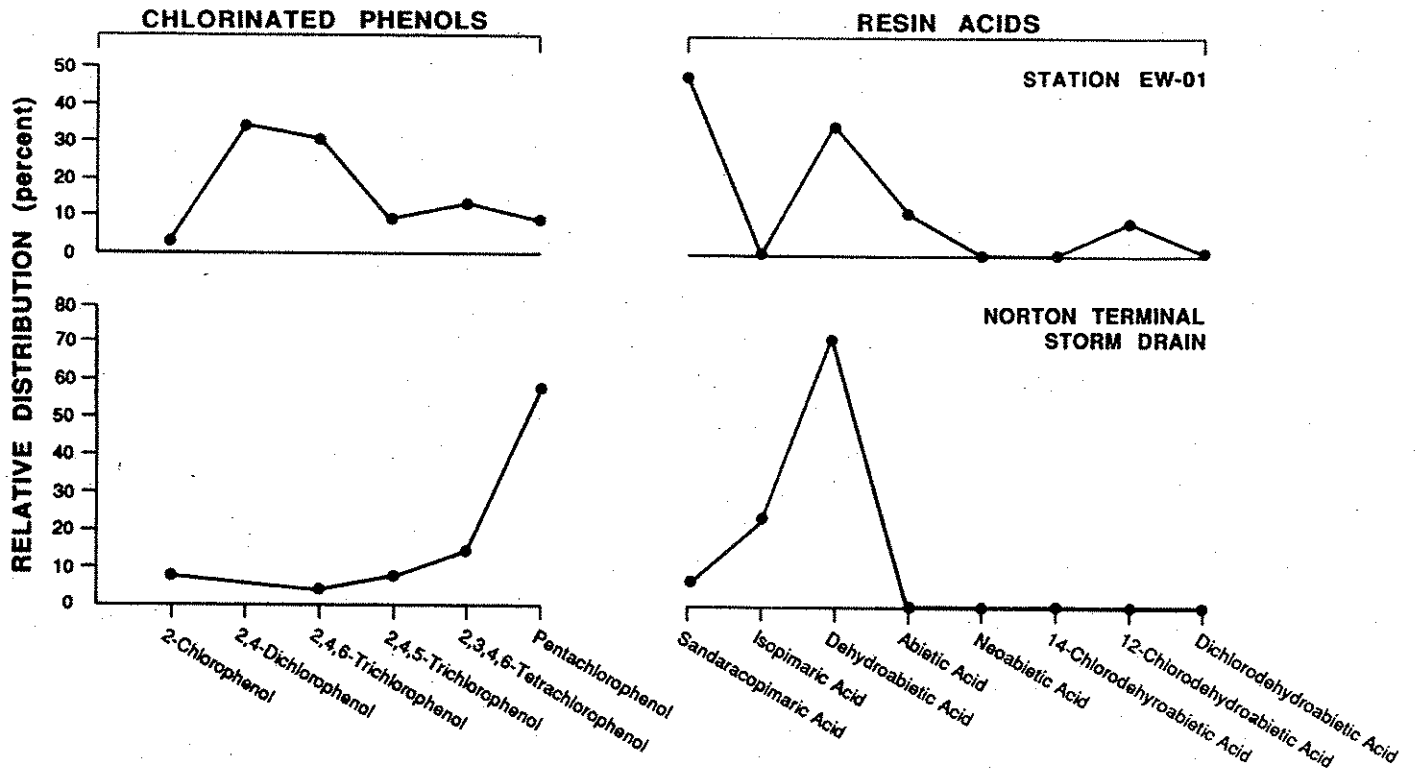


Figure 15. Comparison of relative percent distribution of pulp industry compounds in sediment from Station EW-01 and sediment from the Norton Terminal Storm Drain.

number of LPAH compounds detected in the drain sediment. The relative distributions of HPAH compounds in the two sediments are more similar, but there are still differences between the two [e.g., fluoranthene, pyrene, and dibenzo(a,h)anthracene relative abundances]. The relative distributions of the pulp industry compounds in the two sediments (Figure 15) also do not match each other well. It is apparent from these data that the Norton Terminal SD was probably not a major contributor to the elevated concentrations of organic compounds found in the sediment from Station EW-01.

The relative distribution and total concentration of PAH compounds in the drain sediment were generally well outside the ranges expected for street dust (Table 46), which suggests that the source of the relatively small amount of PAH contamination found in the drain may not have been solely from street runoff. (It should be noted that the data presented in Tables 46 and 47 for street dust is from analysis of street dust from Bellevue and Seattle, WA rather than Everett, and is presented for comparison purposes only).

The relative distribution of metals in the Norton Terminal SD sediment is very similar to the relative distribution of metals in the sediment from offshore Station EW-01 (Figure 16). It is possible that the Norton Terminal SD has contributed to metals contamination at Station EW-01, although concentrations of metals had not reached problem levels in the offshore sediment at the time of sampling. However, the relative distribution of metals in the drain sediment generally falls outside the ranges expected for urban street dust (Table 47), which suggests that street runoff may not have been the only source of the metals found in the drain.

Given the lack of similarity in problem chemicals between the drain and offshore sediments, and the general lack of agreement between the relative distributions of chemicals in the two sediments, it is doubtful that the Norton Terminal SD was a major contributor to the elevated concentrations of organic compounds measured in the sediments from Station EW-01, despite their proximity to each other. However, the storm drain may have contributed to metals contamination offshore that had not reached problem levels at the time of sampling.

TABLE 46. RELATIVE PERCENT DISTRIBUTION OF PAH COMPOUNDS IN SEDIMENTS FROM DRAINS DISCHARGING INTO THE EAST WATERWAY

PAH	Norton Terminal Storm Drain	CSO E011 Manhole 1	CSO E011 Manhole 2	CSO E007	Street Dust[a]	Street Dust[b]
LPAH						
Naphthalene	42	20	53	7.7	0	0
Acenaphthylene	ND[c]	2.3	13	3.5	0	0
Acenaphthene	ND[c]	18	1.4	13	0	0-7
Fluorene	ND[c]	13	2.2	9.4	0	0-7
Phenanthrene	46	32	26	45	100	68-100
Anthracene	12	15	4.1	22	0	0-18
Total LPAH (ug/kg)	26[d]	8,190[d]	5,824[d]	1,814[d]	1,200-2,600[e]	640-3,400[e]
HPAH						
Fluoranthene	6.8	33	30	17	26-48	24-100
Pyrene	ND[c]	36	26	17	26-52	0-52
Benzo(a)anthracene	7.0	6.9	6.3	8.2	0-12	0
Chrysene	14	7.9	9.8	13	0-19	0-23
Benzo(b)fluoranthene	} 16	} 7.2	} 13	} 18	0	0
Benzo(k)fluoranthene					0-16	0-24
Benzo(a)pyrene	8.8	3.9	5.1	10	0-9	0-13
Indeno(1,2,3-c,d)pyrene	7.0	1.9	4.0	7.1	0	0
Dibenzo(a,h)anthracene	18	0.6	1.0	2.0	0	0
Benzo(g,h,i)perylene	8.8	2.3	4.9	7.1	0	0
Total HPAH (ug/kg)	57[d]	8,869[d]	4,282[d]	5,500[d]	3,100-9,480[e]	780-9,480[e]

[a] Street dust samples collected from two industrial and two commercial areas in Seattle, WA.

[b] Street dust samples collected from five residential areas and three suburban arterials in Bellevue, WA; and two industrial and two commercial areas in Seattle, WA.

[c] ND = Not detected.

[d] Values reported as dry-weight concentration.

[e] Street dust values reported as wet-weight concentration.

Reference: Galvin and Moore (1982).

TABLE 47. RELATIVE PERCENT DISTRIBUTION OF METALS IN SEDIMENTS FROM DRAINS DISCHARGING INTO THE EAST WATERWAY

Metal	Norton Terminal Storm Drain	CSO E011 Manhole 1	CSO E011 Manhole 2	CSO E007	Street Dust[a]
Antimony	1.3	4.5	0.2	1.4	<1
Arsenic	2.9	0.8	0.2	1.1	1-5
Cadmium	0.15	0.1	0.2	0.1	<1
Chromium	29	44	1.7	28	2-15
Copper	15	3.9	2.0	7.8	4-12
Lead	7.9	9.8	3.7	29	30-64
Mercury	1.1	0.01	0.01	0.1	<1
Silver	0.08	0.02	0.03	0.06	<1
Zinc	43	37	92	32	14-54
Total metals (mg/kg)	463[b]	371[b]	10,753[b]	675[b]	650-1,800[c]

[a] Street dust samples collected from two industrial and two commercial areas in Seattle, WA.

[b] Values reported as dry-weight concentration.

[c] Street dust values reported as wet-weight concentration.

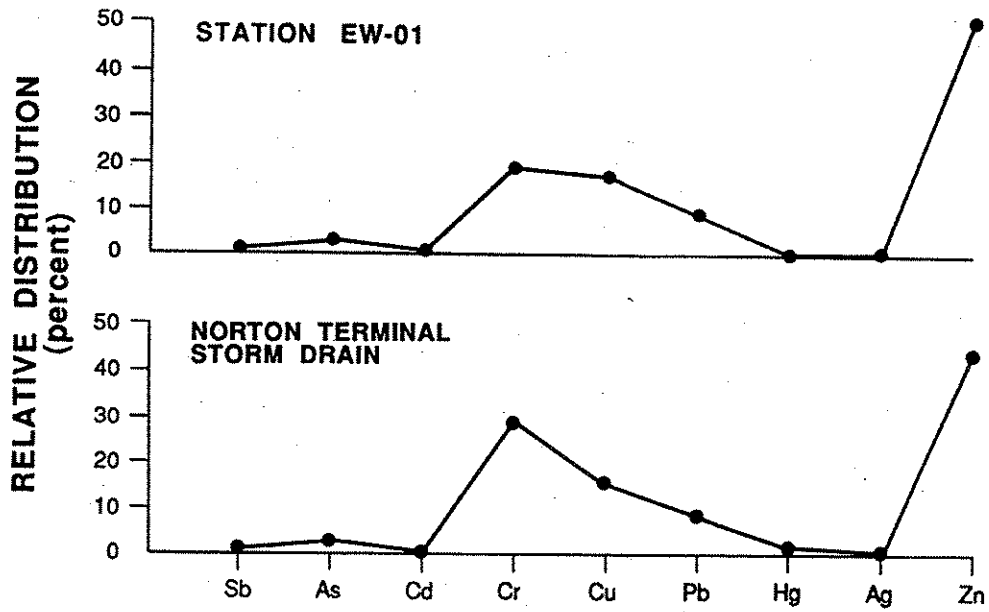


Figure 16. Comparison of relative percent distribution of metals in sediment from Station EW-01 and sediment from the Norton Terminal Storm Drain.

CSO E011-- CSO E011 is the CSO for Lift Station #5 in the City of Everett's sewer system. Sediment samples were collected from two manholes on the CSO line (see Figure 3). Sample E011-1 was collected from Manhole 1 (MH1), the manhole closest to the outfall. Sample E011-2 was collected from Manhole 2 (MH2), the next most upstream manhole (Tetra Tech 1986b). Both manholes are on Scott Paper Company property.

The outfall for CSO E011 is approximately 250 ft north of offshore Station EW-04 (see Figure 13). In the sediment from Station EW-04, LPAH (25,000 ug/kg), phenol (2,100 ug/kg), 2-methylphenol (1,200 ug/kg), 4-methylphenol (35,000 ug/kg), 2,4-dimethylphenol (520 ug/kg), benzyl alcohol (810 ug/kg), 1,2-dichlorobenzene (96 ug/kg), and PCBs (E9,600 ug/kg) were measured at concentrations that exceeded HAET. Fluoranthene (2,300 ug/kg) exceeded the LAET concentration, and 2-chlorophenol (160 ug/kg), 2,4-dichlorophenol (91 ug/kg), 2,3,4,6-tetrachlorophenol (78 ug/kg), pentachlorophenol (E460 ug/kg), abietic acid (52,000 ug/kg), isopimaric acid (E5,600 ug/kg), sandaracopimaric acid (8,800 ug/kg), 12-chlorodehydroabietic acid (11,000 ug/kg), and 14-chlorodehydroabietic acid (3,400 ug/kg) exceeded 90th percentile concentrations. DHA (83,000 ug/kg) exceeded an EAR of 1,000 in the sediment from Station EW-04 (PTI and Tetra Tech 1988b).

A similar group of problem chemicals was identified in the drain sediments from CSO E011. In drain sediment Sample E011-1, LPAH (8,190 ug/kg), acenaphthene (1,500 ug/kg), 4-methylphenol (3,300 ug/kg), and benzoic acid (2,400 ug/kg) exceeded HAET concentrations. In drain sediment Sample E011-2, napthalene (Z3,100 ug/kg), acenaphthylene (770 ug/kg), and dimethyl phthalate (250 ug/kg) exceeded HAET concentrations. Chemicals that exceeded LAET concentrations in Sample E011-1 or E011-2, or both, included various PAH compounds, total LPAH, total HPAH, and butylbenzyl phthalate.

Three contaminants identified as problem chemicals in the sediment from offshore Station EW-04 (benzyl alcohol, 2-methylphenol, and 2,4-dimethylphenol) were undetected in samples E011-1 and E011-2, but were undetected at detection limits that exceeded HAET (see Table 44). It is possible that

these three compounds were present in the drain sediments at concentrations that exceeded HAET.

Pulp industry compounds were generally undetected in Sample E011-1 at relatively low detection limits. In Sample E011-2, chlorinated phenols were the predominant pulp industry compounds measured, rather than the resin acids that were more predominant in the offshore sediment. DHA (700 ug/kg; EAR=11) was the only resin acid detected in drain sediment Sample E011-2 at a substantially elevated concentration. Relative distributions of pulp industry compounds in the two sediment samples from CSO E011 and the sediment from offshore Station EW-04 (Figure 17) do not match each other well, except for the high relative abundance of DHA in both sediments.

The relative distributions of PAH compounds in the sediments from CSO E011 are similar to the relative distribution of PAH compounds in sediments from Station EW-04 (Figure 18). The relative abundances of certain individual LPAH and HPAH compounds measured in the two drain sediments fall within the ranges expected for street dust (see Table 46), while relative abundances of others do not. In addition, the total concentrations of LPAH and HPAH fall within the ranges expected for street dust. Therefore, it is possible that a portion of the PAH contamination observed in CSO E011 originated with street runoff.

The relative distributions of metals in sediments from Station EW-04 and CSO E011 (Samples E011-1 and E011-2) presented in Figure 19 do not match each other well, especially with respect to the relative abundances of chromium and zinc. The concentration of zinc (9,890 mg/kg) in Sample E011-2 exceeded HAET, and may have been a source of the elevated zinc concentrations found at various historical stations (discussed earlier in this section) in the East Waterway. Concentrations of zinc and several other metals found in stormwater samples collected from CSOs E009 and E008 by the City of Everett (Mathias, D., 23 May 1988, personal communication) exceeded U.S. EPA acute or chronic effects criteria (see Table 26), which suggests that more than one of the city's CSOs may have contributed to the the metals contamination observed in the sediments from the East Waterway.

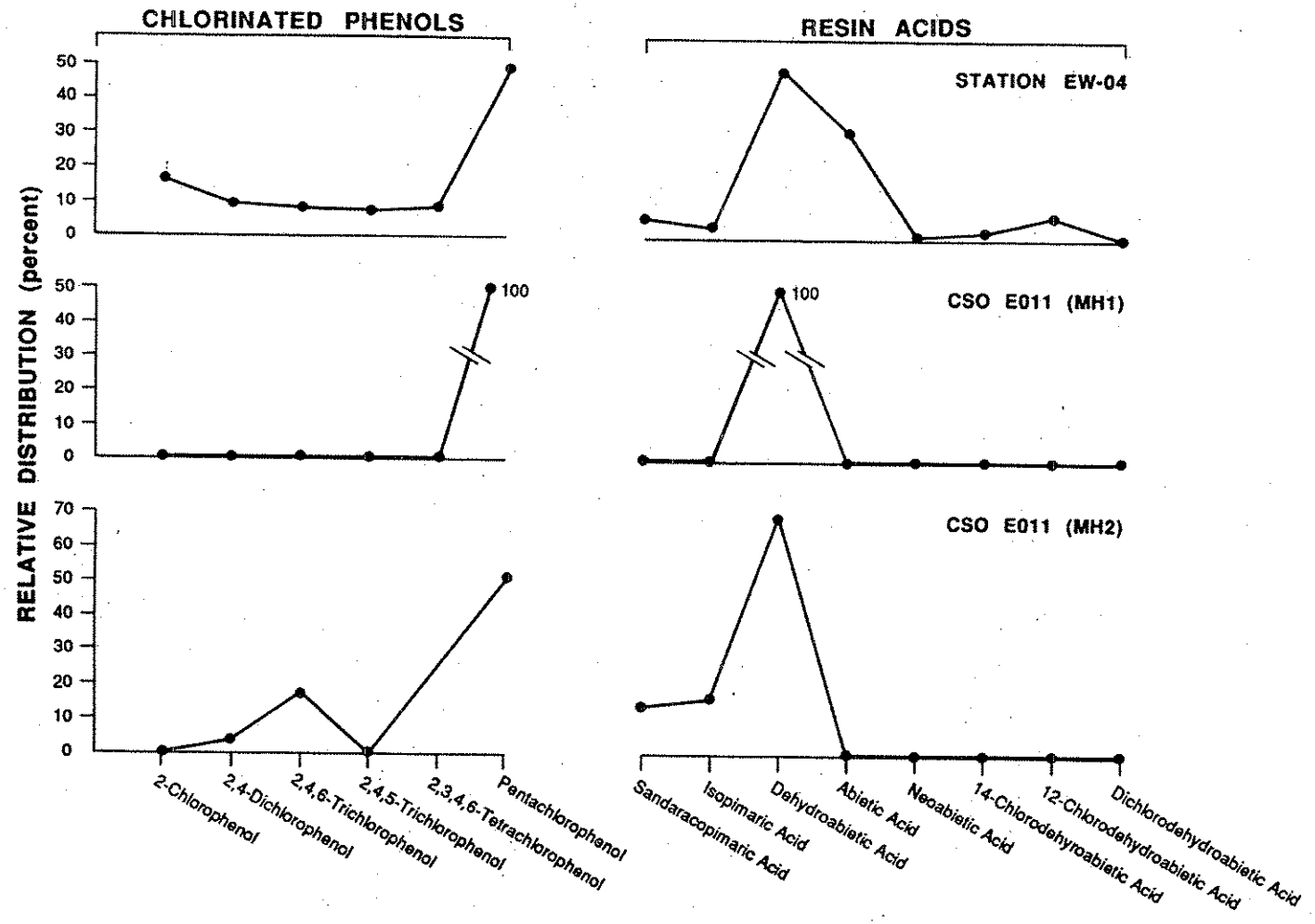


Figure 17. Comparison of relative percent distribution of pulp industry compounds in sediments from Station EW-04 and sediment from two locations along CSO E011.

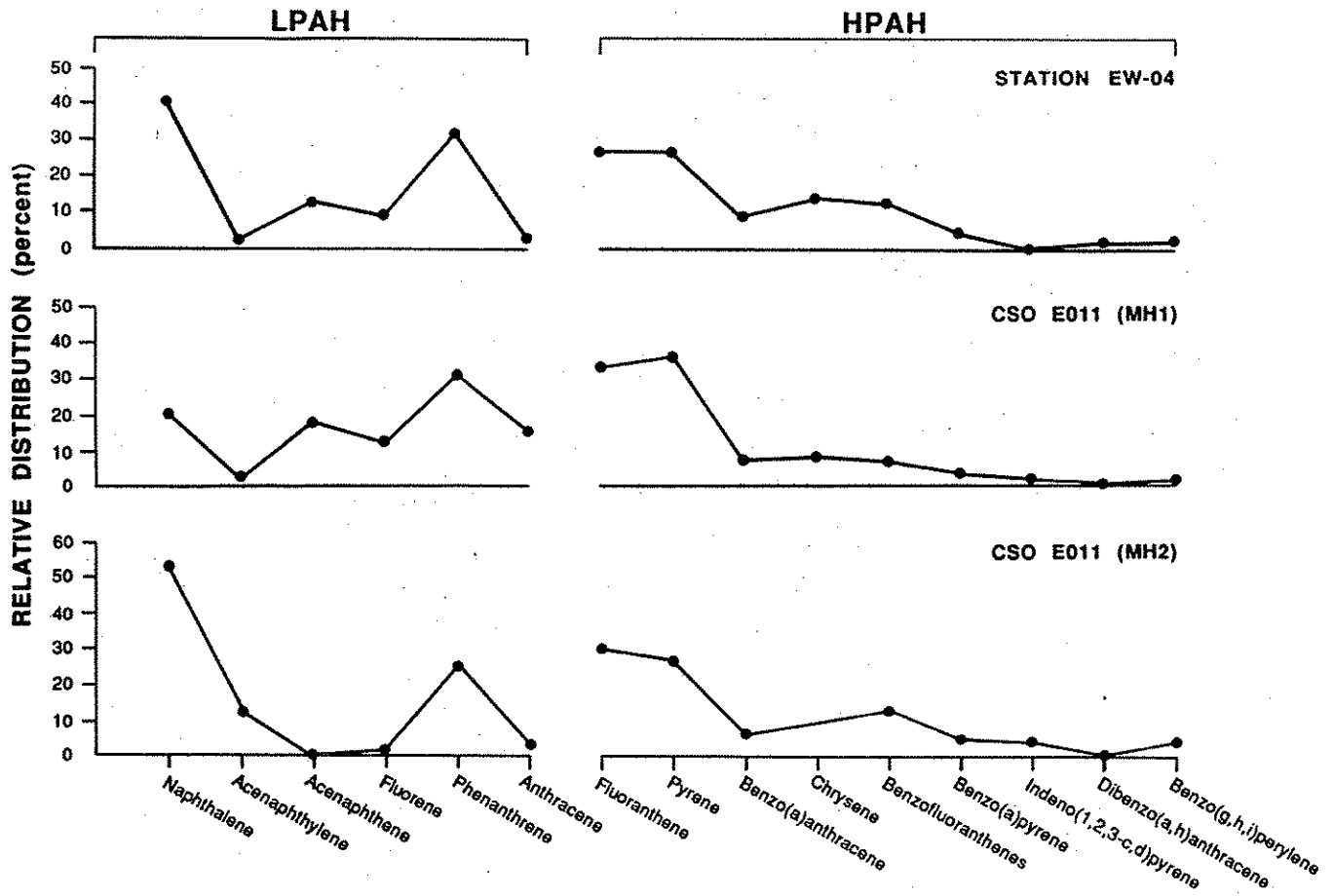


Figure 18. Comparison of relative percent distribution of PAH compounds in sediments from Station EW-04 and sediment from two locations along CSO E011.

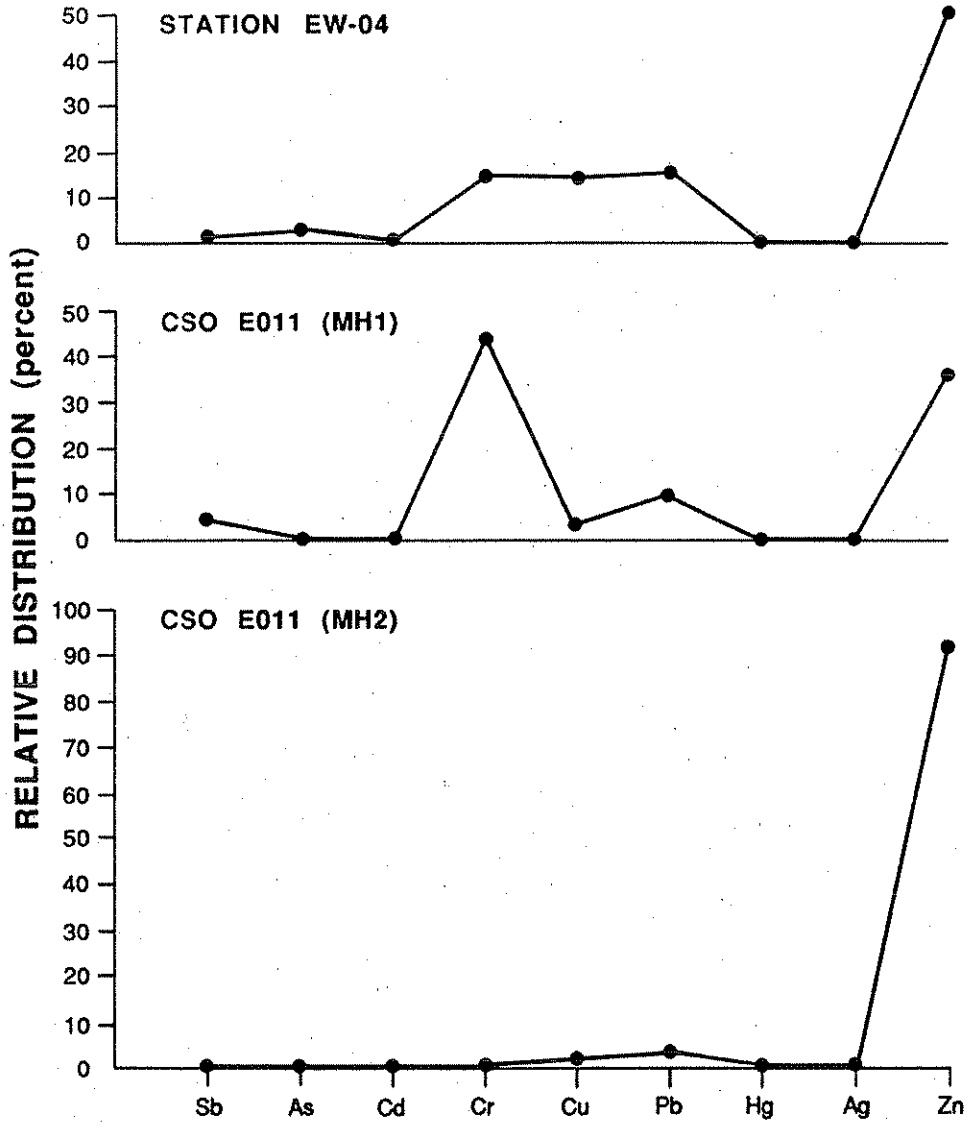


Figure 19. Comparison of relative percent distribution of metals in sediment from Station EW-04 and sediment from two locations along CSO E011.

The relative abundances of most of the metals found in the two drain sediment samples, as well as the total metals concentrations in both samples, fall outside the ranges expected for street dust (see Table 47). It is likely that sources other than street runoff contributed to the metals contamination observed in the drain sediment.

Based on the large number of problem chemicals common to both CSO E011 and offshore Station EW-04, their proximity to each other, and to a lesser extent the relative distributions of chemicals in both, it is likely that CSO E011 has contributed to the chemical contamination measured in the sediment from Station EW-04, especially the PAH and 4-methylphenol contamination. A portion of this PAH contamination may be attributable to street runoff. However, analysis of the data suggests that there are additional sources of contamination at Station EW-04, particularly for the compounds related to the pulp industry (e.g., resin acids, chlorinated phenols).

CSO E007-- The outfall for CSO E007 is located approximately 550 ft east of Station EW-12 (see Figure 13), just south of a Port of Everett pier. In the sediments from Station EW-12, 4-methylphenol (X3,600 ug/kg) exceeded HAET. No other chemicals exceeded AET or 90th percentile concentrations at this station. The concentration of 4-methylphenol in the sediment from CSO E007 was not highly elevated and did not approach the LAET value. The only chemicals measured in the drain sediment at concentrations that exceeded HAET were chromium (189 mg/kg), nickel (56.4 mg/kg), and DDT (26 ug/kg). Concentrations of individual LPAH and HPAH compounds were elevated in the drain sediment, but did not approach LAET values.

The relative distributions of PAH compounds in the sediments from Station EW-12 and CSO E007 are presented in Figure 20. The relative distributions of LPAH compounds in the two sediments are dissimilar, but the relative distributions of HPAH compounds in the two sediments are in closer agreement. It is possible that CSO E007 contributed to HPAH contamination offshore that had not reached problem levels at the time of sampling. The relative abundances of virtually all of the individual PAH compounds detected in the drain sediment fall outside the ranges expected for street dust (see Table 46), which suggests that street runoff was probably not the

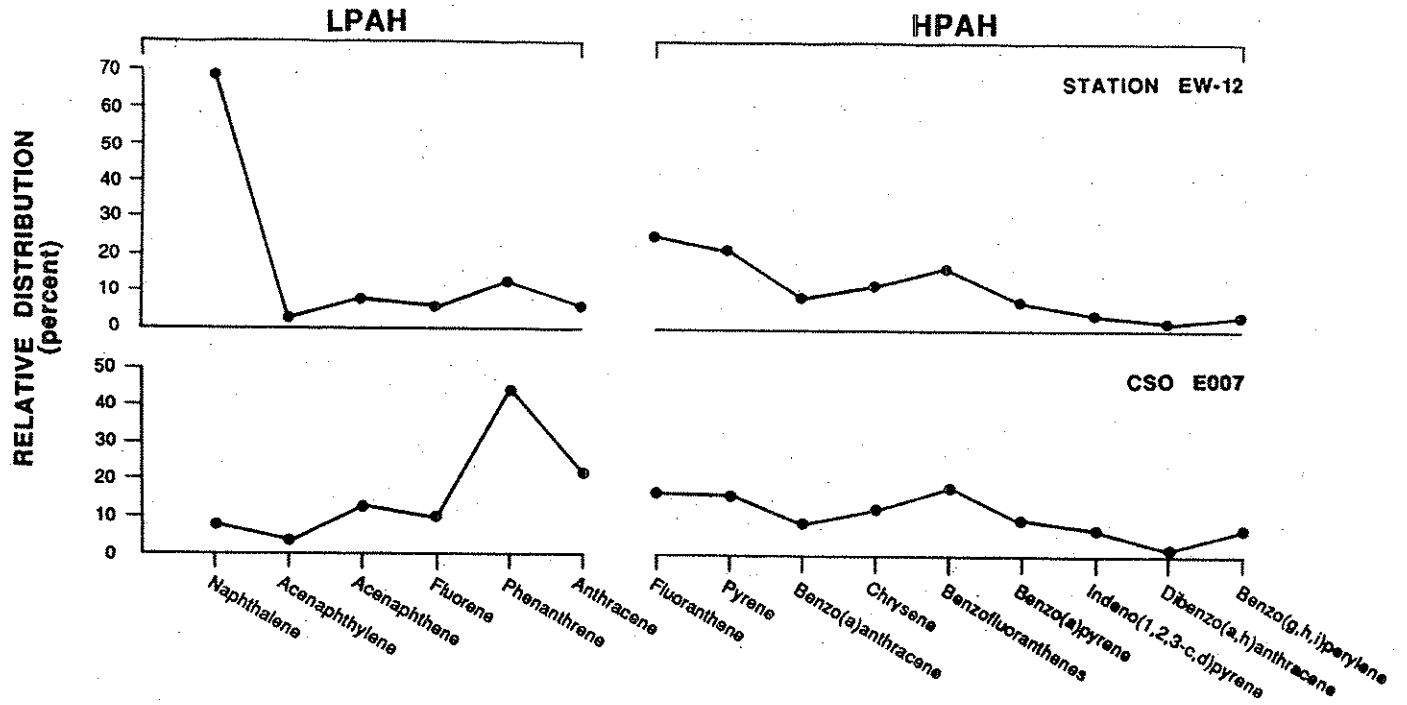


Figure 20. Comparison of relative percent distribution of PAH compounds in sediment from Station EW-12 and sediment from CSO E007.

major source of the PAH compounds measured in the drain sediment. A comparison of the relative distributions of pulp industry compounds in the two sediments is not possible because sediment from Station EW-12 was not analyzed for such compounds.

The relative distribution of metals in the sediments from Station EW-12 and CSO E007 are presented in Figure 21, and match each other well, except for the higher relative abundance of lead in the drain sediment. It is possible that CSO E007 contributed to metals contamination offshore that had not reached problem levels at the time of sampling. However, the relative abundance of most of the metals measured in the drain sediment, as well as the total metals concentration measured, is within the ranges expected for street dust (see Table 47), which suggests that street runoff may have been the major source of the metals measured in the drain sediment.

Based on the above data, it is unlikely that CSO E007 was a major contributor to the 4-methylphenol contamination observed at offshore Station EW-12. However, the drain may have contributed HPAH compounds and metals to the receiving environment at concentrations that did not exceed problem levels at the time of sampling.

Other Potential Sources of Contamination--

Many compounds related to the pulp industry (e.g., chlorinated phenols, chlorinated guaiacols, chlorinated and unchlorinated resin acids) were found in the sediments from the East Waterway. Two major industrial facilities along the East Waterway have been or still are involved in the production of pulp: Scott Paper Company, and Weyerhaeuser Thermomechanical. The Scott Paper Company facility is located on the eastern side of the mouth of the waterway, north of the Hewitt Avenue Terminal and south of the Norton Terminal (see Figure 4). Weyerhaeuser Thermomechanical, now closed, was located south of the mouth of the waterway along its eastern edge, southwest of what is now Anaconda Aluminum and Port of Everett property (see Figure 4).

At its East Waterway facility, Scott Paper Company produces an ammonia-base, paper-grade sulfite pulp and towel and tissue paper. The plant has

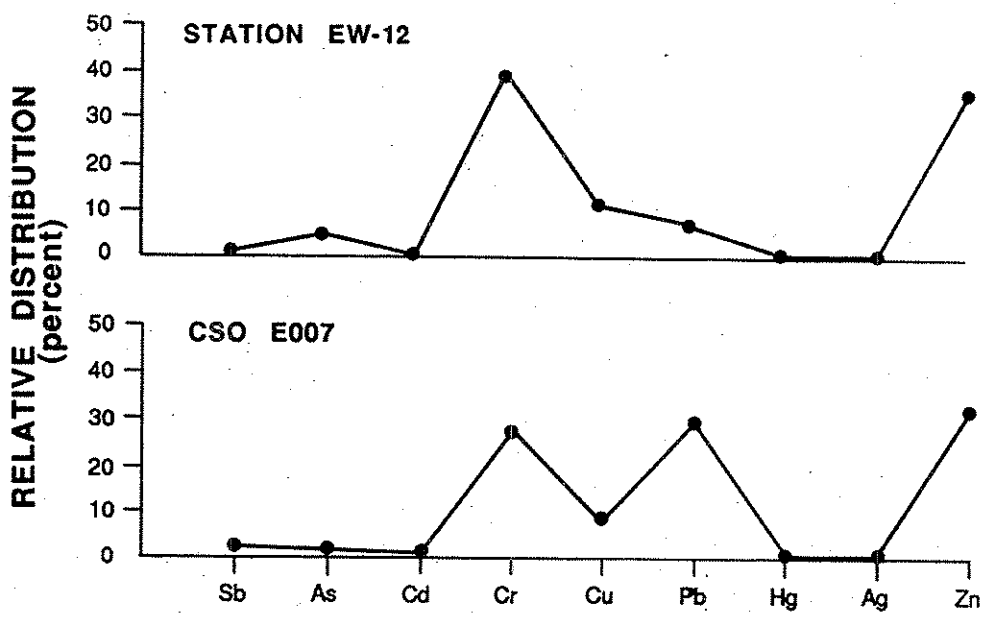


Figure 21. Comparison of relative percent distribution of metals in sediment from Station EW-12 and sediment from CSO E007.

operated at the site since 1930. A number of industrial discharge outfalls (both historical and current) from the facility are located in the East Waterway (see Figure 4). Of those outfalls, only the deepwater diffuser (SW001), the nearshore diffuser (S003), and the secondary treatment plant outfall (S008) are still operating. When primary clarifiers were installed in the 1960s, the use of most of the other outfalls was discontinued (Tetra Tech 1985b).

Discharges from both the nearshore and deepwater diffusers consist of surface runoff and effluent from the primary clarifiers. Clarifier influent consists primarily of paper mill wastewater, and small contributions from pulp mill wastes, steamplant discharges, and filter backwash. Outfall S008 was constructed in 1980 to discharge effluent from the facility's secondary treatment plant. The treatment plant processes wastewater from the pulp mill and from the spent sulfite liquor recovery system (Tetra Tech 1985b). An estimate of pollutant loading from outfall S008 was made in Tetra Tech (1985b), using data from a U.S. EPA survey of compounds found in treated effluents from paper-grade sulfite pulp mills and an assumed flow rate of 12 MGD from the outfall. The resulting estimated loadings of organic compounds to the East Waterway were 25 lbs/day for DHA, 8 lbs/day for abietic acid, and 4 lbs/day for chlorodehydroabietic acid (Tetra Tech 1985b). However, pollutant loadings calculated using Scott Paper Company data for the treated mill effluent are generally lower (e.g., 0.2 lbs/day for DHA and no detected abietic acid; Tetra Tech 1985b).

Weyerhaueser produced paper and dissolving grade pulp at its East Waterway facility, using a calcium-based sulfite process until 1975. Before construction of the deepwater diffuser (SW001; see Figure 4) in 1951, Weyerhaueser discharged untreated wastes from the washing, bleaching, and drying process at the mill through nearshore Outfalls WT002 and WT003. Outfall WT004 discharged stormwater runoff and wastewater from limestone cleaning operations. Outfall WT006 discharged stormwater runoff from the north end of the plant. After 1951, the plant discharged most of its effluent through the deepwater diffuser (SW001). Until wastewater control systems were installed, this effluent consisted primarily of untreated sulfite waste liquor (Tetra Tech 1985b).

In 1975, the sulfite mill was converted to a thermomechanical plant in an effort to reduce pollutant loadings from the mill. At that time, Outfalls WT002 and WT003 were sealed and abandoned, and discharges from Outfalls WT004 and WT006 were limited to stormwater runoff from areas not involved with the pulping process. All process wastes were treated at the newly built secondary treatment plant before being discharged through the deepwater diffuser. The thermomechanical mill was closed permanently in 1980 (Tetra Tech 1985b). Few data are available for loadings of pollutants discharged from these outfalls other than conventional variables, such as BOD and TSS.

Another widespread contaminant found in sediments collected from the East Waterway was 4-methylphenol. 4-Methylphenol is used in phenolic resins, in magnet wire, as a plasticizer in fire retardants, and in an antioxidant, butylated hydroxytoluene (Burch, W., 1 September 1987, personal communication). No specific sources of 4-methylphenol in the East Waterway area have been identified, other than the contamination found in CSO E011.

Concentrations of LPAH and to a lesser extent, HPAH, were also elevated in most areas of the East Waterway. PAH compounds are found in fossil fuels and petroleum-related materials, including coal tar creosote, which is used to protect wood from decay (Merck 1983). The large number of treated wood pilings in the East Waterway area that form docks, piers, and related structures may be a source of PAH compounds. Additionally, shipping industry vessels and their related fuels and oils might be a source of this contamination. LPAH compounds are characteristic of unburned fossil fuels, and HPAH compounds are characteristic of combusted fuel material (Lee et al. 1977).

Summary--

The sediment contamination in the East Waterway apparently originates from several sources. At least one CSO (E011) has probably contributed to the PAH and 4-methylphenol contamination offshore. Historical and current pulp industry activities may have contributed chlorinated phenolic compounds

and resin acids to the sediment offshore. Additional sampling of area CSOs, storm drains, runoff discharges, and additional information on area industries is required to further define relationships between potential sources and the contamination observed in the East Waterway, particularly for contaminants such as 4-methylphenol and PAH compounds.

5.1.2 Nearshore Port Gardner Problem Area

The major contaminants observed in sediments from the nearshore Port Gardner problem area were polar organic compounds, such as 4-methylphenol, benzoic acid, and to a lesser extent, phenol. Relatively high concentrations of PAH and PCBs were observed at a few stations. Overall, distributions of different contaminants were not uniform in this problem area. Of the problem chemicals in this area, 4-methylphenol most often exceeded HAET concentrations, but concentration gradients for this compound were not apparent, and the stations with the highest concentrations were not adjacent to each other. Spatial distributions of 4-methylphenol concentrations between the East Waterway and the Port Gardner problem area suggest a local source or sources rather than sediment transport from the more highly contaminated East Waterway (PTI and Tetra Tech 1988b).

Station NG-09, near the Mulkilteo wastewater treatment plant and west of the Mukilteo fuel depot (see Figure 6), had relatively high concentrations of chemicals in addition to 4-methylphenol. The concentrations of phenol and PCBs in the sediment from this station exceeded HAET, and the concentration of LPAH exceeded LAET. Concentrations of these chemicals at nearby stations were generally much lower. Benzoic acid concentrations exceeded HAET at three stations offshore from the Mulkilteo fuel depot: Stations NG-05, NG-07, and NG-08. Concentrations of benzoic acid generally decreased moving inshore from these stations (PTI and Tetra Tech 1988b).

Groundwater as a Potential Contaminant Source--

During the onshore sampling effort for this study, four groundwater samples (including one field replicate) were collected from three monitoring wells at the Mulkilteo Defense Fuel Supply Depot (see Figure 6). Results

from the chemical analysis of those samples are presented in Appendix A, and are discussed in Section 4.0 of this report. The discussion below evaluates those samples, as well as other onshore facilities and activities, for their potential contributions to the chemical contamination found in the sediments from the nearshore Port Gardner problem area.

The four groundwater samples contained few of the target chemicals listed in Table 42 (see Section 3.2.3), and the few chemicals detected were generally at relatively low concentrations. Only a few metals exceeded U.S. EPA freshwater quality criteria for chronic effects (see Table 45). A few PAH compounds were found at low concentrations (less than 30 ug/L) in the sample from monitoring Well 4 (and its field replicate). The problem chemicals identified in the sediments from the nearshore Port Gardner area, especially 4-methylphenol, benzoic acid, phenol, and PCBs, were generally undetected in the groundwater samples at low detection limits (typically 10 ug/L). Based on the dissimilarity between the problem chemicals found in the sediments offshore of Port Gardner and those found in the groundwater samples, it is unlikely that the groundwater beneath the fuel supply depot contributed substantially to the elevated concentrations of the contaminants found in the sediments offshore. However, as discussed in Section 4.2, sampling personnel observed that groundwater samples from at least two of the monitoring wells were contaminated with one or more oily substances (Tetra Tech 1986b). Since laboratory analyses for specific fuels or other petroleum-related materials were not performed these samples, it is not possible to evaluate the nature or amount of this oily contaminant, or its effects offshore.

Other Potential Sources of Contamination--

The two major facilities along the shoreline of the nearshore Port Gardner problem area are the Mulkilteo WTP and the Mulkilteo Defense Fuel Supply Depot (see Figure 6). The WTP is discussed in Section 2.2.

The fuel depot has several discharge outfalls along shoreline of Port Gardner (see Figures 2 and 6) (see Sections 2.1 and 2.6 of this report). Outfalls 1 through 5 are for stormwater and fuel condensate. Outfall 6

discharges stormwater and wastewater from the fuels laboratory onsite (Tetra Tech 1985b). Few data are available concerning the chemical constituents of the materials discharged from these outfalls.

Three creeks (Japanese Gulch, Edgewater Creek, and Powder Mill Gulch; see Figure 6) discharge into Port Gardner within the problem area. Few data are available concerning the possible presence of contaminants in these creeks. In addition, specific sources of the contaminants observed in offshore sediments have not been documented in the drainage basins for these creeks.

Summary--

Additional data on the contents of discharges from the Mulkilteo wastewater treatment plant and the Mulkilteo Defense Fuel Supply Depot are needed to further define sources of the contamination found in the sediments offshore Port Gardner. Additional data on industries and practices in the drainage basins for the 10 creeks that discharge into the Port Gardner area would also be helpful in identifying sources of contamination. Ecology is currently conducting a study of toxic chemical contamination in and around the Snohomish County Airport (Paine Field) and its related drainages. This study will provide additional data on contaminants in several of the creeks that flow into the Port Gardner area, and may help to identify sources of contamination. The results of the study are expected to be published in July 1988 (Yake, B., 3 June 1988, personal communication).

5.2 PROBLEM STATIONS OUTSIDE PROBLEM AREAS

5.2.1 Problem Station OG-01

The sole problem chemical at Station OG-01 (see Figure 12) was 4-methylphenol (1,300 ug/kg). Sediment from most other stations in the area contained similar 4-methylphenol concentrations, which were slightly less than the HAET but greater than the LAET. Overall this area was characterized by uniform concentrations of a number of chemicals, including 4-methylphenol, PAH (predominantly naphthalene, as in the East Waterway), resin acids

(chlorinated and unchlorinated), and a cymene isomer (PTI and Tetra Tech 1988b). These chemicals have varying degrees of association with the pulp industry.

Although such chemicals could have been transported from the East Waterway, the following evidence suggests that the source of the contamination is closer to Station OG-01:

- Concentrations are spatially uniform in the area, and do not clearly decrease with distance from the East Waterway

- Examination of chemical contamination along a transect from Station EW-15 (at the mouth of the East Waterway) to nearby Station NG-01 to Station OG-01 (further away from EW-15) reveals that concentrations of several diagnostic compounds, such as 4-methylphenol and naphthalene, decrease from Station EW-15 to Station NG-01 and then increase at Station OG-01 (resin acids were not measured at Stations NG-01 and OG-01)

- Contamination patterns within the East Waterway (i.e., prominent concentration maxima for certain chemicals) do not suggest the presence of strong advection processes (PTI and Tetra Tech 1988b).

Station OG-01 was located near the SW001 outfall diffuser (see Figures 2 and 12) currently used by the Scott Paper Company. Scott uses the outfall to discharge effluent from its primary clarifiers (see Section 5.1.1). Before their thermomechanical pulp mill closed in 1980, Weyerhaeuser discharged a variety of effluents through this outfall, including untreated sulfite waste liquor and effluent from a secondary treatment plant (Tetra Tech 1985b). These discharges from Outfall SW001 probably were the source of the resin acids found in the area around Station OG-01. Specific sources of the 4-methylphenol and PAH contamination found in the area have not been identified.

5.2.2 Problem Station SD-03

Station SD-03, located on the Snohomish River delta approximately 1,600 ft offshore of the western side of the East Waterway (see Figure 12), contained sediments with concentrations of three chemicals exceeding HAET: benzoic acid (X770 ug/kg), benzyl alcohol (X99 ug/kg), and DDT (23 ug/kg). The concentration of 4-methylphenol (X760 ug/kg) in the sediment from this station exceeded LAET (PTI and Tetra Tech 1988b).

Station SD-03 is offshore from historical Outfall WG002 (see Figure 4). Western Gear Machinery Company, a firm that specialized in heavy equipment and machinery for the oil drilling industry, was located along the western side of the East Waterway. Prior to the company's move in 1988, Western Gear discharged noncontact cooling water through Outfall WG002. No specific sources of benzoic acid, benzyl alcohol, or DDT have been identified. The use of DDT was severely restricted in 1973, and the contamination found at Station SD-03 may be from past usage of the pesticide.

5.2.3 Problem Station SR-05

Station SR-05 was located in the Snohomish River, offshore of the Weyerhaeuser Kraft mill (see Figures 2 and 12). Benzoic acid (1,000 ug/kg) and 4-methylphenol (2,000 ug/kg) exceeded HAET at this station. The 4-methylphenol concentration at adjacent Station SR-04 (980 ug/kg) exceeded the LAET. A number of resin acids were detected at Station SR-05, including DHA and abietic acid. Concentrations of these resin acids decreased moving upriver from Station SR-05 to SR-03, and were roughly five times lower at Station SR-04 than at Station SR-05 (PTI and Tetra Tech 1988b).

Station SR-05 was located close to several of Weyerhaueser's discharge outfalls (see Figure 2). Outfall WK004, which is upstream of Station SR-05, discharges backwash from the plant's water filtration system. Outfall WK002, slightly downstream of SR-05, discharges noncontact cooling water from the pulp mill. Outfall WK005, on the other side of the Snohomish River and slightly downstream of SR-05, discharges surface water runoff from Smith Island. Weyerhaueser pumps all the wastewater from pulping operations, as

well as stormwater runoff from the mill area, into an aerated lagoon system on Smith Island. Effluent from these lagoons is discharged to Steamboat Slough through Outfall WK001, located on the northwestern side of Smith Island (Tetra Tech 1985b). Because of the distance involved, Outfall WK001 was probably not a major contributor to the contamination at Station SR-05. Few data are available on the specific chemicals found in the other discharges. Weyerhaueser reported in its 1983 permit application that cresol (a methyl phenol) would be present in effluent from all the outfalls (Tetra Tech 1985b). Specific sources of benzoic acid in the area have not been identified.

5.2.4 Problem Station ES-03

Station ES-03 was located in Ebey Slough, just southeast of the mouth of Quilceda Creek (see Figure 12). Benzoic acid (E760 ug/kg) and 4-methylphenol (1,400 ug/kg) concentrations exceeded HAET at this station. Phenol (Z1,200 ug/kg) exceeded the LAET concentration at Station ES-03. Concentrations of benzoic acid and 4-methylphenol at Station ES-02 (upriver) were at least 30 times lower than at Station ES-03 (PTI and Tetra Tech 1988b).

A potential source of the benzoic acid and phenol observed at Station ES-03 may have been the Tulalip landfill (see Figure 2). The landfill is located in an estuarine-tidal action area. Normal tidal action submerges at least part of the site, and would thus allow leachate to be released to the offshore environment. In the past, benzoic acid and phenol have been detected in leachate samples from the landfill (Ecology & Environment 1984).

The 4-methylphenol contamination at Station ES-03 may be associated with the various wood waste and treating facilities throughout the Snohomish River and its sloughs. Buse Timber, located on Union Slough, and the Weyerhaeuser Kraft mill outfall (WK001) on Steamboat Slough, are the nearest wood products facilities to Station ES-03 (see Figure 2). However, sediments collected from Stations SS-03, SS-04, and SS-05 in Steamboat Slough, immediately offshore of Outfall WK001 (see Figures 2 and 10), contained 4-methylphenol at concentrations (17-1,100 ug/kg) lower than those observed

at Station ES-03, which suggests a source of 4-methylphenol closer to Station ES-03 than Outfall WK001. Such a source has not been identified. Outfall WK001 discharges effluent from the treatment lagoon on Smith Island, which contains wastes from the mill's pulping operations (Tetra Tech 1985b).

5.2.5 Problem Station SR-07

Station SR-07, located near the Everett marina in the Snohomish River, north of the East Waterway (see Figure 12), was designated as a problem station based upon benthic effects that exceeded action level guidelines; no AET concentrations were exceeded at this station. However, tributyltin (TBT) was measured in the sediments from this station at a concentration of 0.093 mg/kg, which is 15 times greater than the concentration of TBT (0.006 mg/kg) measured in the single reference sediment that was collected. The sediments from Station SR-07 also contained a high concentration of sulfides (300 mg/kg) and were very fine-grained, consisting of 96 percent fine-grained material (PTI and Tetra Tech 1988b).

Tributyltin is used in marine antifouling paints as a biocide (Grovhoug et al. 1987). TBT found at Station SR-07 may have originated with the boat painting and refinishing activities that take place in the marina area. Specific sources of sulfides in the area have not been identified.

5.2.6 Problem Station SD-01

Sediments from Station SD-01, which was located on the Snohomish River delta (see Figure 12), did not contain any chemicals at concentrations exceeding any AET. It was designated a problem station based on benthic effects that exceeded action level guidelines. Physical characteristics of this station include sandy sediments (12 percent gravel and less than 5 percent fine-grained material), low total organic carbon content, low sulfide content, and swift currents. EAR for Everett Harbor problem chemicals did not exceed 4 at this station. These data contradict the identification of this site as a potential problem area. The biological effects observed at this station may be the results of stresses imposed by

the physical environment rather than chemical contamination (PTI and Tetra Tech 1988b).

6.0 SUMMARY

The data for various potential sources of contamination in the Everett Harbor study area were evaluated in an attempt to link specific contaminant sources (e.g., drains, groundwater, waterfront land-use activities) to the two problem areas and six problem stations identified in PTI and Tetra Tech (1988b). The two CSOs and one storm drain that were sampled for sediment analysis during this study were compared to one another based on the problem chemicals identified in the drain sediments. The three monitoring wells that were sampled for groundwater analysis were also evaluated for chemical contamination, using U.S. EPA Freshwater Quality Criteria as a general description of acceptable water quality. Because of the small number of samples taken, onshore sources were not ranked to establish priorities for further investigation.

In a few cases, it was possible to associate specific sources of contamination to the problem areas or problem stations offshore. The sediments in CSO E011 have probably contributed to the 4-methylphenol and LPAH contamination observed at offshore Station EW-04. Stormwater in CSOs E008 and E009 has probably contributed to metals contamination in the East Waterway. The resin acids observed near Station OG-01 may have been discharged from Outfall SW001. Leachate from the Tulalip landfill may have contributed to the benzoic acid and phenol contamination at Station ES-03. The tributyltin observed in the sediments at Station SR-07 may have originated with the boat painting and refinishing activities that take place in the Everett Marina.

In many cases, no specific sources of the problem chemicals found in offshore sediments could be identified because of a lack of chemical data pertaining to nearby potential sources. To more thoroughly identify specific sources of contamination, further investigation in the study area is needed. Additional sediment and water samples need to be collected from

CSOs, storm drains, natural drainages (e.g., creeks), and industrial discharges in the study area.

Additional sediment and water samples from CSOs are needed because of the complexity of the CSO system. The many overflow weirs, regulators, and pumping stations make it difficult to identify sources of specific chemicals within a drainage basin. A monitoring effort similar to the one suggested for Elliot Bay (Tetra Tech 1988b), combined with information on the activities and practices of industries within the drainage basins, would make it possible to trace a contaminant to its ultimate source.

Sediment and water samples from city and private storm drains are needed because a large number of these drains near problem stations have not been characterized. Sediment and water samples from area creeks are needed because some of these natural drainages serve industrialized areas and have not been investigated. Further characterization of the effluents being discharged from the local industrial facilities, particularly those involved with pulping activities, would help define the contamination caused by historical rather than ongoing activities.

The following studies related to characterization of potential sources of contamination in the Everett Harbor study area are currently being finalized:

- U.S. EPA study of the Tulalip landfill
- An Ecology study of Paine Field and its drainages

The results of these studies are expected to be published soon, and were unavailable for inclusion in this report. In addition, the City of Everett continues to monitor both water quality and quantity in selected CSOs during rainfall events. These data will help determine potential sources of contamination in the study area, while the sampling discussed above will be needed to eliminate the remaining data gaps. The need for this additional sampling should be taken into account when revising the Everett Harbor Action Plan.

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APPENDIX A

PHYSICAL AND CHEMICAL DATA FOR THE DRAINS AND GROUNDWATER SAMPLES COLLECTED DURING THE EVERETT HARBOR ACTION PROGRAM SOURCE INVESTIGATION

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DATA REPORT OF THE EVERETT HARBOR ACTION PROGRAM

Chemical data collected in support of the Everett Harbor Action Program during 15-29 October 1986 are presented in this appendix. Data qualifiers were used to describe, clarify, or explain data values. A complete list of data qualifiers used in the Everett Harbor Action Program is provided below:

- U = The compound or element was not detected at the method detection limit shown. Detection limits are generally defined as the lowest measurable concentration reliably detectable by a particular method.

- E = The reported concentration is an estimate. The estimated qualifier was assigned for a variety of reasons including exceedance of control limits for precision, accuracy, and holding times.

- B = Concentration was corrected for blank contribution. Blank contribution was greater than or equal to the sample value, therefore reported value is the method detection limit.

- Z = Concentration was corrected for blank contribution. Value still exceeds the method detection limit.

- X = This qualifier was assigned if the labeled internal standard recovery reported by the laboratory was less than 10 percent.

- L = This qualifier indicates that the value is less than the maximum shown. An "L" qualifier was applied to a group sum because analytical detection limits for undetected compounds were included in the summation of representative compounds within a chemical group.

TABLE A-1. EVERETT HARBOR SOURCE SAMPLING LOCATIONS

DRAIN SEDIMENT STATIONS

Station	Drainage	Location	East Coord.	North Coord.
E007	17110019-EW-007	24 S. Bond St. CSO (E007)	1660670	359690
E011-1	17110019-EW-011	Lift Station #5 CSO (E011) - Manhole 1	1661145	362230
E011-2	17110019-EW-011	Lift Station #5 CSO (E011) - Manhole 2	1661350	362235
NORT	17110019-EW-042	Norton Terminal Storm Drain	1661380	364320

GROUNDWATER STATIONS

Station	Drainage	Location	East Coord.	North Coord.
MUK4	17110019-NG-004	Mukilteo defense fuel supply, near NE corner of Tank 10	1643270	350730
MUK8	17110019-NG-008	Mukilteo defense fuel supply, between Tanks 8 and 9	1642760	350495
MUK12	17110019-NG-012	Mukilteo defense fuel supply, east of Tank 10	1643350	350740

TABLE A-2. CONCENTRATIONS OF METALS IN EVERETT HARBOR SOURCE SAMPLES

DRAIN SEDIMENTS (mg/kg DRY WEIGHT)

Station	Rep	Date	Antimony	Arsenic	Cadmium	Chromium	Copper	Iron
E007		10/15/86	E9.48	7.5	0.73	189	52.6	2.71
E011-1		10/29/86	E16.8	2.8	0.27	163	14.4	2.33
E011-2		10/29/86	E19.4	17.3	25.3	186	218	3.78
NORT		10/15/86	E6.05	13.5	0.71	133	71.0	4.27

Station	Rep	Date	Lead	Manganese	Nickel	Selenium	Silver	Zinc	Mercury
E007		10/15/86	198	551	56.4	U0.25	0.44	217	E0.603
E011-1		10/29/86	36.3	520	45.4	U0.25	0.087	137	E0.039
E011-2		10/29/86	393	2680	84.0	0.93	2.93	9890	E1.50
NORT		10/15/86	36.7	660	67.2	U0.20	0.36	201	E0.233

GROUNDWATER (ug/L)

Station	Rep	Date	Antimony	Arsenic	Cadmium	Chromium	Copper
MUK4	1	10/16/86	2.7	3.04	0.144	6.13	E10.2
MUK4	2F	10/16/86	4.1	2.35	0.098	6.07	E6.69
MUK4	Mean	10/16/86	3.4	2.70	0.121	6.10	E8.44
MUK8		10/16/86	8.1	5.79	0.0808	7.65	E14.7
MUK12		10/16/86	5.4	1.00	0.0284	1.66	E2.18

Station	Rep	Date	Lead	Nickel	Selenium	Silver	Zinc	Mercury
MUK4	1	10/16/86	12.3	7.24	U0.97	0.0655	18.0	E0.03
MUK4	2F	10/16/86	1.23	6.82	U0.97	0.125	19.6	E0.004
MUK4	Mean	10/16/86	6.76	7.03	U0.97	0.0952	18.8	E0.017
MUK8		10/16/86	7.08	14.5	U0.97	0.0198	22.7	E0.0003
MUK12		10/16/86	1.83	1.21	U0.97	0.0083	3.60	E0.0008

TABLE A-3. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: HALOGENATED ALKANES I

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	chloro-methane	bromo-methane	chloro-ethane	1,1-di-chloro-ethane	chloro-form	1,2-di-chloro-ethane
E007		10/15/86	U8	U8	U8	U4	U4	U4
E011-1		10/29/86	U7	U7	U7	U3	U3	U3
E011-2		10/29/86	U16	U16	U16	U8	31	U8
NORT		10/15/86	U15	U15	U15	U8	U8	U8

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	chloro-methane	bromo-methane	chloro-ethane	1,1-di-chloro-ethane	chloro-form	1,2-di-chloro-ethane
MUK4	1	10/16/86	U50	U50	U50	U25	U25	U25
MUK4	2F	10/16/86	U25	U25	U25	U13	U13	U13
MUK4	Mean	10/16/86	U25	U25	U25	U13	U13	U13
MUK8		10/16/86	U10	U10	U10	U5	U5	U5
MUK12		10/16/86	U10	U10	U10	U5	U5	U5

TABLE A-4. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: HALOGENATED ALKANES II

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station Rep	Sampling Date	1,1,1-trichloroethane	carbon tetrachloride	bromodichloromethane	1,2-dichloropropane	dibromochloromethane	1,1,2-trichloroethane
E007	10/15/86	U4	U4	U4	U4	U4	U4
E011-1	10/29/86	U3	U3	U3	U3	U3	U3
E011-2	10/29/86	U8	U8	U8	U8	U8	U8
NORT	10/15/86	U8	U8	U8	U8	U8	U8

Station Rep	Sampling Date	bromoform	1,1,2,2-tetrachloroethane
E007	10/15/86	U4	U4
E011-1	10/29/86	U3	U3
E011-2	10/29/86	U8	U8
NORT	10/15/86	U8	U8

TABLE A-4. (CONTINUED)

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	1,1,1-trichloroethane	carbon tetrachloride	bromodichloromethane	1,2-dichloropropane	dibromochloromethane	1,1,2-trichloroethane
MUK4	1	10/16/86	U25	U25	U25	U25	U25	U25
MUK4	2F	10/16/86	U13	U13	U13	U13	U13	U13
MUK4	Mean	10/16/86	U13	U13	U13	U13	U13	U13
MUK8		10/16/86	U5	U5	U5	U5	U5	U5
MUK12		10/16/86	U5	U5	U5	U5	U5	U5

Station	Rep	Sampling Date	bromoform	1,1,2,2-tetrachloroethane
MUK4	1	10/16/86	U25	U25
MUK4	2F	10/16/86	U13	U13
MUK4	Mean	10/16/86	U13	U13
MUK8		10/16/86	U5	U5
MUK12		10/16/86	U5	U5

TABLE A-5. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: HALOGENATED ALKENES

DRAIN SEDIMENT (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	vinyl chloride	1,1-di-chloro-ethene	trans-1,2-di-chloro-ethene	trans-1,3-di-chloro-propene	cis-1,3-di-chloro-propene	tri-chloro-ethene	tetra-chloro-ethene
E007		10/15/86	U8	U4	U4	U4	U4	U4	E1
E011-1		10/29/86	U7	U3	U3	U3	U3	U3	U3
E011-2		10/29/86	U16	U8	U8	U8	U8	U8	U8
NORT		10/15/86	U15	U8	U8	U8	U8	U8	U8

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	vinyl chloride	1,1-di-chloro-ethene	trans-1,2-di-chloro-ethene	trans-1,3-di-chloro-propene	cis-1,3-di-chloro-propene	tri-chloro-ethene	tetra-chloro-ethene
MUK4	1	10/16/86	U50	U25	U25	U25	U25	U25	U25
MUK4	2F	10/16/86	U25	U13	U13	U13	U13	U13	U13
MUK4	Mean	10/16/86	U25	U13	U13	U13	U13	U13	U13
MUK8		10/16/86	U10	U5	U5	U5	U5	U5	U5
MUK12		10/16/86	U10	U5	U5	U5	U5	U5	U5

TABLE A-6. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: AROMATIC HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	benzene	toluene	ethyl-benzene	styrene	total xylenes
E007		10/15/86	U4	U4	U4	U4	U4
E011-1		10/29/86	U3	U3	U3	U3	U3
E011-2		10/29/86	U8	U8	U8	U8	U8
NORT		10/15/86	U8	U8	U8	U8	2

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	benzene	toluene	ethyl-benzene	styrene	total xylenes
MUK4	1	10/16/86	E7	U25	U25	U25	U25
MUK4	2F	10/16/86	E4	U13	U13	U13	U13
MUK4	Mean	10/16/86	E6	U13	U13	U13	U13
MUK8		10/16/86	U5	U5	U5	U5	U5
MUK12		10/16/86	U5	U5	U5	U5	U5

TABLE A-7. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: CHLORINATED AROMATIC HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	chloro-benzene
E007		10/15/86	U4
E011-1		10/29/86	U3
E011-2		10/29/86	U8
NORT		10/15/86	2

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	chloro-benzene
MUK4	1	10/16/86	U25
MUK4	2F	10/16/86	U13
MUK4	Mean	10/16/86	U13
MUK8		10/16/86	U5
MUK12		10/16/86	U5

TABLE A-8. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: ETHERS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	2-chloro-ethyl-vinyl-ether
E007		10/15/86	U8
E011-1		10/29/86	U7
E011-2		10/29/86	U16
NORT		10/15/86	U15

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	2-chloro-ethyl-vinyl-ether
MUK4	1	10/16/86	U50
MUK4	2F	10/16/86	U25
MUK4	Mean	10/16/86	U25
MUK8		10/16/86	U10
MUK12		10/16/86	U10

TABLE A-9. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: KETONES

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	acetone	2-butanone	2-hexanone	4-methyl-2-pentanone
E007		10/15/86	U8	U8	U8	U8
E011-1		10/29/86	U10	U7	U7	U7
E011-2		10/29/86	U10	U16	U16	U16
NORT		10/15/86	U15	U15	U15	U15

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	acetone	2-butanone	2-hexanone	4-methyl-2-pentanone
MUK4	1	10/16/86	U50	U50	U50	U50
MUK4	2F	10/16/86	U25	U25	U25	U25
MUK4	Mean	10/16/86	U25	U25	U25	U25
MUK8		10/16/86	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10

TABLE A-10. CONCENTRATIONS OF VOLATILE COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: MISCELLANEOUS VOLATILE COMPOUNDS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	carbon di-sulfide	vinyl acetate
E007		10/15/86	U4	U8
E011-1		10/29/86	U3	U7
E011-2		10/29/86	U8	U16
NORT		10/15/86	U8	U15

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	carbon di-sulfide	vinyl acetate
MUK4	1	10/16/86	U25	U50
MUK4	2F	10/16/86	U13	U25
MUK4	Mean	10/16/86	U13	U25
MUK8		10/16/86	U5	U10
MUK12		10/16/86	U5	U10

TABLE A-11. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: PHENOLS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	phenol	2-methyl-phenol	4-methyl-phenol	2,4-di-methyl-phenol
E007		10/15/86	19	U20	31	U10
E011-1		10/29/86	Z120	U200	3300	U50
E011-2		10/29/86	U50	U200	48	U50
NORT		10/15/86	6	U200	43	U50

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	phenol	2-methyl-phenol	4-methyl-phenol	2,4-di-methyl-phenol
MUK4	1	10/16/86	U10	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	U10	U10
MUK4	Mean	10/16/86	U10	U10	U10	U10
MUK8		10/16/86	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10

TABLE A-12. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: SUBSTITUTED PHENOLS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	2-nitro-phenol	2,4-dinitro-phenol	4,6-dinitro-2-methyl-phenol	4-nitro-phenol	4-chloro-3-methyl-phenol
E007		10/15/86	U50	U50	U100	U50	U50
E011-1		10/29/86	U50	U50	U100	U50	U50
E011-2		10/29/86	U50	U50	U100	U50	U50
NORT		10/15/86	U50	U50	U100	U50	U50

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	2-chloro-phenol	2,4-di-chloro-phenol	4-chloro-3-methyl-phenol	2,4,6-tri-chloro-phenol	2,4,5-tri-chloro-phenol	penta-chloro-phenol
MUK4	1	10/16/86	U10	U10	U10	U10	U50	U50
MUK4	2F	10/16/86	U10	U10	U10	U10	U50	U50
MUK4	Mean	10/16/86	U10	U10	U10	U10	U50	U50
MUK8		10/16/86	U10	U10	U10	U10	U50	U50
MUK12		10/16/86	U10	U10	U10	U10	U50	U50

Station	Rep	Sampling Date	2-nitro-phenol	2,4-dinitro-phenol	4,6-dinitro-2-methyl-phenol	4-nitro-phenol
MUK4	1	10/16/86	U10	U50	U50	U50
MUK4	2F	10/16/86	U10	U50	U50	U50
MUK4	Mean	10/16/86	U10	U50	U50	U50
MUK8		10/16/86	U10	U50	U50	U50
MUK12		10/16/86	U10	U50	U50	U50

TABLE A-13. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: LOW MOLECULAR WEIGHT HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	naphtha-lene	ace-naphthy-lene	acenaph-thene	fluorene	phenan-threne	anthra-cene
E007		10/15/86	Z140	64	230	170	810	400
E011-1		10/29/86	Z1600	190	1500	1100	2600	1200
E011-2		10/29/86	Z3100	770	84	130	1500	240
NORT		10/15/86	Z11	U10	U10	U10	12	3

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	naphtha-lene	ace-naphthy-lene	acenaph-thene	fluorene	phenan-threne	anthra-cene
MUK4	1	10/16/86	U10	U10	30	26	27	E4
MUK4	2F	10/16/86	U10	U10	21	15	11	E2
MUK4	Mean	10/16/86	U10	U10	26	20	19	E3
MUK8		10/16/86	U10	U10	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10	U10	U10

TABLE A-14. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: HIGH MOLECULAR WEIGHT POLYAROMATIC HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	fluor-anthene	pyrene	benzo-(a)-anthra-cene	chrysene	benzo-(a)-pyrene	indeno-(1,2,3-cd)-pyrene
E007		10/15/86	940	Z930	450	730	570	390
E011-1		10/29/86	4600	Z5000	960	1100	540	270
E011-2		10/29/86	1300	Z1100	270	420	220	170
NORT		10/15/86	12	B10	4	8	5	4

Station	Rep	Sampling Date	di-benzo-(a,h)-anthra-cene	benzo-(g,h,i)-perylene	benzo-(B+K) fluoran-thenes
E007		10/15/86	110	390	E990
E011-1		10/29/86	79	320	E1000
E011-2		10/29/86	42	210	E550
NORT		10/15/86	10	5	E9

TABLE A-14. (CONTINUED)

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	fluor-anthene	pyrene	benzo-(a)-anthra-cene	chrysene	benzo-(a)-pyrene	indeno-(1,2,3-cd)-pyrene
MUK4	1	10/16/86	16	12	U10	U10	U10	U10
MUK4	2F	10/16/86	10	E7	E2	E2	2	U10
MUK4	Mean	10/16/86	13	E10	E2	E2	2	U10
MUK8		10/16/86	U10	U10	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10	U10	U10

Station	Rep	Sampling Date	di-benzo-(a,h)-anthra-cene	benzo-(g,h,i)-perylene	benzo-(B+K) fluoran-thenes
MUK4	1	10/16/86	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	E2
MUK4	Mean	10/16/86	U10	U10	E2
MUK8		10/16/86	U10	U10	U10
MUK12		10/16/86	U10	U10	U10

TABLE A-15. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: CHLORINATED AROMATIC HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	1,3-dichloro-benzene	1,4-dichloro-benzene	1,2-dichloro-benzene	1,2,4-tri-chloro-benzene	2-chloro-naphtha-lene	hexa-chloro-benzene
E007		10/15/86	5	51	42	U10	U50	U20
E011-1		10/29/86	U500	X92	U500	U200	U50	U50
E011-2		10/29/86	X65	X190	U50	U10	U50	U50
NORT		10/15/86	U10	10	U10	U200	U50	U50

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	1,3-dichloro-benzene	1,4-dichloro-benzene	1,2-dichloro-benzene	1,2,4-tri-chloro-benzene	2-chloro-naphtha-lene	hexa-chloro-benzene
MUK4	1	10/16/86	U10	U10	U10	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	U10	U10	U10	U10
MUK4	Mean	10/16/86	U10	U10	U10	U10	U10	U10
MUK8		10/16/86	U10	U10	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10	U10	U10

TABLE A-16. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: CHLORINATED ALIPHATIC HYDROCARBONS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	hexachloroethane	hexachlorobutadiene	hexachlorocyclopentadiene
E007		10/15/86	U20	U20	U200
E011-1		10/29/86	U20	U50	U200
E011-2		10/29/86	U20	U50	U200
NORT		10/15/86	U20	U10	U200

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	hexachloroethane	hexachlorobutadiene	hexachlorocyclopentadiene
MUK4	1	10/16/86	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	U10
MUK4	Mean	10/16/86	U10	U10	U10
MUK8		10/16/86	U10	U10	U10
MUK12		10/16/86	U10	U10	U10

TABLE A-17. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: HALOGENATED ETHERS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	bis(2-chloro-ethyl) ether	bis(2-chloro-isopropyl) ether	bis(2-chloro-ethoxy) methane	4-chloro-phenyl-phenyl-ether	4-bromo-phenyl-phenyl-ether
E007		10/15/86	U20	U10	U10	U10	U10
E011-1		10/29/86	U20	U10	U10	U10	U10
E011-2		10/29/86	U20	U10	U10	U10	U10
NORT		10/15/86	U20	U10	U10	U10	U10

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	bis(2-chloro-ethyl) ether	bis(2-chloro-isopropyl) ether	bis(2-chloro-ethoxy) methane	4-chloro-phenyl-phenyl-ether	4-bromo-phenyl-phenyl-ether
MUK4	1	10/16/86	U10	U10	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	U10	U10	U10
MUK4	Mean	10/16/86	U10	U10	U10	U10	U10
MUK8		10/16/86	U10	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10	U10

TABLE A-18. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: PHTHALATES

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	di-methyl-phthalate	di-ethyl-phthalate	di-n-butyl-phthalate	butyl-benzyl-phthalate	bis-(2-ethyl-hexyl-phthalate	di-n-octyl-phthalate
E007		10/15/86	U10	U10	Z96	160	Z650	Z48
E011-1		10/29/86	U10	U10	U10	U10	Z1100	U10
E011-2		10/29/86	250	U10	Z740	180	Z430	B42
NORT		10/15/86	U10	U10	B10	13	Z39	U10

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	di-methyl-phthalate	di-ethyl-phthalate	di-n-butyl-phthalate	butyl-benzyl-phthalate	bis-(2-ethyl-hexyl-phthalate	di-n-octyl-phthalate
MUK4	1	10/16/86	U10	U10	U10	U10	U10	U10
MUK4	2F	10/16/86	U10	U10	U10	U10	U10	U10
MUK4	Mean	10/16/86	U10	U10	U10	U10	U10	U10
MUK8		10/16/86	U10	U10	U10	U10	U10	U10
MUK12		10/16/86	U10	U10	U10	U10	U10	U10

TABLE A-19. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: MISCELLANEOUS OXYGENATED COMPOUNDS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	iso-phorone	benzyl alcohol	benzoic acid	dibenzo-furan
E007		10/15/86	U50	U20	400	170
E011-1		10/29/86	U50	U200	2400	1300
E011-2		10/29/86	U50	U200	U800	680
NORT		10/15/86	U50	U200	E6	3

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	iso-phorone	benzyl alcohol	benzoic acid	dibenzo-furan
MUK4	1	10/16/86	U10	U10	U50	17
MUK4	2F	10/16/86	U10	U10	U50	11
MUK4	Mean	10/16/86	U10	U10	U50	14
MUK8		10/16/86	U10	U10	U50	U10
MUK12		10/16/86	U10	U10	U50	U10

TABLE A-20. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: ORGANONITROGEN COMPOUNDS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	nitro-benzene	n-nitroso-di-n-propyl-amine	4-chloro-aniline	2-chloro-aniline	3-chloro-aniline	4-nitro-aniline
E007		10/15/86	U10	U10	U10	U10	U50	U100
E011-1		10/29/86	U10	U10	U10	U10	U50	U100
E011-2		10/29/86	U10	U10	U10	U10	U50	U100
NORT		10/15/86	U10	U10	U10	U10	U50	U100

Station	Rep	Sampling Date	2,6-dinitro-toluene	2,4-dinitro-toluene	n-nitroso-di-phenyl-amine	3,3'di-chloro-benzidine
E007		10/15/86	U10	U10	40	U50
E011-1		10/29/86	U10	U10	U10	U50
E011-2		10/29/86	U10	U10	180	U50
NORT		10/15/86	U10	U10	23	U50

TABLE A-20. (CONTINUED)

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	nitro-benzene	n-nitroso-di-n-propyl-amine	4-chloro-aniline	2-chloro-aniline	3-chloro-aniline	4-nitro-aniline
MUK4	1	10/16/86	U10	U10	U10	U50	U50	U50
MUK4	2F	10/16/86	U10	U10	U10	U50	U50	U50
MUK4	Mean	10/16/86	U10	U10	U10	U50	U50	U50
MUK8		10/16/86	U10	U10	U10	U50	U50	U50
MUK12		10/16/86	U10	U10	U10	U50	U50	U50

Station	Rep	Sampling Date	2,6-dinitro-toluene	2,4-dinitro-toluene	n-nitroso-di-phenyl-amine	3,3'di-chloro-benzidine
MUK4	1	10/16/86	U10	U10	U10	U20
MUK4	2F	10/16/86	U10	U10	U10	U20
MUK4	Mean	10/16/86	U10	U10	U10	U20
MUK8		10/16/86	U10	U10	U10	U20
MUK12		10/16/86	U10	U10	U10	U20

TABLE A-21. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: MISCELLANEOUS AROMATIC COMPOUNDS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	2-methyl-naphthalene
E007		10/15/86	Z110
E011-1		10/29/86	Z430
E011-2		10/29/86	Z600
NORT		10/15/86	U10

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	2-methyl-naphthalene
MUK4	1	10/16/86	14
MUK4	2F	10/16/86	U10
MUK4	Mean	10/16/86	U10
MUK8		10/16/86	U10
MUK12		10/16/86	U10

TABLE A-22. CONCENTRATIONS (UG/KG DRY WEIGHT) OF RESIN ACID COMPOUNDS IN EVERETT HARBOR DRAIN SEDIMENTS

Station	Rep	Sampling Date	sand-araco-pimaric acid	iso-pimaric acid	dehydro-abietic acid	abietic acid	neo-abietic acid
E007		10/15/86	E69	E170	790	660	U200
E011-1		10/29/86	U150	U150	E29	U150	U150
E011-2		10/29/86	E140	E170	700	U290	U290
NORT		10/15/86	E390	E1600	4800	U340	U340

Station	Rep	Sampling Date	14-chloro-dehydro-abietic acid	12-chloro-dehydro-abietic acid	di-chloro-dehydro-abietic acid
E007		10/15/86	U200	U200	U200
E011-1		10/29/86	U150	U150	U150
E011-2		10/29/86	U290	U290	U290
NORT		10/15/86	U340	U340	U340

TABLE A-23. CONCENTRATIONS (UG/KG DRY WEIGHT) OF CHLORINATED PHENOLS AND GUAIACOLS IN EVERETT HARBOR DRAIN SEDIMENTS

Station	Rep	Sampling Date	2-chloro-phenol	2,4-di-chloro-phenol	2,4,6-tri-chloro-phenol	2,4,5-tri-chloro-phenol	2,3,4,6-tetra-chloro-phenol	penta-chloro-phenol
E007		10/15/86	U5	U5	E1	E2	E4	63
E011-1		10/29/86	U4	U4	U4	U4	U4	E3
E011-2		10/29/86	U13	44	170	E11	230	480
NORT		10/15/86	47	36	26	43	88	330

Station	Rep	Sampling Date	3,4,5-tri-chloro-guaiacol	4,5,6-tri-chloro-guaiacol	tetra-chloro-guaiacol
E007		10/15/86	U5	U5	U5
E011-1		10/29/86	U4	U4	U4
E011-2		10/29/86	U13	U13	U13
NORT		10/15/86	U20	U20	U20

TABLE A-24. CONCENTRATIONS OF EXTRACTABLE ORGANIC COMPOUNDS IN EVERETT HARBOR SOURCE SAMPLES: GROUP SUMS

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	low molecular weight aromatic hydro-carbons	high molecular weight aromatic hydro-carbons	total benzo-fluoran-thenes
E007		10/15/86	Z1800	Z5500	990
E011-1		10/29/86	Z8200	L14000	1000
E011-2		10/29/86	Z5800	Z4300	550
NORT		10/15/86	L56	L67	9

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	low molecular weight aromatic hydro-carbons	high molecular weight aromatic hydro-carbons	total benzo-fluoran-thenes
MUK4	1	10/16/86	E110	L98	U10
MUK4	2F	10/16/86	E69	L55	E2
MUK4	Mean	10/16/86	E88	L77	E2
MUK8		10/16/86	U60	U90	U10
MUK12		10/16/86	U60	U90	U10

TABLE A-25. CONCENTRATIONS (UG/KG DRY WEIGHT) OF TENTATIVELY IDENTIFIED ORGANIC COMPOUNDS IN EVERETT HARBOR DRAIN SEDIMENTS

Station	Rep	Sampling Date	cymene	1,2,4-tri-thiolane	base peak m/z 181, isomer 1	base peak m/z 181, isomer 2	di-benzo-thio-phene	hexa-decenoic acid methyl ester
E007		10/15/86	E20	U	U	U	E34	E24
E011-1		10/29/86	E100	E970	U	U	E210	U
E011-2		10/29/86	E370	U	E29	U	E40	U
NORT		10/15/86	E1.6	U	B	B	U	E10

Station	Rep	Sampling Date	hexa-decanoic acid methyl ester	hexa-decanoic acid	diter-penoid hydro-carbon	diter-penoid alcohol	retene	1-methyl-pyrene
E007		10/15/86	E140	E510	E16	U	U	E62
E011-1		10/29/86	E530	U	E80	E49	E88	E760
E011-2		10/29/86	E140	B	E89	U	U	E36
NORT		10/15/86	E42	E52	U	E1.0	U	U

Station	Rep	Sampling Date	alkanol	chol-esterol	camp-esterol
E007		10/15/86	E130	E40	U
E011-1		10/29/86	E760	U	U
E011-2		10/29/86	E61	U	U
NORT		10/15/86	E17	E51	U

TABLE A-26. CONCENTRATIONS OF PESTICIDES IN EVERETT HARBOR SOURCE SAMPLES

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	p,p'-DDE	p,p'-DDD	p,p'-DDT	aldrin	dieldrin	chlordane
E007		10/15/86	U1.0	U1.0	26	U5.0	13	U50
E011-1		10/29/86	U10	U10	U10	U5.0	U10	U50
E011-2		10/29/86	U10	U10	U10	U5.0	U10	U500
NORT		10/15/86	U1.0	U1.0	U1.0	U0.50	U1.0	U5.0

Station	Rep	Sampling Date	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (lindane)	alpha-endo-sulfan	beta-endo-sulfan
E007		10/15/86	U5.0	U5.0	U5.0	U5.0	U5.0	U1.0
E011-1		10/29/86	U5.0	U5.0	U5.0	U5.0	U5.0	U10
E011-2		10/29/86	U50	U50	U5.0	U50	U5.0	U10
NORT		10/15/86	U0.50	U0.50	U0.50	U0.50	U0.50	U1.0

Station	Rep	Sampling Date	endo-sulfan sulfate	endrin	hepta-chlor	hepta-chlor epoxide	toxa-phene	endrin ketone	methoxy chlor
E007		10/15/86	U10	U1.0	U5.0	U5.0	U100	U10	U50
E011-1		10/29/86	U10	U10	U5.0	U5.0	U100	U10	U50
E011-2		10/29/86	U10	U10	U50	U5.0	U100	U10	U50
NORT		10/15/86	U1.0	U1.0	U0.50	U0.50	U10	U1.0	U5.0

TABLE A-26. (CONTINUED)

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	p,p'-DDE	p,p'-DDD	p,p'-DDT	aldrin	dieldrin	chlordane
MUK4		10/16/86	U0.10	U0.10	U0.10	U0.05	U0.10	U0.50
MUK8		10/16/86	U0.10	U0.10	U0.10	U0.05	U0.10	U0.50
MUK12		10/16/86	U0.10	U0.10	U0.10	U0.05	U0.10	U0.50

Station	Rep	Sampling Date	alpha-HCH	beta-HCH	delta-HCH	gamma-HCH (lindane)	alpha-endo-sulfan	beta-endo-sulfan
MUK4		10/16/86	U0.05	U0.05	U0.05	U0.05	U0.05	U0.10
MUK8		10/16/86	U0.05	U0.05	U0.05	U0.05	U0.05	U0.10
MUK12		10/16/86	U0.05	U0.05	U0.05	U0.05	U0.05	U0.10

Station	Rep	Sampling Date	endo-sulfan sulfate	endrin	hepta-chlor	hepta-chlor epoxide	toxa-phene	endrin ketone	methoxy chlor
MUK4		10/16/86	U0.10	U0.10	U0.05	U0.05	U1.00	U0.10	U0.50
MUK8		10/16/86	U0.10	U0.10	U0.05	U0.05	U1.00	U0.10	U0.50
MUK12		10/16/86	U0.10	U0.10	U0.05	U0.05	U1.00	U0.10	U0.50

TABLE A-27. CONCENTRATIONS OF POLYCHLORINATED BIPHENYLS IN EVERETT HARBOR SOURCE SAMPLES

DRAIN SEDIMENTS (ug/kg DRY WEIGHT)

Station	Rep	Sampling Date	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total PCBs
E007		10/15/86								E220
E011-1		10/29/86								U50
E011-2		10/29/86								U50
NORT		10/15/86								U50

GROUNDWATER (ug/L)

Station	Rep	Sampling Date	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Total PCBs
MUK4		10/16/86	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U1.00	
MUK8		10/16/86	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U1.00	
MUK12		10/16/86	U0.50	U0.50	U0.50	U0.50	U0.50	U0.50	U1.00	

TABLE A-28. PERCENT TOTAL SOLIDS AND GRAIN SIZE DETERMINATIONS IN EVERETT HARBOR DRAIN SEDIMENTS

Station	Rep	Sampling Date	percent total solids	percent rocks	percent sand	percent silt	percent clay
E007	1	10/15/86	75.6	0.1	88.8	5.1	6.0
E007	2	10/15/86	75.8	0.2	88.3	7.2	4.3
E007	Mean	10/15/86	75.7	0.2	88.4	6.2	5.2
E011-1		10/29/86	76.5	4.8	93.5	1.4	0.3
E011-2		10/29/86	44.3	4.8	57.1	29.9	8.2
NORT	1	10/15/86	34.9	6.4	22.5	27.1	44.0
NORT	2	10/15/86	36.3	10.1	22.5	25.2	42.1
NORT	Mean	10/15/86	35.6	8.2	22.4	26.2	43.0

APPENDIX B

POTENTIAL CONTAMINANT SOURCES IDENTIFIED IN THE EVERETT HARBOR STUDY AREA

APPENDIX B

POTENTIAL CONTAMINANT SOURCES
IDENTIFIED IN THE EVERETT HARBOR STUDY AREA

EAST WATERWAY (EW)

Scott Pulp and Paper Company, 26th Street and Federal Avenue
- Nearshore diffuser S003
- Secondary treatment plant outfall S008
- S002 (historical)
- Storm drains

Port of Everett
- Hewitt Terminal Piers 1 and 3
- Pacific Terminal Piers B, D, and E
- South Terminal - Weyerhaeuser Sulfite/Thermomechanical Plant (closed)
- Storm drains

Anaconda aluminum dome

Everett Cold Storage (American Ice & Cold Storage), 2815 Federal Avenue

Mobil Oil Co. (Johnston Petroleum Products), 2731 Federal Avenue

Foss Tug, Port of Everett (between Pier B and Pier D)

Dunlap log yard

Dunlap Towing, 2702 Federal Avenue

Western Gear (closed), 2100 Norton Avenue

U.S. Naval Reserve

TAT, USA Corp. log yard

CSOs (City of Everett)

Storm drains (City of Everett)

OFFSHORE PORT GARDNER (OG)

Scott-Weyerhaeuser deepwater diffuser SW001

NEARSHORE PORT GARDNER (NG)

Mukilteo storm drains

Mukilteo WWTP

Defense Fuel Support Point - Mukilteo - outfalls M001 through M006

Boeing-Paine Field Area
- Snohomish County Airport-Paine Field
  - Air Force landfill
  - Underground storage tanks
- Boeing Commercial Aircraft, 3003 West Casino Road

John Fluke Mfg. Co., 9028 Evergreen Way

John Fluke Mfg. Co., 6920 Seaway Boulevard

Kohkoku (USA), Inc., 1407 - 80th Street SW

Associated Sand & Gravel, 6300 Glenwood Avenue

Creeks

Japanese Gulch	Phillips Creek
Edgewater Creek	Glenwood Creek
Powder Mill Gulch	Seahurst and Glenhaven Creek
Narbeck Creek	Pigeon Creek #2
Merrill and Ring Creek	Pigeon Creek #1

SNOHOMISH RIVER (SR)

Everett WWTP

Weyerhaeuser Kraft Mill, Alverson Boulevard
- outfalls WK002, WK004, and WK005

Everett Landfill

CSOs (City of Everett)

Storm drains (City of Everett and private)

Marshland Canal

Marina area
- Everett Marina, 1700 West Marine View Drive
  - Marina Village, 14th Street
- Boat repair businesses
  - Harbor Marine, 1402 West Marine Drive

Fisherman's Boat Shop, 949 - 14th Street
Everett Bayside Marine, 1001 - 14th Street
Performance Marine, 1130 West Marine Drive
Individual boat owners

Storm drains

Steuart Seafoods, 1520 West Marine View Drive

American Boiler Works, 1332 West Marine Drive

Tri-Coatings (Marpac), Inc., 1104 - 10th Street

Centrecon, 1130 West Marine View Drive

Norton Terminal

Log storage yards

Buse Timber, 3812 - 28th Place NE

Canyon Lumber, 3821 - 26th Place

E.A. Nord Co., 300 West Marine View Drive

Bay Wood Products, 200 West Marine View Drive

Pacific Plating, 2421 Hewitt Avenue

Custom Pacific Plating, 2421 Hewitt Avenue

Truckcare, 2730 Harrison

EBEY SLOUGH (ES)

Marysville storm drains

Marysville WWTP

Boeing test facility, Tulalip Indian Reservation

Tulalip Landfill

Quilceda Creek

Allen Creek

STEAMBOAT SLOUGH (SS)

Tulalip Landfill

Weyerhaeuser Kraft Mill - outfall WK001

UNION SLOUGH

Buse Mill

MISCELLANEOUS

Burlington Northern Railroad

Atmospheric deposition (Appendix G)

APPENDIX C

NPDES-PERMITTED DISCHARGERS AND CITY OF EVERETT INDUSTRIAL PRETREATMENT PERMITTED FACILITIES

APPENDIX C

NPDES-PERMITTED INDUSTRIAL DISCHARGERS AND CITY OF EVERETT INDUSTRIAL PRETREATMENT PERMITTED FACILITIES

NPDES-PERMITTED INDUSTRIAL DISCHARGERS

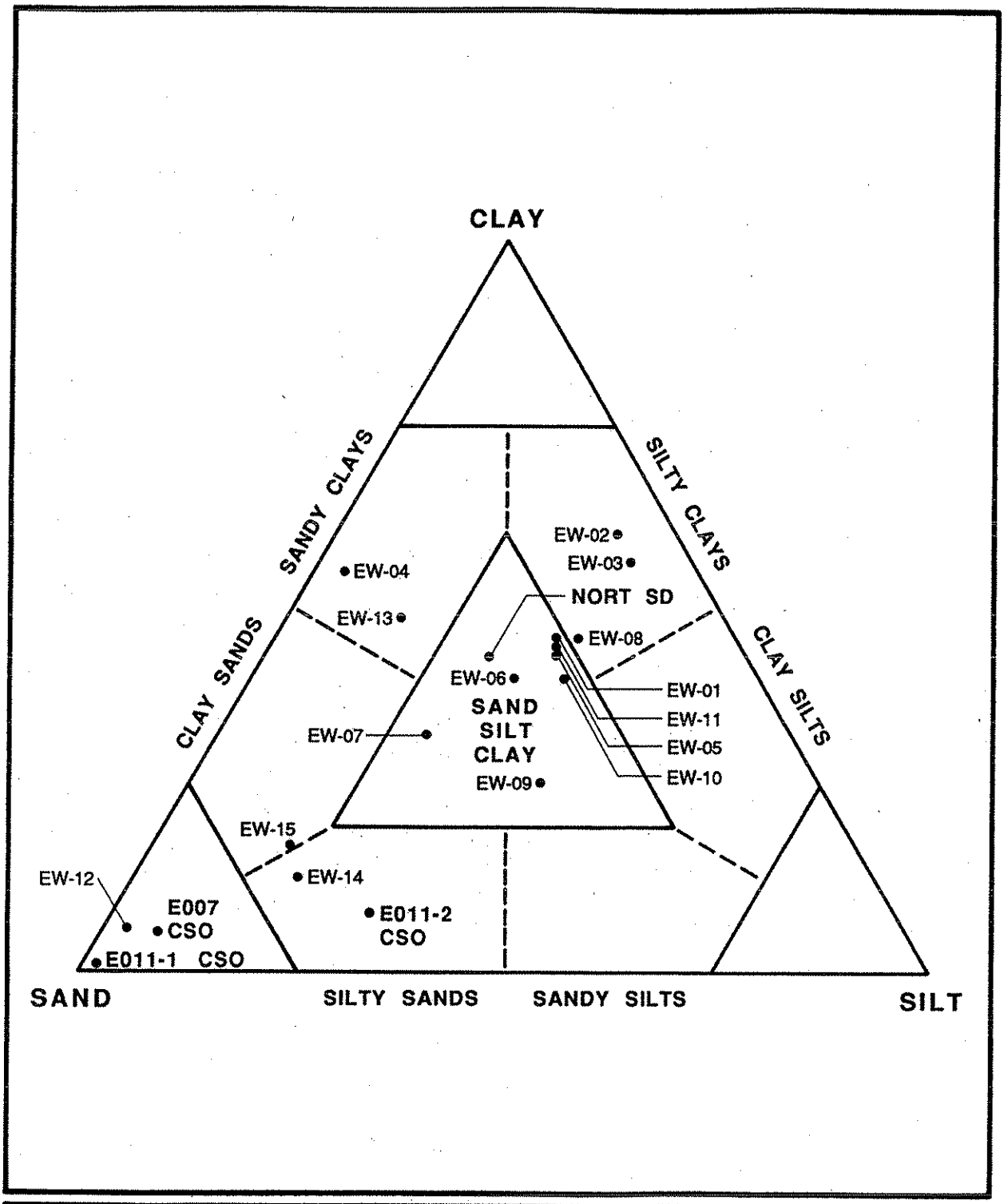
Defense Fuel Support Point - Mukilteo
Scott Pulp and Paper Co.
Weyerhaeuser Everett Kraft Mill

CITY OF EVERETT INDUSTRIAL PRETREATMENT PERMITTED FACILITIES

Boeing Commercial Airplane Co.
Centrecon
Custom Pacific Plating
John Fluke Mfg. Co. - Seaway Blvd.
John Fluke Mfg. Co. - Evergreen Way
Kohkoku (USA), Inc.
Pacific Plating
Cathcart Landfill
Stewart Seafood
Tri-Coatings, Inc. (Marpac)

APPENDIX D

GRAIN SIZE CHARACTERISTICS OF THE SEDIMENTS IN THE DRAINS AND OFFSHORE RECEIVING ENVIRONMENT IN THE EVERETT HARBOR STUDY AREA



Grain size characteristics of offshore and drain sediment samples collected from the East Waterway study segment (see Figure 11 for station locations).

APPENDIX E

ELEVATION ABOVE REFERENCE VALUES FOR CHEMICALS OBSERVED IN DRAIN SEDIMENTS

TABLE E-1. EAR VALUES FOR SELECTED METALS FOUND IN EVERETT HARBOR DRAIN SEDIMENTS[a]

Compound	24th Street and Bond Street (CSO E007)	Lift Station #5 Manhole 1 (CSO E011-1)	Lift Station #5 Manhole 2 (CSO E011-2)	Norton Terminal Storm Drain (NORT)
Arsenic	2.2	--[b]	5.1	4.0
Cadmium	--	--	26.6	--
Chromium	12.6	10.9	12.4	8.9
Copper	8.2	2.2	34.1	11.1
Lead	21.5	3.9	42.7	4.0
Nickel	3.3	2.7	4.9	4.0
Zinc	11.4	7.2	520	10.6
Mercury	15.1	--	37.5	5.8
Silver	4.9	--	32.6	4.0
Selenium	--	--	1.3	--
Antimony	86.2	153	176	55

[a] EARs are calculated by dividing the measured concentration of a contaminant in a sediment by the measured concentration of the contaminant in sediment from a reference area. Mean reference concentrations in sediments from Carr Inlet were obtained from Tetra Tech (1988b).

[b] -- = Concentrations of contaminants less than those found in the reference area sediments (i.e., an EAR of less than 1).

TABLE E-2. EAR VALUES FOR SELECTED EXTRACTABLE ORGANIC COMPOUNDS FOUND IN EVERETT HARBOR DRAIN SEDIMENTS[a]

Compound	24th Street and Bond Street (CSO E007)	Lift Station #5 Manhole 1 (CSO E011-1)	Lift Station #5 Manhole 2 (CSO E011-2)	Norton Terminal Storm Drain (NORT)
Phenol	--[b]	3.6	--	--
4-Methylphenol	2.4	254	3.7	3.3
Naphthalene	20.6	235	456	1.6
Acenaphthylene	15.6	46.3	188	--
Acenaphthene	56.1	366	20.5	--
Fluorene	41.5	268	31.7	--
Phenanthrene	62.3	200	115	--
Anthracene	44	132	26.4	--
Fluoranthene	61	299	84.4	--
Pyrene	64.6	347	76.4	--
Benzo(a)-anthracene	56.2	120	33.8	--
Chrysene	67.6	102	38.9	--
Bis(2-ethyl-hexyl)phthalate	38.2	64.7	25.3	2.3
Di-n-butyl-phthalate	--	--	4.4	--
Dimethyl-phthalate	--	--	6.2	--
Di-n-octyl-phthalate	2.4	--	2.1	--
Butylbenzyl-phthalate	9.4	--	10.6	--

TABLE E-2. (Continued)

Compound	24th Street and Bond Street (CSO E007)	Lift Station #5 Manhole 1 (CSO E011-1)	Lift Station #5 Manhole 2 (CSO E011-2)	Norton Terminal Storm Drain (NORT)
Benzo(a)pyrene	100	94.7	38.6	--
Indeno(1,2,3-cd)pyrene	81.2	56.2	35.4	--
Dibenzo(a,h)-anthracene	26.8	19.3	10.2	2.4
Benzo(g,h,i)-perylene	84.8	69.6	45.6	1.1
Total benzo-fluoranthenes	124	125	69	1.1
1,3-Dichloro-benzene	1.4	--	18.6	--
1,4-Dichloro-benzene	14.6	26.3	54.3	2.8
1,2-Dichloro-benzene	12	--	--	--
Benzoic acid	2.9	17.1	--	--
Dibenzofuran	45.9	351	184	--
N-nitroso-diphenylamine	9.8	--	43.9	5.6
2-Methyl-naphthalene	26.2	102	143	--
4'-DDT	2.6	--	--	--
Dieldrin	1.3	--	--	--
2-Chlorophenol	--	--	--	13.4
2,4-Dichloro-phenol	--	--	6.5	5.3

TABLE E-2. (Continued)

Compound	24th Street and Bond Street (CSO E007)	Lift Station #5 Manhole 1 (CSO E011-1)	Lift Station #5 Manhole 2 (CSO E011-2)	Norton Terminal Storm Drain (NORT)
2,4,6-Trichlorophenol	--	--	25.0	3.8
2,4,5-Trichlorophenol	--	--	1.1	4.3
Pentachlorophenol	1.9	--	14.5	10.0
Total PCBs	36.7	--	--	--
Total EAR	1,279	3,478	2,706	164

[a] EARs are calculated by dividing the measured concentration of a contaminant in a sediment by the measured concentration of the contaminant in sediment from a reference area. Mean reference concentrations in sediments from Carr Inlet were obtained from Tetra Tech (1988).

[b] -- = Concentrations of contaminants less than those found in reference area sediments (i.e., an EAR of less than 1).

TABLE E-3. EAR VALUES FOR SELECTED PULP INDUSTRY-RELATED COMPOUNDS FOUND IN EVERETT HARBOR DRAIN SEDIMENTS[a]

Compounds	24th Street and Bond Street (CSO E007)	Lift Station #5 Manhole 1 (CSO E011-1)	Lift Station #5 Manhole 2 (CSO E011-2)	Norton Terminal Storm Drain (NORT)
2-Chlorophenol	---[b]	---	---	---
2,4-Dichlorophenol	---	---	6.5	5.3
2,4,6-Trichlorophenol	---	---	25	3.8
2,4,5-Trichlorophenol	---	---	3.7	14
2,3,4,6-Tetrachlorophenol	---	---	77	29
Pentachlorophenol	1.9	---	14	10
3,4,5-Trichloroguaiacol	---	---	---	---
4,5,6-Trichloroguaiacol	---	---	---	---
Tetrachloroguaiacol	---	---	---	---
Sandaracopimaric acid	---	---	---	2.6
Isopimaric acid	---	---	---	11
Dehydroabietic acid (DHA)	13	---	11	76
Abietic acid	4.4	---	---	---
Neoabietic acid	---	---	---	---
14-Chlorodehydroabietic acid	---	---	---	---
12-Chlorodehydroabietic acid	---	---	---	---
Dichlorodehydroabietic acid	---	---	---	---

[a] EARs are calculated by dividing the measured concentration of a contaminant in a sediment by the measured concentration of the contaminant in sediment from a reference area. Mean reference concentrations in sediments from Port Susan were obtained from PTI and Tetra Tech (1988b).

[b] -- = Concentrations of contaminants less than those found in the reference area sediments (i.e., an EAR of less than 1).

APPENDIX F

DREDGING HISTORY IN THE EVERETT HARBOR STUDY AREA

APPENDIX F
DREDGING HISTORY IN THE EVERETT HARBOR STUDY AREA

Information on historical dredging was compiled to determine the potential for these activities to disturb offshore sediments, and therefore, affect interpretation of spatial patterns of chemical contamination.

Recent dredge and fill activity in the Everett Harbor study area is primarily for channel maintenance and for dock and terminal construction (Figure F-1). Dredging operations are currently conducted by the U.S. Army Corps of Engineers, the Port of Everett, and private landowners. The U.S. Army Corps of Engineers is responsible for the greatest volume of dredging activity in the Snohomish River. Maintenance dredging of the main navigation channel has been performed every few years since 1969 (see Table F-1). Almost twice as much material has been removed from the upstream settling basin as from the downstream settling basin. The Port of Everett is planning a variety of activities to upgrade and expand facilities along the eastern shore of Port Gardner and the southern portion of the East Waterway. A series of dredging and filling projects will be associated with these actions. The U.S. Navy ("Homeport") plans to dredge approximately 3.305 million yd^3 of sediment from the East Waterway in different phases beginning in 1988, pending court appeals.

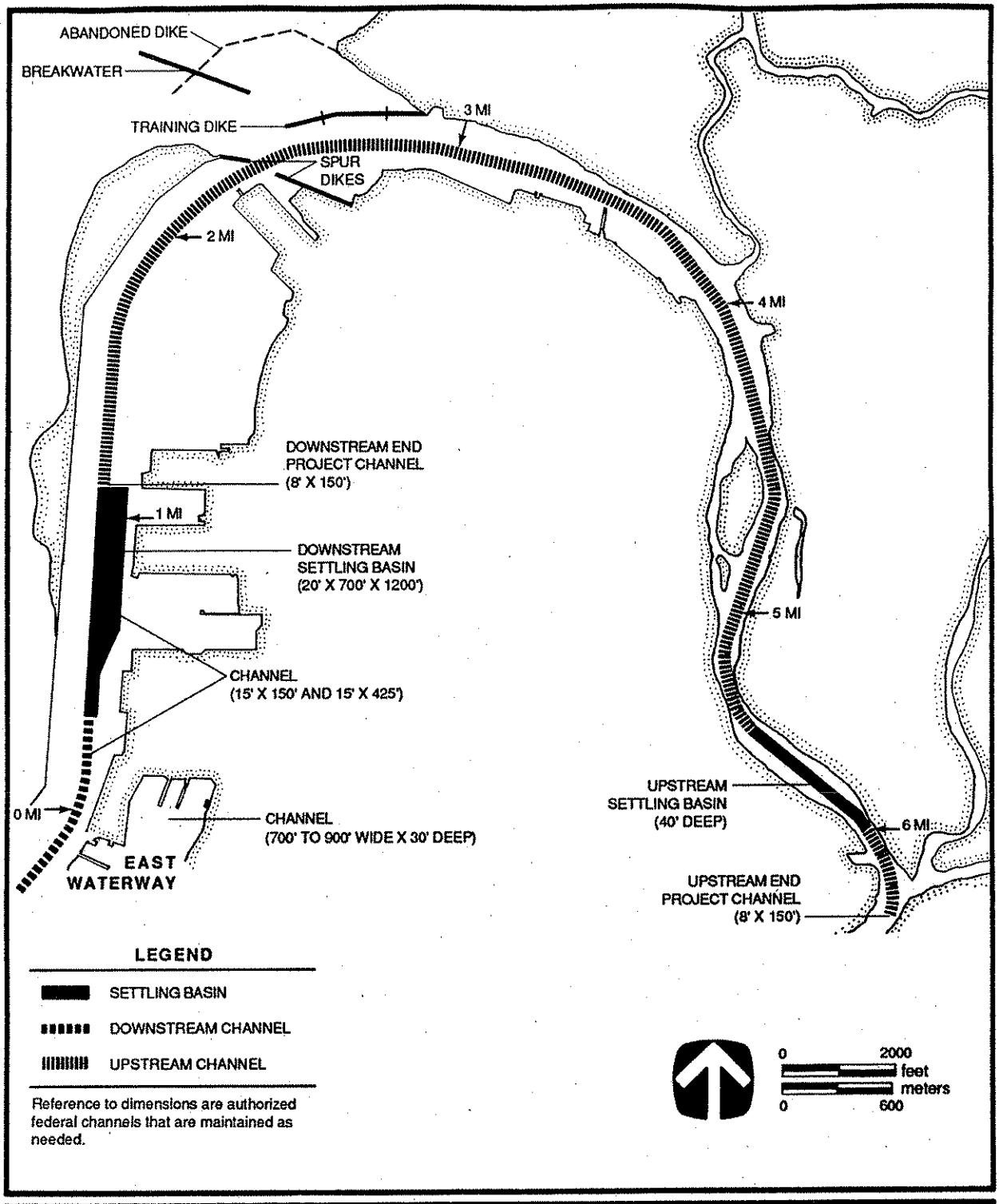


Figure F-1. Locations of dredging sites within the lower Snohomish River basin.

TABLE F-1. EVERETT HARBOR AND SNOHOMISH RIVER DREDGING SUMMARY 1969-1986

Year	Area Dredged	Volume (yd^3)
1969	Downstream basin and channel	452,704
1970-1	Upstream basin and channel	540,232
1974	Upstream basin and channel	278,500
1976-7	Downstream basin and channel	507,843
1978	East Waterway	131,919
1980	Upstream basin and channel	678,487
1983	Downstream basin and channel	208,427
1984	Upstream basin and channel	213,586
1986	Upstream basin and channel	181,582
Scheduled 1988	Upstream basin and channel	Estimated 350,000

Note: Dredged volumes from settling basins typically account for most of the total volume removed from basin and channel combined.

Reference: Arden, H. (8 June 1988, personal communication).

APPENDIX G

PUGET SOUND AIR POLLUTION REGISTRATION FILES IN THE EVERETT HARBOR STUDY AREA

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PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

SNOHOMISH CO (PAINE FIELD) AIRPORT

Reg #:21400
DOE #: 83

BLDG C-1, PAINE FIELD
SNOHOMISH COUNTY 98204

Mail to:
3000 ROCKAFELLER AVE
EVERETT, WA 98204

WILLIAM DOLAN AIRPORT INFORMATION OFFICER 353-2110
THOMAS WINTERS SAFETY SPECIALIST 259-9413

UTM: 554.00 / 5306.00

1988 ANNUAL ASBESTOS NOTIFICATION #889010

SIC # 4512 SCHEDULED AIR TRANSPORTATION
EPA Program: SIP Classification: A1

Inspection Record (CM File):

INSPECTED 12-02-83 HWD
12-24-84 RJG
12-11-85 RJG
02-12-87 MAM 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
FORMALDEHYDE	=	1	1	Lb
NICKEL	=	4	4	Lb

Kg/Day

	1986	1987

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	8	9
SOX	7	7
NOX	33	36
VOC	31	35
CO	616	730
PM10	7	9
TAC	0	0

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JUN 8, 1988, 1:09 PM

Registration File Listing

SNOHOMISH CO (PAINE FIELD) AIRPORT Reg #:21400

Air Contaminant Emissions:

	Kg/Day 1986	1987
TSPM	20	22
SOX	17	17
NOX	82	89
VOC	77	87
CO	1531	1814
PM10	17	22
TAC	0	0

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

BOEING COMMERCIAL AIRPLANE (EVERETT) Reg #:13120
DOE #: 39

3003 W CASINO RD, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 3707 MS OH-26
SEATTLE, WA 98124

FRED STEWART FACILITIES ENGINEERING MANAGER 342-1130
CONNIE CARLSON POLLUTION CONTROL ENGINEER 342-0871

UTM: 554.00 / 5307.40

1988 ANNUAL ASBESTOS NOTIFICATION #889045

SIC # 3721 AIRCRAFT
EPA Program: SIP Classification: A1

Inspection Record (CM File):

INSPECTED 06-13-81 RJG/AKN
09-16-81 HWD
12-10-81 HWD
09-29-82 RJG
07-13-83 HWD
06-13-84 HWD
01-07-85 RJG
07-18-85 RJG
09-29-86 JLH 2
08-27-87 PBB 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
ACETONE	=	7	12	Ton
AMMONIA	=	1962	1593	Lb
BUTANONE (METHYL ETHYL KETONE)	=	192	275	Ton
BUTYL ACETATE	=	30	9	Ton
BUTYL ALCOHOL	=	1047	1598	Lb
BUTYROLACTONE	=	0	3	Ton
CHROMIUM	=	10	2	Lb
CYCLOHEXANONE	=	32	41	Ton
ETHOXYETHYL ACETATE (CELLOSOLVE ACETATE)	=	27	34	Ton
ETHYL ACETATE	=	15	6	Ton
ETHYLENE GLYCOL	=	6	5	Ton
ETHYLENE GLYCOL MONOBUTYL ETHER (BUTYL CELLOSOLVE)	=	0	7	Ton
FORMALDEHYDE	=	124	31	Lb

PUGET SOUND AIR POLLUTION CONTROL AGENCY
JUN 8, 1988, 1:09 PM

Registration File Listing

BOEING COMMERCIAL AIRPLANE (EVERETT) Reg #:13120

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
ISOPROPYL ALCOHOL	=	13	24	Ton
MANGANESE	=	6	1	Lb
METHYL PENTANONE (METHYL ISOBUTYL KETONE)	=	7	10	Ton
NICKEL	=	203	48	Lb
SYNTHETIC RESIN	=	5	3	Ton
TOLUENE	=	128	105	Ton
TRICHLOROETHANE	=	222	26	Ton
TRICHLOROETHYLENE	=	4	2	Ton
XYLENE	=	43	59	Ton

		Kg/Day 1986	1987
ACETONE	=	16	31
AMMONIA	=	2	2
BUTANONE (METHYL ETHYL KETONE)	=	478	683
BUTYL ACETATE	=	76	22
BUTYL ALCOHOL	=	1	2
BUTYROLACTONE	=	0	7
CYCLOHEXANONE	=	78	101
ETHOXYETHYL ACETATE (CELLOSOLVE ACETATE)	=	67	85
ETHYL ACETATE	=	38	14
ETHYLENE GLYCOL	=	15	12
ETHYLENE GLYCOL MONOBUTYL ETHER (BUTYL CELLOSOLVE)	=	0	18
ISOPROPYL ALCOHOL	=	32	59
METHYL PENTANONE (METHYL ISOBUTYL KETONE)	=	17	26
SYNTHETIC RESIN	=	12	7
TOLUENE	=	319	262
TRICHLOROETHANE	=	552	64

PUGET SOUND AIR POLLUTION CONTROL AGENCY
JUN 8, 1988, 1:09 PM

Registration File Listing

BOEING COMMERCIAL AIRPLANE (EVERETT) Reg #:13120

Toxic Air Contaminant (TAC) Emissions (SP File):

		Kg/Day 1986	1987
TRICHLOROETHYLENE	=	10	5
XYLENE	=	108	147

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	21	14
SOX	207	55
NOX	217	222
VOC	754	860
CO	5807	6423
PM10	20	14
TAC	733	623

	Kg/Day 1986	1987
TSPM	52	35
SOX	514	137
NOX	539	552
VOC	1874	2138
CO	14433	15964
PM10	50	35
TAC	1821	1548

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

ASSOCIATED SAND AND GRAVEL CO INC — Reg #:10169
DOE #: 3

6300 GLENWOOD AVE, EVERETT
SNOHOMISH COUNTY 98203

Mail to:
PO BOX 2037
EVERETT, WA 98203

DALE SURDYK MANAGER 624-0301
GERALD CRANE MANGR PROPERTY & ENGR 355-2111

UTM: 556.80 / 5309.72

SIC # 3273 READY-MIXED CONCRETE
EPA Program: SIP NSPS Classification: A1

Inspection Record (CM File):

INSPECTED 11-12-81 HWD
05-13-82 HWD
06-30-83 RJG
09-27-83 JKA
05-14-84 HWD
05-23-84 HWD
05-15-85 RJG
07-07-86 RJG 2
07-15-86 RJG 2
08-25-87 JLH 2
04-14-88 RJG 1

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
CHROMIUM	=	3	4	Lb
FORMALDEHYDE	=	3	3	Ton
MANGANESE	=	2	2	Lb
NICKEL	=	63	72	Lb

Kg/Day

		1986	1987
FORMALDEHYDE	=	7	8

PUGET SOUND AIR POLLUTION CONTROL AGENCY
JUN 8, 1988, 1:09 PM

Registration File Listing

ASSOCIATED SAND AND GRAVEL CO INC — Reg #:10169

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	208	224
SOX	0	0
NOX	8	9
VOC	0	0
CO	2	2
PM10	37	38
TAC	3	3

	Kg/Day 1986	1987
TSPM	517	557
SOX	0	0
NOX	20	22
VOC	0	0
CO	5	5
PM10	92	94
TAC	8	8

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

U S DEFENSE FUEL SUPPLY AGENCY DLA — Reg #:16000
DOE #: 78

FRONT & PARK ST, MUKILTEO
SNOHOMISH COUNTY 98275

Mail to:
DFSC-FQ CAMERON STATION
ALEXANDER, VA 22304-6160

W E GOODE/HASAN DOGRUL — CHIEF ENVIR QUALITY DIV/CONTACT — 274-6989
JIM REYNOLDS/GEORGE HELMS — SUPERINTENDENT/REGIONAL ENGINEER — 355-2051

UTM: 552.50 / 5310.70

SIC # 5171 PETROLEUM BULK STATIONS AND TERMINALS
EPA Program: SIP — Classification: A1

Inspection Record (CM File):

INSPECTED 11-15-83 RJG
11-08-84 RJG
12-11-85 RJG
02-19-87 MAM 2
07-08-87 PBB 2

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	42	20
CO	0	0
PM10	0	0
TAC	0	0

	Kg/Day 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	104	50
CO	0	0
PM10	0	0
TAC	0	0

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

TIZ'S DOOR SALES INC

Reg #:16338
DOE #:

2118 38TH ST, EVERETT
SNOHOMISH COUNTY 98201-5021

Mail to:
PO BOX 1078
EVERETT, WA 98206

PAT MAAHS PRODUCTION MANAGER 259-4437

UTM: 559.80 / 5312.80

SIC # 2431 MILLWORK
EPA Program: SIP

Classification: B

Inspection Record (CM File):

INSPECTED 12-20-83 HWD
12-11-84 RJG
11-01-85 RJG
11-26-86 JLH 2
08-27-87 PBB 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
TOLUENE	=	11	11	Ton

		Kg/Day 1986	1987
TOLUENE	=	29	27

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	13	12
CO	0	0
PM10	0	0
TAC	11	11

PUGET SOUND AIR POLLUTION CONTROL AGENCY
JUN 8, 1988, 1:09 PM

Registration File Listing

TIZ'S DOOR SALES INC — Reg #:16338

Air Contaminant Emissions:

	Kg/Day 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	32	30
CO	0	0
PM10	0	0
TAC	27	27

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

PROVIDENCE HOSPITAL — Reg #:16006
DOE #:

916 PACIFIC AVE, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 1067
EVERETT, WA 98206-1067

CARL MUNDING/WALT SALINE	ADMINISTRATOR/ADMIN DIR BU SERV	258-7123
EUGENE GOEHRS	CHIEF ENGINEER	258-7854

UTM: 558.55 / 5313.75

SIC # 8062 GENERAL MEDICAL AND SURGICAL HOSPITALS
EPA Program: SIP Classification: B

Inspection Record (CM File):

INSPECTED 06-25-81 RJG
06-09-82 HWD
06-23-83 RJG
11-06-84 RJG
10-16-85 RJG
02-11-87 JLH 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
ETHYLENE OXIDE	=	1680	1700	Lb

		Kg/Day 1986	1987
ETHYLENE OXIDE	=	2	2

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	0	0
TAC	1	1

PUGET SOUND AIR POLLUTION CONTROL AGENCY
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Registration File Listing

PROVIDENCE HOSPITAL — Reg #:16006

Air Contaminant Emissions:

	Kg/Day 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	0	0
TAC	2	2

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

SCOTT PAPER CO NORTHWEST OPERATIONS

Reg #:12164
DOE #: 70

2600 FEDERAL AVE, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 925
EVERETT, WA 98206-0925

TIMOTHY BECHTEL ENVIRONMENTAL MANAGER 259-7393
ALEX M. HOOD UTILITIES MGR 259-7482

UTM: 558.50 / 5314.60

SIC # 2621 PAPER MILLS
EPA Program: SIP NESHAP Classification: A1

Inspection Record (CM File):

INSPECTED 11-09-81 HWD
05-19-82 HWD
05-23-83 RJG
05-16-84 HWD
05-30-85 RJG
02-27-87 JLH 2
07-08-87 PBB 2
03-22-88 RJG 1

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
CHLORINE	=	600	0	Lb
CHLOROFORM	=	22	22	Ton
CHROMIUM	=	1	3	Lb
DIOXINS	=	9	9	Lb
FORMALDEHYDE	=	23	30	Lb
MANGANESE	=	1	2	Lb
NICKEL	=	27	55	Lb
POM (POLYCYCLIC ORGANIC MATTER)	=	1023	1013	Lb
XYLENE	=	78	45	Ton

		Kg/Day 1986	1987
CHLORINE	=	1	0
CHLOROFORM	=	56	56

PUGET SOUND AIR POLLUTION CONTROL AGENCY
JUN 8, 1988, 1:09 PM

Registration File Listing

SCOTT PAPER CO NORTHWEST OPERATIONS — Reg #:12164

Toxic Air Contaminant (TAC) Emissions (SP File):

		Kg/Day 1986	1987
POM (POLYCYCLIC ORGANIC MATTER)	=	1	1
XYLENE	=	195	112

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	456	454
SOX	373	405
NOX	1310	1318
VOC	257	223
CO	3435	3404
PM10	373	371
TAC	101	68

	Kg/Day 1986	1987
TSPM	1133	1128
SOX	927	1007
NOX	3256	3276
VOC	639	554
CO	8538	8461
PM10	927	922
TAC	251	168

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

EVERETT PORT FACILITIES

Reg #:14024
DOE #: 9

PIER 1, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 538
EVERETT, WA 98206-0538

PHIL BANNON DIRECTOR 259-3164
ED PASKOVSKIS OPERATIONS MNGR 259-3164

UTM: 558.00 / 5314.00

SIC # 4491 MARINE CARGO HANDLING
EPA Program: SIP Classification: A1

Inspection Record (CM File):

INSPECTED 11-05-81 HWD
07-14-82 RJG
11-10-82 RJG
06-13-83 RJG
12-12-83 HWD
11-14-84 RJG
10-24-85 RJG
10-24-85 RJG
02-05-87 JLH 2
08-31-87 PBB 2

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	186	185
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	7	7
TAC	0	0

	Kg/Day 1986	1987
TSPM	462	460
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	17	17
TAC	0	0

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
JUN 8, 1988, 1:09 PM

Registration File Listing

SOUND CASKET MFG. CO., INC. — Reg #:14121
DOE #:

2815 BAKER AVE, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 1023
EVERETT, WA 98206-1023

KEN WASHO PRESIDENT 259-6012
E.R. CHRISTENSEN MANAGER 259-6012

UTM: 560.13 / 5314.19

SIC # 3995 BURIAL CASKETS
EPA Program: SIP Classification: B

Inspection Record (CM File):

INSPECTED 10-21-83 HWD
11-06-84 RJG
10-29-85 RJG
02-05-87 JLH 2
09-08-87 PBB 2
10-06-87 PBB 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
ACETONE	=	242	250	Lb
BUTANONE (METHYL ETHYL KETONE)	=	958	990	Lb
BUTYL ALCOHOL	=	242	250	Lb
HEXANE	=	1917	1980	Lb
ISOPROPYL ALCOHOL	=	242	250	Lb
METHANOL (METHYL ALCOHOL)	=	242	250	Lb
NAPHTHA VM&P	=	242	250	Lb
TOLUENE	=	484	500	Lb

		Kg/Day 1986	Kg/Day 1987
BUTANONE (METHYL ETHYL KETONE)	=	1	1
HEXANE	=	2	2
TOLUENE	=	1	1

PUGET SOUND AIR POLLUTION CONTROL AGENCY
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Registration File Listing

SOUND CASKET MFG. CO., INC. Reg #:14121

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	2	2
CO	0	0
PM10	0	0
TAC	2	2

	Kg/Day 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	5	5
CO	0	0
PM10	0	0
TAC	6	6

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
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Registration File Listing

CENTRECON INC

Reg #:11271
DOE #: 88

1130 W MARINE VIEW DR, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 28
EVERETT, WA 98206-0028

JAMES SCHACK PRESIDENT 258-2616
ROBERT SCHARF PLANT SUPERINTENDENT 258-2616

UTM: 558.70 / 5316.55

SIC # 3272 CONCRETE PRODUCTS
EPA Program: SIP Classification: B

Inspection Record (CM File):

INSPECTED 12-07-82 RJG
12-14-83 HWD
12-20-84 RJG
11-19-85 RJG
02-05-87 JLH 2
08-26-87 PBB 2

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	12	12
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	1	1
TAC	0	0

	Kg/Day 1986	1987
TSPM	30	30
SOX	0	0
NOX	0	0
VOC	0	0
CO	0	0
PM10	2	2
TAC	0	0

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
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Registration File Listing

NORD/JELD-WEN OF EVERETT INC — Reg #:10663
DOE #: 17

300 W MARINE VIEW DR, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
PO BOX 1187
EVERETT, WA 98206-1187

RONALD J MINER GENERAL MANAGER 259-9292
LEON WELLS MAINTENANCE MANAGER 259-9292

UTM: 558.91 / 5317.90

SIC # 2431 MILLWORK
EPA Program: SIP Classification: A1

Inspection Record (CM File):

INSPECTED 01-06-81 RJG
06-24-81 RJG
01-14-82 HWD
06-17-82 HWD
01-19-83 RJG
06-27-84 HWD
01-24-85 RJG
06-17-86 RJG 1
07-14-87 PBB 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
ACETALDEHYDE	=	1920	1730	Lb
FORMALDEHYDE	=	2	2	Ton
MANGANESE	=	4	4	Ton
PHENOL	=	8	7	Ton
POM (POLYCYCLIC ORGANIC MATTER)	=	32	29	Lb

		Kg/Day 1986	1987
ACETALDEHYDE	=	2	2
FORMALDEHYDE	=	5	4
MANGANESE	=	10	9
PHENOL	=	20	18

PUGET SOUND AIR POLLUTION CONTROL AGENCY
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Registration File Listing

NORD/JELD-WEN OF EVERETT INC — Reg #:10663

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	154	167
SOX	0	0
NOX	11	10
VOC	6	5
CO	104	94
PM10	110	112
TAC	15	14

	Kg/Day 1986	1987
TSPM	383	415
SOX	0	0
NOX	27	25
VOC	15	12
CO	258	234
PM10	273	278
TAC	37	34

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
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Registration File Listing

ALPINE RETREADERS (J&V INVESTMENTS) Reg #:12425
DOE #:

406 SE EVERETT MALL WAY #104, EVERETT
SNOHOMISH COUNTY 98208

Mail to:
2701 WALNUT AVE
EVERETT, WA 98201

JOHN BRONSON OWNER 259-0814
KEN EPPERLY MANAGER 347-5626

UTM: 560.60 / 5317.70

SIC # 7534 TIRE RETREADING AND REPAIR SHOPS
EPA Program: SIP Classification: B

Inspection Record (CM File):

INSPECTED 04-08-81 JLH
09-23-81 HWD
07-09-82 RJG
07-14-83 HWD
07-31-84 RJG
08-05-85 RJG
11-20-85 RJG
02-02-87 JLH 2
09-04-87 PBB 2
02-17-88 RJG 2

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
HEXANE	=	2	2	Ton

Kg/Day

		1986	1987
HEXANE	=	5	5

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	2	2
CO	0	0
PM10	0	0
TAC	2	2

PUGET SOUND AIR POLLUTION CONTROL AGENCY
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Registration File Listing

ALPINE RETREADERS (J&V INVESTMENTS) Reg #:12425

Air Contaminant Emissions:

	Kg/Day 1986	1987
TSPM	0	0
SOX	0	0
NOX	0	0
VOC	5	5
CO	0	0
PM10	0	0
TAC	5	5

PUGET SOUND AIR POLLUTION CONTROL AGENCY
200 W Mercer St #205, Seattle, WA 98119-3958
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Registration File Listing

WEYERHAEUSER CO, KRAFT MILL

Reg #:12754
DOE #: 8

101 E MARINE VIEW DR, EVERETT
SNOHOMISH COUNTY 98201

Mail to:
101 E MARINE VIEW DR
EVERETT, WA 98201

WILLIAM P MILLER 339-2800
HAROLD RUPPERT ENVIRONMENTAL SUPERVISOR 339-2868

UTM: 560.30 / 5318.30

SIC # 2611 PULP MILLS
EPA Program: SIP Classification: A1

Inspection Record (CM File):

INSPECTED 05-21-81 RJG
06-23-82 HWD
06-28-83 RJG
06-27-84 HWD
12-16-85 RJG
10-16-86 JLN 2
03-16-88 RJG 1
03-16-88 RJG 1

Toxic Air Contaminant (TAC) Emissions (SP File):

		1986	1987	
CHLORINE	=	23	0	Ton
CHLOROFORM	=	20	21	Ton
CHROMIUM	=	34	25	Lb
FORMALDEHYDE	=	160	119	Lb
HYDROGEN SULFIDE	=	32	0	Ton
MANGANESE	=	19	14	Lb
NICKEL	=	677	504	Lb
POM (POLYCYCLIC ORGANIC MATTER)	=	1	1	Lb

		Kg/Day 1986	1987
CHLORINE	=	57	0
CHLOROFORM	=	51	53
HYDROGEN SULFIDE	=	80	0
NICKEL	=	1	1

PUGET SOUND AIR POLLUTION CONTROL AGENCY
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Registration File Listing

WEYERHAEUSER CO, KRAFT MILL — Reg #:12754

Air Contaminant Emissions:

	Tons/Year 1986	1987
TSPM	538	549
SOX	1023	840
NOX	159	147
VOC	4	3
CO	943	993
PM10	285	287
TAC	75	21

	Kg/Day 1986	1987
TSPM	1337	1365
SOX	2543	2088
NOX	395	365
VOC	10	7
CO	2344	2468
PM10	708	713
TAC	188	53