

EPA 910/9-90-028

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10**

COMMENCEMENT BAY / PORT OF TACOMA

FIELD STUDY

JUNE 3, 1980

Commencement Bay/Port of Tacoma
Field Study - June 3, 1980

Both the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (COE) are conducting extensive studies in the Commencement Bay area which include water quality evaluations. Chlorinated organics (such as Hexachloro-1,3-butadiene), and heavy metals (such as arsenic) have been found in bottom sediments at various points in the Bay and its waterways. Fish abnormalities such as liver lesions have been observed. In a study conducted in 1979 by Battelle Pacific Northwest Laboratories for NOAA (Quantitation of Pollutants in Suspended Matter and Water from Puget Sound, NOAA Technical Memorandum ERL-MESA-49, April 1980), it was reported that both chlorinated organics and polynuclear aromatic compounds (such as naphthalene) were found in water samples taken from the mouths of the Hylebos and Blair Waterways. Based on that finding, NOAA determined to conduct intensive follow-up studies within the two waterways. Subsequently, they requested the Environmental Protection Agency's assistance in locating areas of concentration or actual or potential sources of chlorinated organics, polynuclear aromatics, and/or heavy metals in the surface waters of the two waterways and their respective drainages. EPA Region 10 was also interested in obtaining additional data in this area due to concern over the chemicals reported in the NOAA study and the Region's continuing program of investigating known or potential hazardous waste disposal sites. For the reasons cited above, a field investigation was planned and conducted.

The purpose of the investigation was to obtain preliminary information to be used by both EPA and NOAA in planning more detailed studies of toxic contaminants in the Commencement Bay area. Samples were obtained both from the waterways and from possible sources along the banks. The survey did not include collection of bottom sediment or fish samples.

Stations sampled are shown on Figure 1. All stations were sampled at the water surface. Additionally, some of the waterway stations were sampled at 20 feet below the surface to determine if water quality were influenced by depth. Those samples taken at depth have a (D) included on their station number in the tables. In addition to the two waterways referenced above, samples were collected at a control station near Browns Point, at the mouth of the Sitcum Waterway, and just off-shore midway between the Blair and Hylebos Waterways.

Data obtained is shown in the attached tables as follows:

Metals -- Table I
Purgeable Halocarbons -- Table II
Chlorinated Hydrocarbons -- Table III
Polynuclear Aromatics -- Table IV
Priority Pollutant Scan for Selected Stations -- Table V
Conductivity - Temperature Profile -- Table VI

Purgable halocarbons and chlorinated hydrocarbons as represented in the tables are subgroups of chlorinated chemicals divided for the purpose of this study primarily due to the method of analysis used to identify the specific chemical. Polynuclear aromatics represent a group of chemicals related to benzene in that they all contain one or more benzene ring (C_6H_6) as part of their chemical structure. They are presented separately here due to that unique characteristic.

The term "Priority Pollutant" refers to a list of 129 chemicals compiled by EPA following the June 1976 consent decree. This list includes those chemicals in Tables I, II, III, and IV as well as pesticides and other organic toxics.

It should be stressed that all samples were grab rather than composite and thus represent a point in time rather than a longer term condition. Also, abbreviated laboratory procedures modified from EPA's priority pollutant analytical protocol were used in hopes of obtaining rapid indications of possible trouble spots worthy of further study. Procedures used are referenced in the tables. All waterway sampling was done during the late stages of ebb tide and into the early stages of flood tide with the sequence of sampling going from the mouth of the waterways to the head.

In general, all groups of chemicals analyzed for were present to some extent in the waterways; however, there were very few indications of waterway concentrations in excess of suggested aquatic life criteria for salt water*. There were higher concentrations noted in some storm drains, bank seepage, and effluent samples. The amount of discharge at these points was generally low.

More specifically, the following observations were made:

Metals (Reference Table I)

Copper and selenium concentrations were in excess of recommended criteria in many of the waterway stations, including the control station. For other metals where criteria have been suggested, only arsenic was present in extremely high concentrations and only in "shoreside" samples. These shoreside samples were either storm drains or bank seepage and of low volume.

Purgeable Halocarbons (Reference Table II)

None of the waterway stations had concentrations in excess of recommended criteria (while 54 ug/l of trichloroethene was measured

* EPA-R3-73-033, March, 1973
EPA-440/9-76-023, July, 1976

at Station H₂, no criteria are available for comparison). Two shoreside stations (a bank seepage and storm drain both located on the property of Pennwalt Chemical Company) had elevated levels of tetrachloroethene and chloroform; however, these chemicals did not exceed criteria limits at the nearby waterway stations.

Chlorinated Hydrocarbons (Reference Table III)

One waterway station (H₇) had 2-chloronaphthalene at a concentration exceeding average criteria in the sample taken at 20 feet. A concentration of 3.6 ug/l was measured (average criteria level recommended is 2.8 ug/l; the maximum recommended level is 6.4 ug/l). Also, a large number of unidentified chlorinated hydrocarbons were present at Station H₆. Shoreside samples included large amounts of unknown chemicals in the Hooker effluent, and elevated hexachloroethane concentrations in a storm drain and bank seepage at Pennwalt. Again, while concentrations of hexachloroethane were high (101 and 225 ug/l) the flow rates were low and a relationship between these values and those observed in the waterway could not be established.

Polynuclear Aromatics (Reference Table IV)

Benzene was the only identified aromatic present in high concentrations at any station--in this case the storm drain along Lincoln Avenue flowing north to the Blair Waterway (S₂) and the Sound Refinery effluent (E₈). Large quantities of unidentified aromatics were present in three waterway samples as well as four shoreside samples.

Priority Pollutant Scan (Reference Table V)

Due to the high concentrations of chemicals from the above groups found in samples from Stations E₄, E₅ and E₆, the samples were analyzed for EPA's list of priority pollutants which includes 115 organics and 14 inorganic chemicals. This scan confirmed the presence of chemicals from the groups referenced in previous tables as well as additional chemicals representative of the pesticides group. The pesticides found were Dieldrin, 4,4'DDT, 4,4'DDE, Alpha Endosulfan, Endrin, Alpha BHC, Beta BHC, Lindane, and Delta BHC. Overall, 59 of the 129 chemicals were identified.

Summary

On June 3, 1980, samples were collected at 37 locations, including a control station, in the Commencement Bay area. The screening analytical procedure used was designed to look for 38 chemicals. This process showed that most of the chemicals were present in one or more stations but only 6 in concentrations which would be of concern if they were found in the waterways, based on recommended aquatic life criteria. "High"

concentrations were found at eight shoreside stations and one waterway station. Additional field studies are being planned by EPA as a continuing effort to locate and confirm areas of concentration and/or sources of toxic chemicals entering the aquatic environment of Commencement Bay and its waterways. Plans are now being made for a second screening survey of the two waterways in which additional bank seepage points will be investigated. Stations having high concentrations of any of the chemicals screened for on June 3rd will be resampled during the survey which should take place in late September or early October, 1980. Additionally, EPA will be meeting with NOAA and the Corps of Engineers in early September to discuss each agencies' efforts in the Commencement Bay area so that future studies can complement each other.

TABLE 1a
Metals* Hylebos Waterway, Tacoma, Wa

		Parameter														
Sample Time (DST)	Station No.	Lab. No.	Lead	Cadmium	Copper	Beryllium	Silver	Thallium	Selenium	Antimony	Arsenic	Zinc	Manganese	Chromium	Nickel	Mercury
13 50	C ₂ (control)	22200	16	.9	25	< 0.2	.3	1	23	< 2	12	30	10	2	13	.45
14 05	H ₁	22201	19	.6	20	< 0.2	.3	1	17	< 2	9	30	15	1	19	.3
14 05	H ₁ (D)	22202	35	2.0	73	.3	< .3	1	37	< 2	12	30	10	12	51	.3
14 15	H ₂	22203	28	1.6	59	< .2	< .3	1	23	< 2	18	35	20	4	30	.3
14 15	H ₂ (D)	22204	38	2.4	84	< .2	< .3	1	33	< 2	16	40	10	7	50	.38
14 25	H ₃	22205	15	1.2	75	< .2	< .3	1	20	< 2	15	40	20	3	29	.45
14 25	H ₃ (D)	22206	17	3.0	81	< .2	< .3	1	33	< 2	15	30	10	8	14	.3
14 32	H ₄	22207	26	1.0	60	< .2	.6	1	23	< 2	24	25	35	3	18	.3
14 36	H ₅	22208	16	1.4	80	< .2	.5	1	37	< 2	29	20	35	3	43	.3
14 39	H ₆	22209	15	1.2	73	< .2	< .3	1	23	< 2	27	50	40	3	36	.3
14 45	H ₇	22210	12	1.3	80	< .2	< .3	1	23	< 2	33	35	40	3	19	.3
14 45	H ₇ (D)	22211	16	2.8	83	.3	< .3	1	37	< 2	17	30	15	4	31	.3
14 48	H ₈	22212	10	2.9	56	1.0	.6	1	23	< 2	33	35	45	2	8	.45
14 52	H ₉	22213	10	1.6	75	.2	< .3	1	20	< 2	30	30	45	3	10	.3
14 52	H ₉ (D)	22214	9	3.1	98	.2	< .3	1	33	< 2	18	20	10	4	9	.3
14 57	H ₁₀	22215	23	2.6	81	< .2	< .3	1	30	< 2	26	40	40	3	11	.3
15 01	H ₁₁	22216	22	2.4	75	< .2	< .3	1	30	< 2	27	55	60	3	8	.3
15 05	H ₁₂	22217	17	.8	56	< .2	< .3	1	22	< 2	30	30	150	1	6	.45
15 05	H ₁₂ (D)	22218	25	2.1	85	< .2	< .3	1	40	< 2	18	20	< 10	7	64	.45
15 30	C ₂ (control)	22219	13	1.1	70	< .2	.4	1	27	< 2	11	30	< 10	2	10	.38
	Isco Blank	22220	3	< .1	8	< .2	< .3	1	< 2	< 2	< 2	20	< 10	5	15	.15

* Results expressed as micrograms per liter.

TABLE Ib
Metals* Blair Waterway, Tacoma, WA

Parameter																
Sample Time (DST)	Station No.	Lab. No.	Lead	Cadmium	Copper	Beryllium	Silver	Thallium	Selenium	Antimony	Arsenic	Zinc	Manganese	Chromium	Nickel	Mercury
13 35	C1	22250	15	.1	45	< 0.2	< .3	< 1	13	< 2	6	45	15	2	19	.68
13 35	C1(D)	22251	13	1.1	49	< 0.2	< .3	< 1	22	< 2	9	40	15	2	4	.45
13 50	B1	22252	16	.5	40	< 0.2	.3	< 1	12	< 2	6	40	10	2	2	.6
13 50	B1(D)	22253	18	3.5	25	< 0.2	< .3	< 1	30	< 2	15	30	< 10	7	11	.45
13 57	B2	22254	14	.4	35	< 0.2	.4	< 1	17	< 2	9	20	< 10	1	19	.45
14 05	B3	22255	14	.9	41	< 0.2	< .3	< 1	13	< 2	9	25	< 10	1	40	.38
14 05	B3(D)	22256	17	3.7	69	< 0.2	.3	< 1	27	< 2	14	30	10	8	27	.45
14 10	B4	22257	15	2.5	74	< 0.2	.5	< 1	27	< 2	12	40	10	3	32	.38
14 15	B5	22258	19	2.9	70	< 0.2	.4	< 1	23	< 2	12	60	15	3	17	.45
14 20	B6	22259	19	3.4	61	< 0.2	.3	< 1	22	< 2	15	25	35	3	23	.38
14 23	B7	22260	17	3.0	59	< 0.2	.4	< 1	27	< 2	12	50	30	3	20	.45
14 30	B8	22261	12	3.0	24	< 0.2	.3	< 1	32	< 2	12	30	35	2	17	.3
14 30	B8(D)	22262	14	3.8	21	< 0.2	.8	< 1	33	< 2	15	15	< 10	10	40	.38
14 57	C3	22263	15	.2	18	< 0.2	< .3	< 1	7	< 2	6	15	10	2	17	.38
14 57	C3(D)	22264	9	4.0	24	< 0.2	.4	< 1	27	< 2	15	15	< 10	8	18	.45
	Isco Blank	22265	5	< .1	5	< 0.2	< .3	< 1	< 2	< 2	< 2	15	< 10	< 1	37	.15

Suggested criteria
Aquatic Life-Salt Water
24-hr Avg (ug/l)
Maximum (ug/l)

?	1	.79	?	.26	?	4.4	?	29	?	-	24	220	0.9
?	16	18	?	.58	?	10	?	67	?	-	230	510	1.0

* Results expressed as micrograms per liter.

TABLE 1c
Metals* Shore Survey, Tacoma, Wa

Sample Time (P.M.)	Station	Lab. No.	Lead	Cadmium	Copper	Beryllium	Silver	Thallium	Selenium	Antimony	Arsenic	Zinc	Manganese	Chromium	Nickel	Mercury	pH	Estimated Flow (MGD)
10 40	E ₁ (Hooker)	22300	219	3.3	74	.4	.38	1	20	2	9	10	15	8	20	.38	4.2	15 Hooker
11 25	E ₁ (Pennwalt)	22302	13	3.2	74	.7	.25	1	22	2	33	30	25	9	35	.3	4.7	13 Pennwalt
11 40	E ₁ (Pennwalt)	22303	12	.5	50	.2	.38	21	7	127	7500	60	460	3	93	1.1	6.5	.003 "Storm drain"-Pennwalt
11 50	E ₅ (Pennwalt)	22304	157	6.2	363	.2	5.5	1	53	1634	12000	20	40	6954	200	28.8	13.4	.002 "Storm drain"-Pennwalt
11 50	E ₆ (Pennwalt)	22305	35	1.6	46	1.7	1.5	1	20	56	180	35	15	464	100	11.7	12.4	.002 Bank Seepage - Pennwalt
13 50	S ₅ (Hylebos Creek)	22312	10	.1	6	.2	.25	1	2	2	51	45	150	1	15	2.0	7.0	--
14 05	S ₄ (Wapato Creek)	22311	12	.1	8	.2	.5	1	2	2	3	30	150	4	8	.68	7.0	--
14 15	S ₃ (S. Drain to Blair)	22310	10	.3	35	.2	.25	1	8	2	6	60	1550	4	38	.68	7.0	--
14 40	S ₂ (Lincoln Dr. S.)	22309	35	.2	21	.2	.25	1	2	8	75	85	480	43	22	.45	5.5	--
14 45	S ₁ (Lincoln Dr. N.)	22308	17	.6	85	.3	.38	1	12	14	190	50	400	4	17	.45	7.2	--
14 50	S _{1a} (Lincoln Dr. N.)	22320	10	.1	26	.3	.25	1	2	9	216	55	375	3	40	1.1	7.2	--
15 30	E ₂ (Buffelen)	22301	13	.1	6	.2	.50	1	7	2	15	20	30	1	13	.38	7.1	.007 Buffelen
15 45	E ₇ (Nr. Kaiser)	22306	13	.2	23	.2	1.38	1	2	2	18	25	125	2	12	1.1	7.5	1.5 Kaiser Effluent & Drainage
16 00	E ₈ (Sound Refin.)	22307	21	1.5	16	.2	1.0	1	7	2	3	90	40	11	17	.83	4.0	.072 Sound Refining
Sediment - (ug/gm)																		
11 50	E ₆	22321**	165	.8	78	.14	.5	.2	0.34	24	162	384 380	286	426	75	.44		

* Results expressed as micrograms per liter.

** Analysis of sediment sample for magnesium = 70,000 ug/g.

Notes on Table II Procedures

The procedure followed is referenced in the Federal Register, Vol. 44; No. 231, Thursday, November 29, 1979, p. 68672 under Part I - The Analysis of Trihalomethanes in Drinking Water by the Purge and Trap Method. The method is summarized as follows:

Purgeable Halocarbons, exhibiting low water solubility and a greater vapor pressure than water are sparged from an aqueous sample by an inert gas. These compounds are trapped in a suitable sorbent. The trapped compounds are thermally desorbed and backflushed to a gas chromatograph column where they are separated under programmed conditions. A halogen-specific detector, namely a Hall Detector, was used for the quantitation.

The results are summarized in Table IIa (Hylebos Waterway), Table IIb (Blair Waterway) and Table IIc (Shore Survey).

Samples #22302, 22303, 22304, 22305 and 22309 were also analyzed by GC/MS for confirmation.

TABLE IIa--continued

Purgeable Halocarbons* Hylebos Waterway, Tacoma, WA

Label No.	Location	Description	Chloro- form	Dichloro- bromo- methane	Chloro- dibromo- methane	Bromo- form	Carbon- tetra- chloride	1,2-Di- chloro- ethane	1,2-(trans) Dichloro- ethene	Methylene chloride	Tetra- chloro- ethene	1,1,1-Tri- chloro- ethane	Tri- chloro- ethene
22216	H-11(C)	Hydrosere below Tacoma Boat	2.4	-	-	-	-	-	-,T	-	-	-	1.6
22217	H-12(S)	Hylebos Turning Basin	-	-	-	-	-	-	1.3	-	-	-	1.1
22218	H-12(D)	Hylebos Turning Basin	-	-	-	-	-	-	-,T	-	-	-	1.7
22219	C-2	Browns Point - Control (2nd)	-	-	-	-	-	-	-	-	-	-	-
22220		ISCO Blank - Hylebos W.W.	-	-	-	-	-	-	-	-	-	-	-
		VOA Blank - Hylebos W.W.	-	-	-	-	-	-	-	-	-	-	-
Suggested Criteria													
Aquatic Life - Salt Water													
		24-hour average (ug/l)	620	-	-	180	2000	880	-	1900	79	240	-
		Maximum (ug/l)	1400	-	-	420	4600	2000	-	4400	180	540	-

* = Results expressed as micrograms per liter.

** = Less than 1 microgram per liter.

T = Detected at less than 1 microgram per liter but quantitation at this level is unreliable.

TABLE IIb

Purgeable Halocarbons* Blair Waterway, Tacoma, WA

Lab. No.	Station No.	Site Description	Chloro-form	Dichloro-bromo-methane	Chloro-dibromo-methane	Bromo-form	Carbon-tetra-chloride	1,2-Di-chloro-ethane	1,2-(trans) Dichloro-ethene	Methylene chloride	Tetra-chloro-ethene	1,1,1-Tri-chloro-ethane	Tri-chloro-ethene
22250	C-1(S)	Commencement Bay, Alexander Ave.	1.9	-**	-	-	-	-	-	-	-	-	-
22251	C-1(D)	Commencement Bay, Alexander Ave.	2.3	-	-	-	-	-	-	-	-	-	-,T
22252	B-1(S)	Mouth, Blair Waterway	1.7	-	-	-	-	-	-	-	-	-	-
22253	B-1(D)	Mouth, Blair Waterway	1.4	-	-	-	-	-	-	-	-	-	-
22254	B-2(S)	N.Shore-Middle Multiship Pier	1.9	-	-	-	-	-	-	-	-	-	-,T
22255	B-3(S)	Below 11th St. Bridge	2.0	-	-	-	-	-	-	-	-	-	-,T
22256	B-3(D)	Below 11th St. Bridge	1.4	-	-	-	-	-	-	13	-	-	-
22257	B-4(S)	S.Shore below Stauffer Chemical	1.7	-	-	-	-	-	-	-	-	-	-
22258	B-5(S)	N. Shore below Lincoln Street	1.3	-	-	-	-	-	-	-	-	-	-
22259	B-6(S)	Above Lincoln St. - 100 yards	1.7	-	-	-	-	-	-	3.4	-	-,T	-
22260	B-7(S)	S.Shore below Buckeye Pipeline Co	1.7	-	1.2	-	-	-	-	3.2	-	1.2	-
22261	B-8(S)	Blair Turning Basin	1.6	-	1.1	-	-	-	-	-	-	-	-
22262	B-8(D)	Blair Turning Basin	1.4	-	-	-	-	-	-	-	-	-	-
22263	C-3(S)	Sitcum Waterway	1.8	-	-	-	-	-	-	-	-	-	-
22264	C-3(D)	Sitcum Waterway	1.9	-	-	-	-	-	-	-	-	-	-
22265		ISCO Blank - Blair W.W.	-	-	-	-	-	-	-	-	-	-	-
		VQA Blank - Blair W.W.	-	-	-	-	-	-	-	-	-	-	-

*, **, T Footnotes: See Table IIa

TABLE IIc

Purgeable Halocarbons* Shore Survey, Tacoma, WA

Lab. No.	Station No.	Site Description	Chloro- form	Dichloro- bromo- methane	Chloro- dibromo- methane	Bromo- form	Carbon- tetra- chloride	1,2-Di- chloro- ethane	1,2-(trans) Dichloro- ethene	Methylene chloride	Tetra- chloro- ethene	1,1,1-Tri- chloro- ethane	Tri- chloro- ethene
22300	E ₁	Hooker Effluent	17	1.1	2.2	1.7	-	-	-	1.3	3.0	-	-
22301	E ₂	Buffelen Cooling Water	-**	-	-	-	-	-	-	-	-	-	-
22302	E ₃	Pennwalt Effluent	28+	-,T	1.5	9.5+	2.1	-	-	1.3+	3.3+	-	1.4+
22303	E ₄	Pennwalt Storm Drain	20+	1.2	2.6	3.4	-	-	-	38+	-	-	-
22304	E ₅	Pennwalt Storm Drain	570+	-	-	2.3+	35+	15	-	21+	95+	6.5+	6.8+
22305	E ₆	Pennwalt Bank Seepage	1700+	-	-	-	20+	-	-	17+	1500+	-	21+
22306	E ₇	Taylor Way Drain (Kaiser Effluent & local drainage)	15	1.3	-	-	-	-	-	1.3	-	-	-
22307	E ₈	Sound Refining	-	-	-	-	-	-	-	-,T	-	1.8	-
22308	S ₁	N. Blair Drain	1.8	-	-	-	-	-	-	-,T	-	-	-,T
22309	S ₂	S. Blair Drain	5.7+	-	1.5	-	-	-,T	-,T	34+	-	18+	4.4+
22310	S ₃	Pt. of Tacoma Rd.	-	-	-	-	-	-	-	-,T	-	-	-
22311	S ₄	Wapato Creek	-	-	-	-	-	-	-	1.2	-	-	-
22312	S ₅	Hylebos Creek	-	-	-	-	-	-	-	-,T	-	-	-
22320	S _{1a}	Reichhold Storm Drain	2.4	-	-	-	-	-	1.0	1.3	-	-	1.5
		VOA Blank with Thio Sulfate	-	-	-	-	-	-	-	-	-	-	-

* = Results expressed as micrograms per liter.

** = Less than 1 microgram per liter.

T = Detected at less than 1 microgram per liter but quantitation at this level is unreliable.

+ = Identification confirmed by GC/MS.

TABLE IIIa

Chlorinated Hydrocarbons* Hylebos Waterway, Tacoma, WA

[illegible]

TABLE IIIa -- continued

Chlorinated Hydrocarbons* Hylebos Waterway, Tacoma, WA

Lab. No.	Station No.	Site Description	1,2-Di-chloro-benzene	1,3-Di-chloro-benzene	1,4-Di-chloro-benzene	Hexa-chloro-ethane	Hexa-chloro-butadiene	1,2,4-Tri-chloro-benzene	2-chloro-naphtha-lene	Hexa-chloro-benzene	Remarks
22216	II-11(S)	N. Shore below Tacoma Boat	-	-	-	-	-	-	-	-	
22217	II-12(S)	Hylebos Turning Basin	-	-	-	-	-	-	-	-	
22218	II-12(D)	Hylebos Turning Basin	-	-	-	-	-	-	-	-	
22219	C-2	Browns Point - Control (2nd)	-	-	-	-	-	-	-	-	
22220		ISCO Blank - Hylebos W.W.	-	-	-	-	-	-	-	-	

Suggested Criteria

Aquatic Life - Salt Water
 24-hour average (ug/l)
 Maximum (ug/l)

15	22	15	7	?	3.4	2.8	?
34	49	34	16	?	7.8	6.4	?

Notes on Table III procedure: To achieve a "rapid" screening of the samples for chlorinated hydrocarbons, approximately two liters of samples was extracted only once with hexane. The extract was concentrated on a steam bath using Kuderna-Danish glassware. The analysis was completed by gas chromatography with a halogen-specific detector, namely a Hall Detector, for the quantification.

* Results expressed as micrograms per liter.

** - = less than 1 microgram per liter.

I - detected at less than 1 microgram per liter but quantitation at this level is unreliable.

TABLE IIIb

Chlorinated Hydrocarbons* Blair Waterway, Tacoma, WA

Lab No.	Site No.	Site Description	1,2-Di-chloro-benzene	1,3-Di-chloro-benzene	1,4-Di-chloro-benzene	Hexa-chloro-ethane	Hexa-chloro-butadiene	1,2,4-Tri-chloro-benzene	2-chloro-naphthalene	Hexa-chloro-benzene	Remarks
22250	C-1(S)	Commencement Bay, Alexander Ave.	-**	-	-	-	-	-	-	-	
22251	C-1(D)	Commencement Bay, Alexander Ave.	-	-	-	-	-	-	-	-	
22252	B-1(S)	Mouth, Blair Waterway	-	-	-	-	-	-	-	-	
22253	B-1(D)	Mouth, Blair Waterway	-	-	-	-	-	-	-	-	
22254	B-2(S)	N. Shore - Middle Multiship Pier	-	-	-	-	-	-	-	-	
22255	B-3(S)	Below 11th St. Bridge	-	-	-	-	-	-	-	-	
22256	B-3(D)	Below 11th St. Bridge	-	-	-	-	-	-	-	-	
22257	B-4(S)	S. Shore below Stauffer Chemical	-	-	-	-	-	-	-	-	
22258	B-5(S)	N. Shore below Lincoln St.	-	-	-	-	-	-	-	-	
22259	B-6(S)	Above Lincoln St. - 100 yards	-	-	-	-	-	-	-	-	
22260	B-7(S)	S. Shore below Buckeye Pipeline Co.	-	-	-	-	-	-	-	-	
22261	B-8(S)	Blair Turning Basin	-	-	-	-	-	-	-	-	
22262	B-8(D)	Blair Turning Basin	-	-	-	-	-	-	-	-	
22263	C-3(S)	Sitcum Waterway	-	-	-	-	-	-	-	-	
22264	C-3(D)	Sitcum Waterway	-	-	-	-	-	-	-	-	
22265		ISCO Blank - Blair W.W.	-	-	-	-	-	-	-	-	

Footnotes: See Table IIIa

TABLE IIIc

Chlorinated Hydrocarbons* Shore Survey, Tacoma, WA

Lab. No.	Station No.	Site Description	1,2-Di-chloro-benzene	1,3-Di-chloro-benzene	1,4-Di-chloro-benzene	Hexa-chloro-ethane	Hexa-chloro-butadiene	1,2,4-Tri-chloro-benzene	2-chloro-naphtha-lene	Hexa-chloro-benzene	Remarks
22300		Hooker Effluent	-**	-	-	-	-	-	-	-,T	High levels of chlorinated organ-ics-not identified
22301		Buffelen Cooling Water	-	-	-	-	-	-	-	-	
22302		Pennwalt Effluent	-	-	-	-	-	-	-	-	
22303		Pennwalt #2	-	-	-	-	-	-	-	-	High levels of chlorinated organ-ics-not identified
22304		Pennwalt #3	-	-	-	101	-	-	-	-	
22305		Pennwalt #4	-	-	-	225	-	-	-	-	
22306		Taylor Way Drain	-	-	-	-	-	-	-	-	
22307		Sound Refining	-	-	-	-	-	-	-	-,T	
22308		N. Blair Drain	-	-	-	-	-	-	-	-,T	
22309		S. Blair Drain	-	-	-	-,T	-	-	-	-	
22310		Pt. of Tacoma Rd.	-	-	-	-	-	-	-	-	
22311		Wapato Creek	-,T	-	-	-	-	-	-	-	
22312		Hylebos Creek	-	-	-	-	-	-	-	-	
22320		Reichhold Storm Drain	-,T	-	-	-	-	-	-	-	

* Results expressed as micrograms per liter.

** - = less than 1 microgram per liter.

T = detected at less than 1 microgram per liter but quantitation at this level is unreliable.

TABLE IVa

POLYNUCLEAR AROMATIC RESULTS* HYLEBOS WATERWAY, TACOMA, WA

ab. lo.	Station No.	Site Description	Benzene	Toluene & Xylene	Naphthalene	Fluoranthene	Other PNAs***	Remarks
2200	C-2	Browns Point - Control (1st)	4	4	---	---	---	
2201	H-1(S)	Mouth of Hylebos Waterway	13	4	-	-	-	
2202	H-1(D)	Mouth of Hylebos Waterway	27	4	-	-	-	
2203	H-2(S)	S. Shore below Hooker	12	4	-	-	-	
2204	H-2(D)	S. Shore below Hooker	14	4	-	-	-	
2205	H-3(S)	Mid channel below 11th St. Br.	160	4	-	-	-	
2206	H-3(D)	Mid channel below 11th St. Br.	7	4	-	-	-	
2207	H-4(S)	N. Shore below Sound Refining	59	4	-	-	-	
2208	H-5(S)	S. Shore below Buffelen	17	4	-	-	-	
2209	H-6(S)	N. Shore across from Lincoln St.	4	4	-	-	-	
2210	H-7(S)	S. Shore below Pennwalt	4	4	-	-	-	Other unidentified aromatics present
2211	H-7(D)	S. Shore below Pennwalt	6	4	-	-	-	
2212	H-8(S)	N. Shore across from Pennwalt	208	4	-	-	-	
2213	H-9(S)	N. Shore W. Edge General Metals	36	4	-	-	-	
2214	H-9(D)	N. Shore W. Edge General Metals	10	4	-	-	-	
2215	H-10(S)	S. Shore below Kaiser Drain	156	4	2.3	-	-	Other unidentified aromatics present.
2216	H-11(S)	N. Shore below Tacoma Boat	4	4	-	-	-	
2217	H-12(S)	Hylebos Turning Basin	4	4	-	-	-	

TABLE IVa--Continued

POLYNUCLEAR AROMATIC RESULTS* HYLEBOS WATERWAY, TACOMA, WA

Lab. No.	Station No.	Site Description	Benzene	Toluene & Xylene	Naphthalene	Fluoranthene	Other PNAs***	Remarks
22218	H 12(0)	Hylebos Turning Basin	8	4	-	-	-	
22219	.	Bridge Point - Control (Ind)	4	4	-	-	-	
22220		ISCO Blank - Hylebos Waterway	4	4	-	-	-	
			<u>Toluene Xylene</u>					
Suggested criteria								
Aquatic life - saltwater								
24 hour avg. (ug/l)			920	100	?	?	0.3	?
Maximum (ug/l)			2100	230	?	?	0.69	?

* = Results expressed as micrograms per liter. To achieve a "rapid" screening of the samples for polynuclear aromatics either 500 ml or one liter of sample was extracted and concentrated using SEP-PAK cartridges from Waters, Associates. (Method as per Waters, Associates.) The analysis was completed by HPLC using both fluorescence and UV detectors in series.

** = Less than 0.5 micrograms per liter.

*** = Acenaphthylene Chrysene
 Anthracene Dibenzo (ah)-anthracene
 Benzo (a) anthracene Fluorene
 Benzo (a) pyrene Phenanthrene
 Benzo (b) fluoranthene Pyrene
 Benzo (ghi) perylene
 Benzo (k) fluoranthene

† = Detected at less than 0.5 micrograms per liter but quantitation at this level is unreliable.

TABLE IVb

POLYNUCLEAR AROMATIC RESULTS* BLAIR WATERWAY, TACOMA, WA

Lab. No.	Station No.	Site Description	Benzene	Toluene & Xylene	Naphthalene	Fluoranthene	Other PNAs	Remarks
22250	C-1(S)	Commencement Bay, Alexander Ave.	250	4	—**	—**	—**	
22251	C-1(D)	Commencement Bay, Alexander Ave.	202	4	—	—	—	
22252	B-1(S)	Mouth, Blair Waterway	4	4	—	—	—	
22253	B-1(D)	Mouth, Blair Waterway	10	4	—	—	—	
22254	B-2(S)	N. Shore-Middle Multiship Pier	4	4	—	—	—	
22255	B-3(S)	Below 11th St. Bridge	4	4	—	—	—	
22256	B-3(D)	Below 11th St. Bridge	4	4	—	—	—	
22257	B-4(S)	S. Shore below Stauffer Chemical	4	4	—	—	—	Other unidentified aromatics present
22258	B-5(S)	N. Shore below Stauffer Chemical	4	4	—	—	—	
22259	B-6(S)	Above Lincoln St. - 100 yards	79	4	—	—	—	
22260	B-7(S)	S. Shore below Buckeye Pipeline Co.	21	4	—	—	—	
22261	B-8(S)	Blair Turning Basin	4	4	—	—	—	
22262	B-8(D)	Blair Turning Basin	12	4	—	—	—	
22263	C-3(S)	Sitcum Waterway	51	4	—	—	—	
22264	C-3(D)	Sitcum Waterway	6	4	—	—	—	
22265		ISCO Blank - Blair Waterway	4	4	—	—	—	

Footnotes: See Table IVa

TABLE IVc
POLYNUCLEAR AROMATIC RESULTS* SHORE SURVEY, TACOMA, WA

Lab. No.	Station No.	Site Description	Benzene	Toluene & Xylene	Naphthalene	Fluoranthene	Other PNAs***	Remarks
22300		Miller Effluent	4	4	---	---	---	
22301		Buttelen Cooling Water	4	4	-	-	-	
22302		Pennwalt Effluent	4	4	-	-	-	
22303		Pennwalt #2	85	4	-	-	-	
22304		Pennwalt #3	4	4	-	-	-	
22305		Pennwalt #4	80	80	-	-	-	Other unidentified aromatics present-high concentration.
22306		Taylor Way Drain	4	4	-	-,T	-	Other unidentified aromatics present.
22307		Sound Refining	2500	4	-	-	-	
22308		N. Blair Drain	4	4	-	-	-	
22309		S. Blair Drain	1260	4	-	-	-	
22310		Port of Tacoma Rd.	4	4	-	-	-	Other unidentified aromatics present.
22311		Wapato Creek	76	4	-	-	-	
22312		Hylebos Creek	26	4	-	-	-	
22320		Richhold Storm Drain	422	4	8.9	-	-	Other unidentified aromatics present.

* = Results expressed as micrograms per liter.

** = less than 0.5 micrograms per liter.

*** = See Table IVa.

= Detected at less than 0.5 micrograms per liter but quantitation at this level is unreliable.

TABLE V*

Priority Pollutant Scan and Compound Confirmation at Selected Stations
Hylebos - Blair Waterways Survey, June 3, 1980

(Table Va - Pesticides/PCB's)**, ***

Lab. No.	Station No.	Site Description	Dieldrin	4,4'DDT	4,4'DDE	Alpha Endosulfan	Endrin	Alpha BHC	Beta BHC	Gamma BHC (Lindane)	Delta BHC	Endosulfan Sulfate	Endrin Aldehyde	Toxa- phene	PCB's
22303	F ₄	Storm Drain at Pennwalt	-	.30	-	.12	-	.25	.32	.12	.06	<.10	<.10	<.10	<.10
22304	E ₅	Storm Drain at Pennwalt	.04	.08	.37	-	0.04	.19	-	.36	-	<.10	<.10	<.10	<.10
22305	E ₆	Bank Seepage at Pennwalt	.09	1.91	.24	.22	.03	.10	-	.28	-	<.10	<.10	<.10	<.10

* All data reported in ug/l unless noted otherwise. Refer to Table I for metals.

** Complete scan done for this group, compounds not detected at 0.01 ug/l are not listed, those with higher detection limits are listed at <0.10 ug/l.

*** Extraction per Priority Pollutant Protocol. Analysis by GC/EC with dual column confirmation.

TABLE Vb

(Base/Neutral Extractibles (++)

Lab. No.	Station No.	Acena-phthene	Hexachlor-oethane	Fluoran-thene	Naphth-alene	Bis(2-Ethylhexyl) Phthalate	Di-N-Butyl Phthalate	Di-N-Octyl Phthalate	Benzo(A) Pyrene	Benzo(B) Fluoranthene	Chrysene	Anthra-cene	Acenaphthylene
22303	E ₄	-	-	-	-	J	0.6	J	-	-	-	-	-
22304	E ₅	-	110	-	1	58	1	-	-	-	-	1(y)	-
22305	E ₆	13	225	126	8	28	-	-	9	18	77	130(y)	4
	Blank	-	-	-	-	-	-	-	-	-	-	-	-

(Table Vb - continued)

Lab. No.	Station No.	Fluorene	Phenanthrene	Pyrene	(+) Dimethyl Naphthalene	(+) Dibenzofuran	(+) 4,5-methylene-phenanthrene	(+) methylanthracene or methyl phenanthrene	(+) methyl pyrene	(+) at least 30 additional
22303	E ₄	-	-	-	-	-	-	-	-	-
22304	E ₅	-	(y)	-	-	-	-	-	-	-
22305	E ₆	20	(y)	72	13	17	7	34	18	?
	Blank	-	-	-	-	-	-	-	-	-

(+) - These compounds not listed with priority pollutants, estimates are given based on Rf value of 0.5. Identification is based on EPA/NIH mass spectral search system.

(++) - Analysis by GC/MS.

(y) - Total for both compounds reported as anthracene.

TABLE Vc
Acid Extractibles*

Lab. No.	Injection No.	Injection Description	2,4,6-Trichlorophenol	1-chloro-3-cyclohexanol	1-chloro-3-ethyl-pent-ene-4yn-3ol	dimethyl-Butenedi-oic acid	Unknown #1 (C ₆ H ₈ Cl ₄)	Unknown #2	Unknown #3 (C ₆ H ₉ Cl ₃)	Unknown #4	Unknown #5 (C ₅ H ₈ NoBr)	Unknown #6	Bromocyclohexanol
22303	14		-	-	-	-	-	-	-	-	-	-	-
22304	15		6	150	57	15	12	20	105	63	18	5	7
22305	16		4	14	-	-	-	1	2	-	-	-	142
	Blank		-	-	-	-	-	-	-	-	-	-	-

* Analysis by GC/MS; The identification of all compounds except 2,4,6 Trichlorophenol are based solely on the EPA/NIH M.S.S.S. Numerical values given are estimates for all compounds (except 2,4,6 Trichlorophenol) based on an assumed reference of one.

TABLE Vd
Volatile Organics

Lab. No.	Sta. No.	Site Description	Carbon Tetrachloride	1,1,1 Trichloroethane	Chloroethane	Chloroform	1,1-dichloroethylene	methylene chloride	bromoform	bromodichloromethane	dibromochloromethane	tetra-chloroethylene	toulene	trichloroethylene	1,2-dichloroethane
22303	E4		-	-	-	20	-	24	-	-	-	-	1	-	-
22304	E5		140	7	5	1600	4	5	30	50	45	750	-	4	-
22305	E6		70	2	5	1630	-	575	8	42	-	4800	-	30	-
(Confirmation analysis only)															
22203			-	-	-	4	-	1	-	-	-	3	-	18	12
22210			-	3	-	3	-	.6	-	-	-	.8	-	-	-
22215			-	-	-	2	-	.5	-	-	-	.7	-	2	-
22302			-	-	-	25	-	2	12	-	-	12	-	3	-
22309			-	60	-	3	-	25	-	-	-	6	-	1	7
	Blank		-	-	-	-	-	1	-	-	-	-	-	-	-

(Table Vd - continued)

Lab. No.	Station. No.	Site Description	1,2, trans-dichloroethylene	(**) ethyl acetate	(**) acetone	(**) methyl ethyl ketone	(**) xylene
22303	E4		-	150	700	50	-
22304	E5		-	-	8	-	-
22305	E6		-	-	4	-	-
(Confirmation analysis only)							
22203			-	-	-	-	-
22210			2	-	-	-	-
22215			2	-	-	-	-
22302			-	-	3	-	130
22309			-	-	500	65	-
	Blank		-	-	-	-	-

** Identification based solely on EPA/RIH M.S.S.S. results. Numerical values given for these compounds are estimates based on an assumed response factor of 1.0.

TABLE VI
Conductivity/Temperature Profile - Tacoma Waterways
June 3, 1980

Station	Time	Depth (ft)	Temperature* (°C)	Conductivity* (u mho)
C ₁	9:42 a.m.	Surface	11.5	31000
		5	10.0	43000
		10	9.5	43500
		15	9.5	44000
		Bottom	9.0	44000
B ₁	9:52	Surface	11.2	31500
		5	10.1	42000
		10	9.5	43500
		15	9.1	44000
		20	9.2	44000
		25	9.0	44000
	9:57	30	9.0	44000
B ₂	10:02	Surface	12.0	38000
		5	10.5	42500
		10	9.5	44000
		15	9.5	44000
		20	9.2	44000
	10:06	25	9.1	44500
B ₃	10:08	Surface	11.5	41000
		5	10.0	43500
		10	9.5	43500
		15	9.2	44000
		20	9.0	44200
	10:13	25	9.0	44500
B ₄	10:17	Surface	12.2	40000
		5	10.2	43000
		10	9.5	44000
		15	9.5	44000
		20	9.2	44000
	10:21	25	9.1	44000
B ₅	10:23	Surface	12.5	41000
		5	10.5	43000
		10	9.5	43000
		15	9.5	44000
		20	9.3	44000
	10:27	25	9.2	44300

* Hydrolab used to obtain data; all data collected during ebbing tide (high tide at 7:47 a.m. PDT +9.8', low tide at 2:56 p.m. -1.1').

TABLE VI -- continued
Conductivity/Temperature Profile - Tacoma Waterways
June 3, 1980

Station	Time	Depth (ft)	Temperature (°C)	Conductivity (u mho)
B6	10:29 a.m.	Surface	13.2	40750
		5	10.5	43000
		10	9.5	43500
		15	9.1	44000
		20	9.1	44000
		25	9.1	44300
	10:32			
B7	10:36	Surface	12.2	41500
		5	10.2	43000
		10	9.5	43750
		15	9.1	44000
		20	9.1	44000
		25	9.0	44300
	10:40			
B8	10:43	Surface	11.8	41500
		5	10.0	43000
		10	9.2	43500
		15	9.0	44000
		20	9.0	44200
		25	9.0	44300
	10:48	30	9.0	44500
B3	11:07	35	9.0	44500
C3	11:17	Surface	11.5	34500
		5	10.0	43500
		10	9.5	44000
		15	9.1	44200
		20	9.0	44500
		25	9.0	44500
		30	8.9	44750

TABLE VI -- continued

Conductivity/Temperature Profile - Tacoma Waterways
June 3, 1980

Station	Time	Depth (ft)	Temperature* (°C)	Conductivity* (u mho)
H ₁	10:20 a.m.	Surface	-	-
		5	11	40500
		10	11	43000
		15	10.5	44000
		20	10	45000
		25	10	45000
		30	10	45000
H ₂	10:40	Surface	12.5	-
		5	11.5	39500
		10	11.0	43000
		15	10.5	43500
		20	10.5	44500
		25	10	45000
		30	9.75	45000
H ₃	10:50	Surface	12.5	38500
		5	12.0	40000
		10	10.75	43000
		15	10.25	44000
		20	10.0	44500
		25	10.0	45000
		30	9.75	45000
H ₄	11:50	Surface	13.0	39000
		5	12.75	39500
		10	11.5	41500
		15	10.5	43500
		20	10.25	44000
		25	10	44500
H ₅	11:00	Surface	12.5	39000
		5	12.0	39500
		10	11.0	42000
		15	10.5	43500
		20	10.0	44000
		25	10.0	44500
		30	9.75	45000

TABLE VI -- continued

Conductivity/Temperature Profile - Tacoma Waterways
June 3, 1980

Station	Time	Depth (ft)	Temperature (°C)	Conductivity (u mho)
H6	11:40 a.m.	Surface	13.5	38500
		5	12.25	39500
		10	11.25	42000
		15	10.5	43500
		20	10.25	44000
H7	11:05	Surface	13.0	38500
		5	12.25	39000
		10	11.0	42000
		15	10.5	43500
		20	10.0	44000
		25	10.0	44500
		30	9.75	44500
H8	11:08	Surface	13.0	37000
		5	12.0	39500
		10	11.0	42000
		15	10.5	43500
		20	10.0	44000
		25	10.0	44500
		30	9.75	44500
H9	11:15	Surface	13.0	36500
		5	12.0	39500
		10	11.0	41500
		15	10.5	43500
		20	10.0	44000
		25	10.0	44500
		30	9.75	44500
H11	11:20	Surface	13.75	38000
		5	12.25	39500
		10	11.0	41500
		15	10.5	43000
		20	10.25	43500
		25	10.0	44500
		30	10	44500
H12	11:25	Surface	13.0	36000
		5	12.0	39500
		10	10.75	42000
		15	10.5	43000
		20	10.25	44000
		25	10	44000
		30	10	44500

