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M E M O R A N D U M
March 1, 1982

To: Frank Monahan

Through: Dick Cunningham

From: John Bernhardt JB

Subject: Assessment of Surface Water Quality in the Vicinity of Reichhold Chemicals, Inc., Tacoma, Washington

INTRODUCTION

Early in 1981, the Department of Ecology (WDOE) and U.S. Environmental Protection Agency (USEPA) initiated a cooperative study of selected dischargers in the Port of Tacoma area to identify sources of toxic pollutants found in Commencement Bay water, biota, and sediment. Six facilities were selected for study based on proximity to the bay and consideration of the chemicals handled, namely:

1. Reichhold Chemicals, Inc;
2. U.S. Oil and Refining Company;
3. Pennwalt Corporation;
4. Tacoma Central Sewage Treatment Plant;
5. Sound Refining; and
6. St. Regis Paper Company

The locations of these facilities are shown in Figure 1.

A standard WDOE Class II inspection/receiving water study was to be performed concurrently at each facility with one major modification -- inclusion of sampling for the USEPA organic priority pollutants and certain other toxics. The results would be documented in WDOE investigative reports which, along with other studies, would provide government management agencies with the information needed to make the most informed decisions regarding the issue of toxics pollution in Commencement Bay. USEPA assisted in the field and provided laboratory support and quality assurance for the organic priority pollutant aspect of the studies.

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Assessment of Surface Water Quality in the Vicinity of Reichhold Chemicals, Inc., Tacoma, Washington
March 1, 1981

An environmental assessment of surface waters in the vicinity of Reichhold Chemicals, Inc., the first of the surveys performed, is presented in this report. The Class II inspection results are presented in a separate report (Yake, 1981).

LOCATION AND DESCRIPTION

Reichhold is one of three large chemical manufacturers (Hooker and Pennwalt are the other two) sited on the finger peninsula between Blair and Hylebos waterways. The plant site and adjacent areas of significance to the study are depicted in Figure 2.

The plant manufactures a variety of organic and inorganic chemicals and resins at three main process areas located on-site: chemicals; resins; and treated fiber products. Chemicals involved in these processes include phenol, pentachlorophenol, formaldehyde, butyl phenol, and others as shown in Table 1.

Historical records of chemical spills were reviewed as part of this study. Since 1974 Reichhold personnel have reported seven chemical spills where some of the spilled material extended beyond the plant site:

Date	Chemical Spilled	Amount Spilled
08/21-22/74	50% sodium hydroxide	1,800 lbs.
01/01/75	phenol	4,000 lbs.
11/17/75	oily material	5 gal.
06/11/78	phenol	small
01/16/80	phenol	small
11/30/80	phenol	3,000 lbs.

Spills contained on-site normally are not reported. An excellent Spill Prevention Containment and Countermeasure Plan has been developed by the company for responding to spills (Manlove, 1981).

Facility process wastewaters and surface runoff are handled in several ways, as described by Yake (1981):

> "Process wastewaters are routed to a series of four ponds for treatment. Washdown and storm drainage from the general plant site is routed to a pump house, from which it can either be pumped to the pond system or to the city sewer, while wash and storm waters from the north corner of the plant drain to

an arm of the peripheral drain ditch. This peripheral ditch drains a "dredged solids disposal area" at the south end of the property. During normal conditions, the water in this ditch is essentially static. During storm events, the drain ditch may discharge to the Lincoln Avenue drain and thence to Blair Waterway. If, however, greater than 1 mg phenols/L is detected in the drain ditch, all flow is pumped to the treatment ponds; or, if the treatment capacity of the ponds is exceeded, directly to the Tacom City sewer."

METHODS

Sampling for the most part was performed during April 21-22, 1981 at five stations (Figure 2). Grab or composite samples were collected depending on the constituent addressed. The following conventional water quality analyses were performed:

Laboratory	Field
pH (S.U.)	Temperature (°C)*
Dissolved oxygen (mg/L)*	Specific conductivity* (umhos/cm)
Salinity (ppt)	
Specific conductance (umhos/cm)	
Chemical oxygen demand (mg/L)	
Fecal coliform (col/100 ml)	
Nitrate-N (mg/L)	
Nitrite-N (mg/L)	
Ammonia-N (mg/L)	
Orthophosphate (mg/L)	
Total phosphate (mg/L)	
Total solids (mg/L)	
Total non volatile solids (mg/L)	
Total suspended solids (mg/L)	
Total non volatile suspended solids (mg/L)	
Formaldehyde (mg/L)	
R. phenolics as phenol (mg/L)*	
R. oil and grease (mg/L)*	

*The grab sample parameters are designated by an asterisk.

A second set of fecal coliform samples was collected on May 6, 1981.

Samples for laboratory analysis were packed in ice (as required) and transported to the WDOE environmental laboratory in Tumwater. All analyses were performed according to Standard Methods (APHA, AWWA, and WACF, 1976) or USEPA methods (USEPA, 1979).

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Three water samples were collected for analysis of organic toxic chemicals included in the USEPA 129 "priority pollutant" list and other selected toxics:

1. South Branch Lincoln Avenue Drain above Reichhold;

2. Lincoln Avenue Drain below Reichhold; and

3. Alexander Avenue Drain below Reichhold.

These sites were selected to best bracket the plant with the limited number of analyses available for the study.

Lincoln Avenue and Alexander Avenue drains below Reichhold were to be sampled at 15-minute intervals (approximately 500 ml per sample) over a two-hour period with ISCO compositors specially cleaned for toxics sampling. However, the Alexander unit malfunctioned so grab samples collected at the planned interval were hand-composited at this site. A quality assurance "blank" sample was processed through each compositor before sampling commenced.

A single toxics grab sample was collected at the Lincoln Avenue station above Reichhold.

The toxics samples were forwarded to three laboratories depending on analyses needed:

1. USEPA Contract Laboratory, West Coast Services, Inc. - organic priority pollutants and other selected organics;

2. USEPA Manchester Laboratory - cyanide; or

3. WDOE Tumwater Laboratory - phenol, formaldehyde, and metals (except mercury, Redmond laboratory).

Bottom sediment was sampled at two sites, lower Lincoln Avenue drain and Blair Waterway near the Lincoln Avenue outfall (Figure 2). At each site approximately 10 subsamples were collected with a small scoop and composited into a single sample. The samples were forwarded to the USEPA contract laboratory for organic toxics analyses.

Limited biological sampling was performed on May 6, 1981 at the two stations cited above. At 50 organisms per sample, the edible mussel Mytilus edulis, a filter feeder, was collected, then later homogenized to provide the five grams of tissue required for metals analysis. The organisms ranged from 33 to 55 mm in length. These analyses were performed at the WDOE Tumwater laboratory.

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During July 30, 1981, WDOE and USEPA collected intertidal and deepwater sediment samples at a number of locations in Commencement Bay as part of another toxics investigation relating to these waters (Swartz, et al., 1982). Four or five samples of surface sediments (10 x 10 x 2 centimeters each) were collected along a transect at each intertidal sampling site. Amphipod bioassays (Rhepoxynius abronius) were performed at the federal Marine Science Center in Newport, Oregon. The two sediment sampling sites cited above were included in this sampling.

RESULTS

Five basic areas are addressed: (1) Physical; (2) Water Quality Sampling; (3) Bottom Sediment Sampling; (4) Mussel Tissue Analysis; and (5) Sediment Bioassays.

(1) Physical

Reichhold is situated in a lowland area where surface runoff, seepage, small pipes of unknown origin, and other industrial sources possibly may influence the quality of drainage waters. Estuarine waters enter the ditches during flood tide providing flushing action. Thus, there are numerous possible sources of toxic substances observed.

Drainage flows were very low at the time of the survey. The plant's sampling and gaging weir was not overflowing. Thus, essentially all of the Lincoln drain flow (0.18 cfs) below the plant originated from the two small ditches upstream (Figure 2). Alexander drain was about four times larger (0.71 cfs) resulting in a combined flow of less than 1 cfs reaching Blair Waterway.

Flow in the Alexander drain appeared to be somewhat higher than normal due to street washing periodically performed as heavy-duty trucks hauled excavated soils from nearby J.A. Jones Construction Company property (Figure 2).

(2) Water Quality Sampling

Sampling results for the conventional analyses provided by the WDOE analytical laboratories are presented in Table 2. Noteworthy findings observed for the 18 parameters covered and five stations sampled are summarized below.

a. At about 10 ppt during the low tide, free-flowing conditions that existed at the time sampling was performed, salinities were high in all of the ditches sampled. Commencement Bay in general is about 30 ppt salinity. These data and height of

the high tide line along the ditch banks suggest tidal waters substantially influence water quality in the ditches. The tidal gates located near the mouth of the Lincoln drain apparently are not effective.

b. Periodic washdowns by heavy-duty gravel trucks hauling excavated soils from J.A. Jones' property accounted for the high suspended solids observed in the Alexander Drain.

c. The high total solids values in the ditches apparently are due to the saline waters which typically give such analytical results.

d. Formaldehyde, used in the manufacture of resins and plastics, was present at levels substantially below the generally accepted criteria of about 50 mg/L (McKee and Wolfe, 1965). The concentration varied considerably by station. High variance is typical of this laboratory test; however, even with this considered the data suggest one or more sources in the Lincoln/Alexander drainage.

The results of analyses performed by West Coast Services, Inc. for the organic priority pollutants and other toxics are presented in Table 3 for the three sites sampled.

Six organics were observed of which two, methylene chloride and acetone, appeared to be, at least in part, sample bottle cleaning residuals. These compounds also are used by Reichhold. One of the remaining compounds, pentachlorophenol (PCP), exceeded the USEPA chronic toxicity criteria for both freshwater and saltwater (Table 4). Pentachlorophenol is a commercially produced bactericide, fungicide, and slimicide used primarily for the preservation of wood, wood products, and other materials (USEPA, 1980). Reichhold produces PCP; however, whether or not this was the source was not confirmed. PCP is widely used and not observed in previous sampling of surface waters near Reichhold (Table 3).

The three remaining organics were detected at generally low concentrations.

Alexander Drain exceeded the USEPA freshwater "not to exceed anytime" or "acute" criterion for five metals (Zn, Pb, Cu, Cd, and Hg) while the criteria for two metals (Cu and Cd) were exceeded in the two Lincoln Drain samples. The "not to exceed as a 24-hour average" or "chronic" criterion was exceeded for most metals at all freshwater stations. It is not known why metals concentrations were

highest in the Alexander drain other than the street washing or earthen material hauled may have been factors. Metals criteria violations were generally less severe in the marine sample (Table 3).

The 1980 USEPA priority pollutant scan consistently detected considerably more organics per sample in Lincoln Drain than the present sampling. The reason for this difference is not known; however, it is important to note since laboratory variance or intermittent discharge may be factors.

Excluding the contaminants methylene chloride and acetone, toluene and 1,1,1-trichloroethane were the only organics present in both the current and earlier USEPA samples. The concentrations were low and far below criteria in all cases.

Heavy metals were generally present in higher concentrations during the present effort. This is particularly true of lead, arsenic, and cadmium.

(3) Bottom Sediment Sampling

Seven organic compounds were observed in the sediments (Table 3). The sample bottle cleaning solvents methylene chloride and acetone again were present.

Bis (2-ethylhexyl) phthalate (BEHP) is one of a group of plasticizers, the phthalated esters, which are interfused with various polymers to increase flexibility, extensibility, and workability (White and Robbins, 1974). These substances are ubiquitous in modern society, being present in foil wraps, tubing, clothing, upholstery, and almost anything else involving plastics.

BEHP in the environment is readily adsorbed onto suspended particulates, complexes with humic substances, and to some extent, is taken up by organisms (USEPA, 1979).

Since sediment criteria do not exist for priority pollutants or other toxics, these data can only be evaluated by comparison with data collected from other areas.

Priority pollutant analyses performed statewide by USEPA during 1979 to 1980 (Unpubl. data, 1981) were reviewed in an effort to place the findings for Lincoln drain in perspective. BEHP (dry weight) was detected in 22 of 35 bottom sediment samples collected:

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Location	BEHP Concentration (ug/Kg dry weight)
Duwamish River below Renton	200
Naches River at Mouth	200
Spokane River at Spokane STP Outfall	100
Cedar River near Landsburg	80
Spokane R. 1.5 mi. below Spokane STP	70
Spokane R. 0.5 mi. below Spokane STP	54
Spokane R. at Spokane STP Outfall	53
Five sites	0.3 to 52
Ten sites	0.02 to 0.29
Thirteen sites	none detected

It should be noted that all of these samples were collected from freshwater areas. At 5,675 and 1,449 ug/Kg, respectively, the Lincoln drain and Blair Waterway sediment BEHP values were very high, if the statewide sampling is used as a point of reference. The significance of these levels in terms of the aquatic toxicity is not known. BEHP is known to persist in sediments for some time but not to the extent of some compounds such as PCBs and DDT.

A high concentration of this compound (9,900 ug/Kg dry weight) was observed in a sediment sample collected where Lincoln Avenue Drain enters the opposite side of Blair Waterway from the south (Bernhardt, 1982). These data and the Reichhold survey results suggest a significant source in or near Blair Waterway. Reichhold does not use this compound.

Gamma BHC (Lindane) is an effective stomach, fumigant, and contact poison with relatively long residual effects (USEPA, 1980). It is used on a variety of crops to control aphids, grasshoppers, ants, roaches, flies, mosquitos, weevils, and many others (Thompson, 1977). Generally this compound is only slightly adsorbed by bottom muds. At 6.61 and 2.48 ug/Kg, the Gamma BHC observed in the Lincoln drain below Alexander Avenue and Blair Waterway sediment samples may be of some concern judging from the 0.34 ug/L saltwater acute toxicity criteria; however, it is not known whether the sediment BHCs are actually available to epifauna or infauna for uptake. Gamma BHC was detected in only one of 35 sediment samples collected by USEPA from freshwater areas of Washington State during 1978 to 1980 (Unpubl. data, 1981).

Location	BHC Concentration (ug/Kg dry weight)
Spokane R. at Spokane STP Outfall	2
Thirty-four sites	none detected

The source of this insecticide with regard to Blair Waterway sediments near the mouth of Lincoln Avenue drain is unknown.

Sediment metals were not collected because of laboratory load considerations. Samples were collected at a later date. The results are not available as of this writing.

(4) Mussel Tissue Analysis

The tissue metals data for the edible mussel, Mytilus edulis, are compared with data from other Puget Sound studies in Table 5. It is important to note in reviewing these data that Price (1978) on a fairly consistent basis, detected higher metals concentrations than the other investigators (Cloud, 1978; Heffner, 1981; Olsen and Schell, 1977). Data analyzed at the same laboratory are most comparable although an expected range of values can be obtained from samples analyzed by several laboratories.

Considering the WDOE analytical results only, copper and zinc concentrations in mussels collected during the present study appear to be somewhat elevated compared to the BWMP background stations. They are, however, not as high as concentrations near ASARCO (Table 5). Nickel, chromium, and lead were generally near background while cadmium was lower than the other areas. Arsenic was higher than any previous sampling results for Commencement Bay, including near ASARCO.

(5) Sediment Bioassays

Laboratory results for the two samples collected are given below:

Location Sampled	Initial Number	Number Recovered	Comments
Lower Lincoln Ave. drain embayment	20	0	very fine sediments
Similar zone of Blair Waterway near Lincoln Avenue outfall	20	16	medium sand
Control (Yaquina Bay)	20	18.2	mean of 50 samples

A problem is suggested by the high mortality observed in the lower Lincoln Avenue drain embayment. However, sufficient information is not available to determine the cause. Gamma BHC was very high in the sediment sample analyzed for organics. Sediment metals have

been shown to be elevated in other Blair Waterway areas and this is more than likely the case for Lincoln drain, as indicated by the mussel tissue and water sampling data. There could be some adverse habitat characteristic not evaluated in the study. The embayment sediments were visually quite different from the waterway sediments. The percent organics appeared to be greater (high sediment oxygen demand) in the embayment. There also is the problem that neither the sampling nor testing were replicated.

As a first step in reviewing the sediment toxicity results, USEPA plans to analyze all of the samples collected in Commencement Bay as a single unit. Correlation tests will be performed to determine if any constituents are routinely level at elevated concentrations when high mortalities occur. Specific site results cannot be adequately interpreted for cause and effect until this is done.

DISCUSSION

Reichhold Chemicals, Inc. was not discharging during the low flow conditions that existed at the time of the survey. Thus, this facility, other inputs within the Lincoln/Alexander Avenue drainage, and incoming Blair Waterway waters were all considered as possible sources in evaluating factors affecting water quality. Reichhold was considered as an intermittent source.

Lincoln/Alexander drainage waters contained a small number of toxic pollutants which appeared to be intermittent in nature and not associated with an easily definable source. The levels observed also were generally low with only one organic constituent, the preservative pentachlorophenol, exceeding the USEPA criteria by a slight margin. Low levels of formaldehyde were observed and the data suggested one or more sources within the drainage.

Metals were somewhat elevated within the drainage with, like other Commencement Bay areas, the following being of concern: zinc; lead; copper; cadmium; arsenic; nickel; and mercury.

Concentrations of constituents in the environment can be somewhat misleading when small drainage ditches are addressed which are of limited value as habitat for aquatic life and used almost entirely as an avenue for surface runoff and discharges. Pollutant loading to Blair Waterway which supports a significant assemblage of biota and recreational and other benefits, is of greater concern. Loadings to the waterway based on the flow conditions that existed at the time of the survey (low flow) are given below for the toxic constituents observed:

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Parameter	Lincoln Avenue Drain (lbs/day)	Alexander Avenue Drain (lbs/day)	Total (lbs/day)
Formaldehyde	<1.94	9.07	9.07 to 11.00
Pentachlorophenol	N.D.	0.18	0.18
1,1 Dichloroethane	0.004	0.04	0.044
Toulene	N.D.	0.01	0.01
1,1,1-Trichloroethane	0.02	N.D.	0.02
Zinc	0.03	0.76	0.79
Lead	0.10	0.76	0.86
Copper	0.02	0.91	0.93
Cadmium	0.01	0.04	0.05
Chromium	<0.01	0.34	0.35
Arsenic	0.97	3.78	4.75
Nickel	0.05	0.42	0.47
Molybdenum	0.03	0.07	0.10
Mercury	.0002	.0008	0.001

N.D. = None Detected.

The loadings were calculated by the conversion: Flow (cfs) x concentration in mg/L x 5.4 = lbs/day. Pertinent flows and concentrations are given in Tables 2 and 3.

The need for further investigation into the source of formaldehyde is indicated by what appears to be a relatively high loading rate. Arsenic may be a problem in the embayment. A problem is not suggested with the remaining parameters because dilution is considerable once the receiving waters of Blair Waterway are reached. The effects of these constituents can only be fully ascertained when evaluated along with loadings from the many other point and nonpoint sources along Commencement Bay.

JB:cp

Attachments

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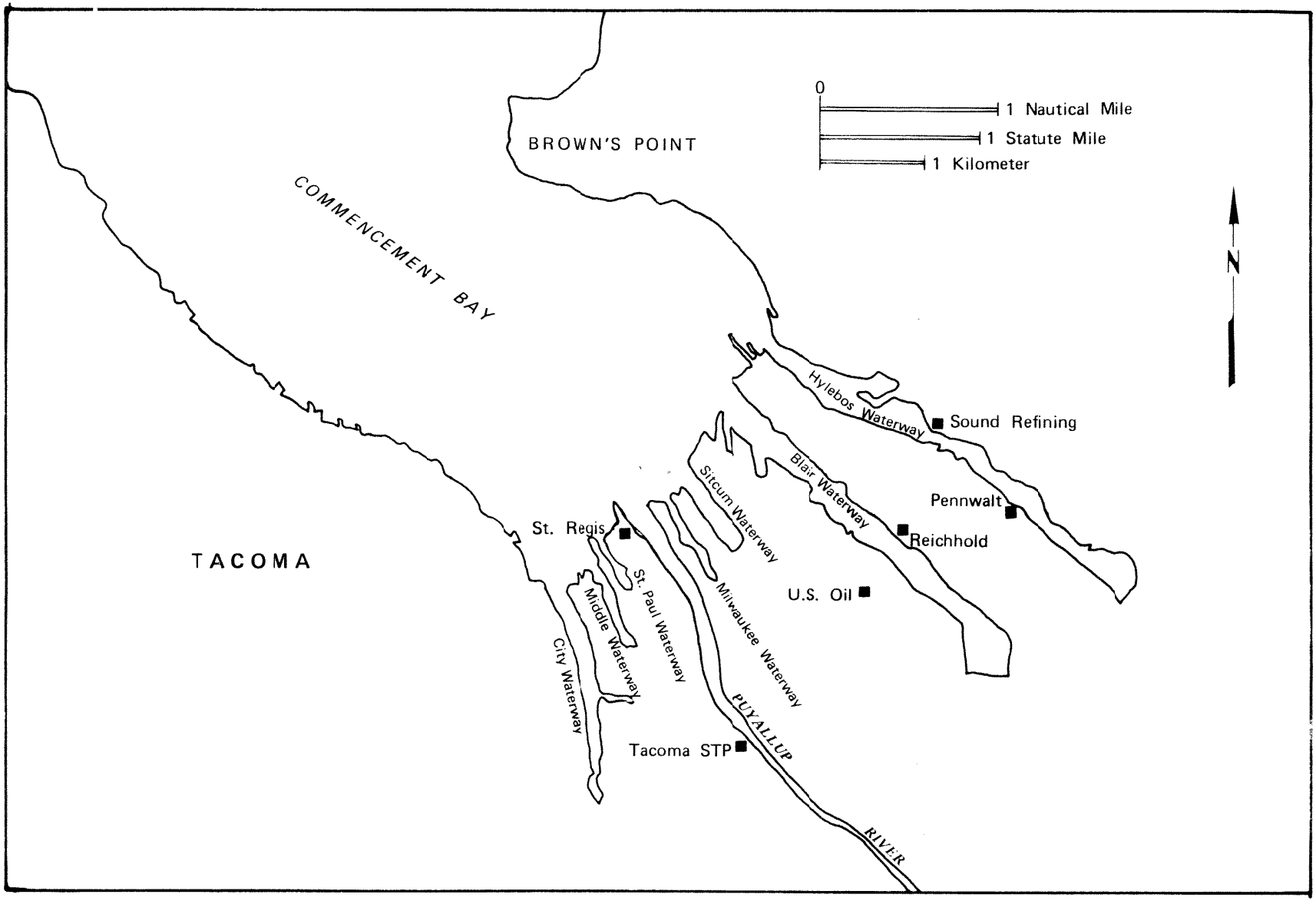

FIGURE 1. Map depicting locations of industries investigated as part of WDOE assessment of toxics pollution in Commencement Bay, during summer 1981.

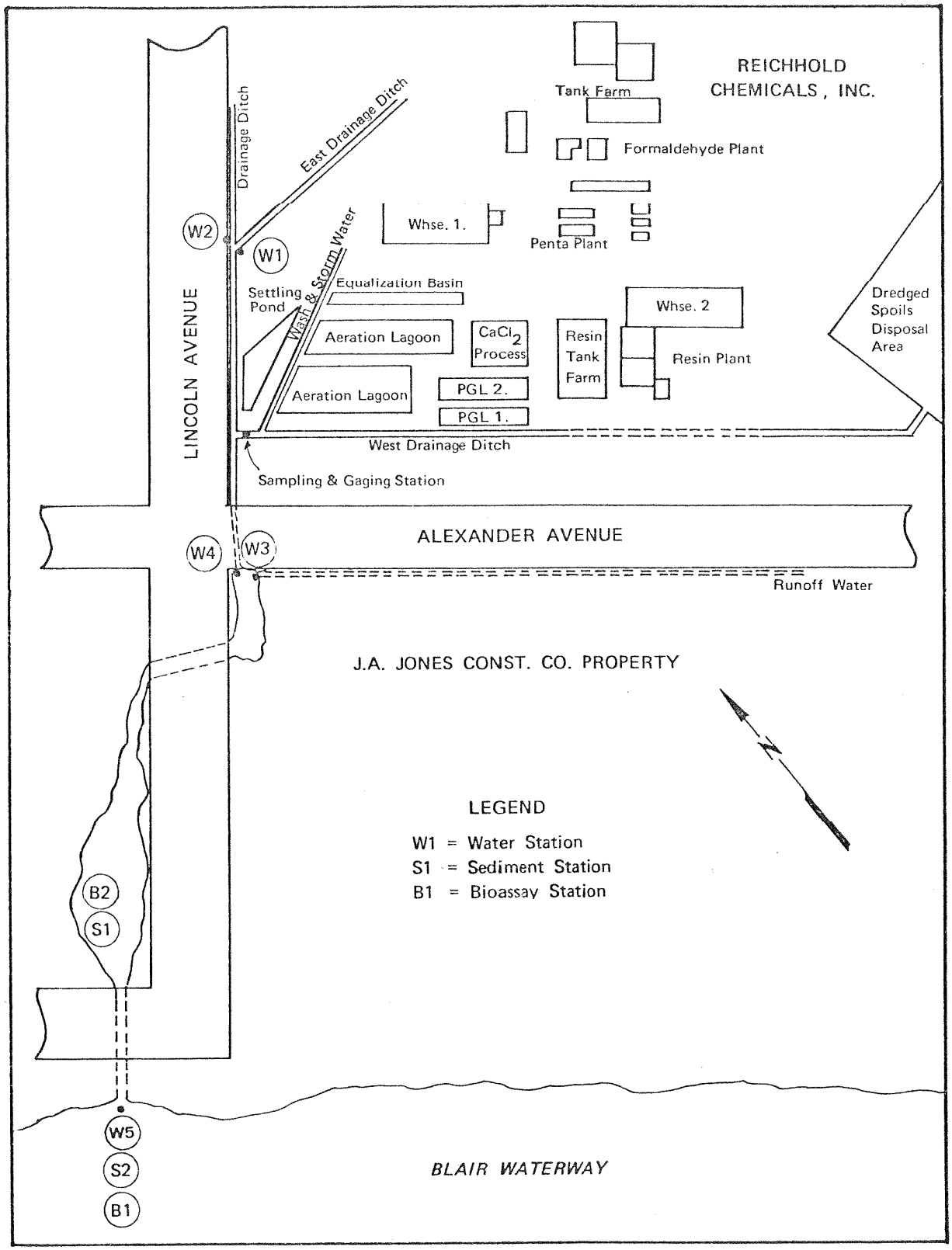

FIGURE 2. Map showing layout of Reichhold Chemicals, Inc. and water quality sampling sites included in WDOE receiving water survey, April 21-22, 1981.

Table 1. List of chemicals involved in the three major manufacturing processes employed at Reichhold Chemicals, Inc.[1/]

Chemical Process Area	Resin Process Area	Treated Fiber Products
Chemicals Manufactured:	Major Resins Produced:	Major Solvents Used:
Formaldehyde solution	Urea-formaldehyde	Methyl ethyl ketone
Formaldehyde catalyst	Phenol-formaldehyde	Acetone
Pentachlorophenol	Polyvinyl acetate	
Butyl phenol	Polyster	
p-tert butyl phenol	Polyurethane	
Calcium chloride brine		
	Major Raw Materials:	
Major Raw Materials:	Phenol	
Methanol	Urea	
Molybdenum trioxide	Formaldehyde	
Ammonium hydroxide	Vinyl acetate	
Ferric chloride	Propylene glycol	
Phenol	Phthatic anhydride	
Chlorine	Maleic anhydride	
Isobutylene	Adipic acid	
Hydrochloric acid	Poly-glycol	
	Freon	
	Styrene	

[1/] Source: Manlove (1981).

Table 2. Summary of conventional water quality sampling data collected by WDOE from surface waters in the vicinity of Reichhold Chemicals, Inc. during April 21, 1981.

Parameter	Water Quality Sampling Data				
	South Branch Lincoln Avenue Drain above Reichhold (W1)	North Branch Lincoln Avenue Drain above Reichhold (W2)	Lincoln Avenue Drain below Reichhold (W3)	Alexander Avenue Drain below Reichhold (W4)	Blair Waterway Near Lincoln Avenue Drain Outfall (W5)
GENERAL					
Site Description	Open ditch	Open ditch	Culvert outfall	Culvert outfall	Estuary
Average width/depth (ft)	1.4/0.10	1.4/0.10	1.8/0.12	40-inch	--
Flow	Trickle	Trickle	.18/0.28	.70/1.10	--
Time Sampled	1200	1200	1415	1415	1520
FIELD TESTS					
Temperature (°C)	14.4	13.2	12.4	12.6	--
LABORATORY TESTS					
pH (S.U.)	7.3	--	7.3	7.6	7.6
Dissolved oxygen (mg/L)	13.7	--	11.5	--2/	10.4
Salinity (ppt)	9.4	--	11.2	9.3	21.8
S. Conductance (umhos/cm)	14,400	--	16,100	13,400	27,700
Chemical Oxygen Demand (mg/L)	350	--	930	670	730
Fecal coliform (col/100 ml)	5800/170 1/	-/18	-/150	-/80	2/31
Nitrate-N (mg/L)	0.10	--	0.31	0.16	0.25
Nitrite-N (mg/L)	<0.01	--	<0.01	<0.01	<0.01
Ammonia-N (mg/L)	0.98	--	1.1	1.2	0.18
Orthophosphate (mg/L)	0.64	--	0.17	0.01	0.06
Total phosphate (mg/L)	0.67	--	0.48	0.02	0.09
Total solids (mg/L)	10,000	--	13,000	12,000	37,000
Total Non-vol. Solids (mg/L)	7,600	--	10,000	11,000	20,000
Total Suspended Solids (mg/L)	38	--	14	2,200	21
T. Non-vol. Sus. Solids (mg/L)	25	--	7	2,000	15
Formaldehyde (mg/L)	21	--	<2	2.4	6.4
R. Phenolics as phenol (mg/L)	0.023	--	0.012	0.018	0.012
R. Oil and Grease (mg/L)	<1	--	<1	<1	9

1/ A second set of fecal coliform samples was collected on May 6, 1981.

2/ Analysis affected by sediment interference.

Table 3. Summary of Priority pollutant and other toxics sampling data collected by WDOE in the vicinity of Reichhold Chemicals, during April 21, 1981.

	Water Samples (ug/L)[3]							EPA Historical Water Quality Sampling Data				Sediment Samples (ug/Kg)[4]	
Sampling Results	S. Branch Lincoln Drain Above Reichhold	N. Branch Lincoln Drain Above Reichhold	Alexander Drain Below Reichhold	Lincoln Drain Below Reichhold	Blair Waterway near Lincoln Drain	ISCO Field Blank	ISCO Field Blank	Reichhold Storm Drain Above Weir (Sampled 9/23/80)	Lincoln Drain S.W. Corner Reichhold Property[5] (Sampled 9/23/80)	Lincoln Drain Below Alexander Avenue (Sampled 9/23/80)	Lincoln Drain S.W. Corner Reichhold Property (Sampled	Lincoln Drain Below Alexander Drain (Sampled 6/3/80)	Lincoln Drain Below Alexander Drain	Blair Waterway Intertidal Zone Near Lincoln Drain
Time Sampled	1200	1200	1230-1415	1210-1415	--	1200	1050	--	1219	1115	1650	1645	1330	1340
WDOE Station Number	W1	W2	W3	W4	W5	W3	W4	--	--	--	--	--	51	52
EPA Sample Number	--		16713	16712	--	16709	16708	38218	38211	38214	22320	22308	16716	16717
EPA Laboratory Number	--		8J-14	8J-13	--	8J-10	8J-8	--	S1a	--	S1a	S1	8J-15	8J-16
Parameter														
Acid Compounds														
Pentachlorophenol	--		47	ND	--	ND	ND	ND	--	--	ND	ND	ND	ND
t-butylphenol	--		ND	ND	--	ND	ND	200	200	--	ND	ND	ND	ND
Base/Neutral Compounds														
Bis(2-ethylhexyl) phthalate	--		ND	ND	--	2	ND	5	5	--	ND	ND	ND	ND
Diethyl phthalate	--		ND	ND	--	ND	ND	ND	--	--	ND	ND	1934	ND
1,2 Dichlorobenzene	--		ND	ND	--	ND	ND	5.4	--	--	T	ND	ND	ND
Napthalene	--		ND	ND	--	ND	ND	--	--	--	7.9	ND	ND	ND
Flourene	--		ND	ND	--	ND	ND	ND	1.0	--	ND	ND	ND	ND
Volatile Organics														
Methylene chloride	--		ND	19	--	33	48	ND	--	--	1.3	T	264	ND
Dimethyl-1, 4-dioxane	--		ND	ND	--	ND	ND	--	--	--	ND	ND	ND	ND
Acetone	--		ND	16	--	ND	ND	ND	--	--	ND	ND	77	ND
Hexachloroethane	--		ND	ND	--	ND	ND	ND	--	--	ND	T	ND	ND
1,2-(trans)dichloroethylene	--		ND	40	--	ND	ND	4.4	1	--	1.0	ND	ND	ND
1,1 Dichloroethane	--		ND	ND	--	ND	ND	ND	--	--	ND	ND	3	ND
Toluene	--		1	12	--	ND	ND	ND	--	--	4	4	6	ND
Hexachlorobenzene	--		ND	ND	--	ND	ND	ND	--	--	ND	T	ND	ND
Methyl Ethyl Ketone	--		ND	ND	--	6	ND	ND	--	--	ND	ND	ND	ND
1,2-Dichloroethylene	--		ND	ND	--	ND	ND	ND	--	--	T	ND	ND	ND
1,1,1-Trichloroethane	--		4	ND	--	ND	ND	1.2	--	--	ND	ND	ND	ND
Chloroform	--		ND	ND	--	ND	ND	7.2	--	--	2.4	1.8	ND	ND
Trichloroethene	--		ND	ND	--	ND	ND	50	1	--	1.5	T	ND	ND
Hexachlorobenzene	--		ND	ND	--	ND	ND	ND	0.7	--	T	ND	ND	ND
Benzene	--		ND	ND	--	ND	ND	--	0.3	--	422	4	ND	ND
Tetrachloroethylene	--		ND	ND	--	ND	ND	--	--	--	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	--		ND	ND	--	ND	ND	--	0.9	--	ND	ND	ND	ND
Pesticides														
Gamma BHC			ND	ND	ND	ND	ND	ND	--	--	ND	ND	6.61	2.48
Metals (ug/L)[1]														
Zinc	21		200	30	24	<5	<5	40	50	40	55	50	--	--
Lead	30		112	40	89	<5	<5	2	80	25	10	17	--	--
Copper	38		24	38	24	<1	<1	3	19	19	26	85	--	--
Cadmium	10		10	10	20	<5	<5	0.5	<.2	<.2	0.1	0.6	--	--
Chromium[2]	<20		90	<10	<20	<10	<10	<1	5	6	3	4	--	--
Arsenic	90		160	380	28	<5	<5	4	140	75	216	190	--	--
Nickel	<50		110	50	110	<50	100	23	26	21	40	17	--	--
Molybdenum	62		19	30	13	<13	<13	--	--	--	ND	ND	--	--
Beryllium	--		--	--	--	--	--	<0.3	0.5	0.6	0.3	0.3	--	--
Silver	--		--	--	--	--	--	<0.4	<.4	<.4	0.25	0.48	--	--
Thallium	--		--	--	--	--	--	<3	<3	<3	1	1	--	--
Selenium	--		--	--	--	--	--	<2	4	7	2	12	--	--
Antimony	--		--	--	--	--	--	<2	<2	<2	9	14	--	--
Manganese	--			--	--	--	--	--	--	--	375	400	--	--
Total Mercury	<0.20		0.20	0.20	<0.20	<0.20	<0.20	0.07	0.56	0.35	1.1	0.45	--	--
Tentitively Identified Organic Compounds														
2,3,4,6-Tetrachlorophenol	ND		X	ND	ND	ND	ND	ND	--	--	ND	ND	ND	ND
Thiobismethane	ND		ND	ND	ND	ND	ND	ND	--	--	ND	ND	ND	X

[1] The metals criteria are based on the total recoverable form and a hardness of 50 as $CaCO_3$.

[2] Total recoverable hexavalent chromium.

[3] -- = Not analyzed for; ND = analyzed for but none detected; X = tentatively identified; T = trace.

[4] Analyses are reported on the dry basis; samples are 36.3 percent solids.

[5] Same location as USEPA 9/23/80 sample number 22320.

Table 4. Summary of USEPA water quality criteria for chemical compounds observed in surface waters near Reichhold Chemicals, Inc.

Parameter	Freshwater (ug/L) Not to Exceed: Anytime	24-hr. Average	Acute	Chronic	Saltwater (ug/L) Not to Exceed: Anytime	24-hr. Average	Acute	Chronic
Acid Compounds								
Pentachlorophenol	--	--	55	3.2	--	--	53	34
t-butylphenol	--	--	--	--	--	--	--	--
Base/Neutral Compounds								
Bis(2-ethylhexyl) phthalate	--	--	940	3	--	--	2,944	3.4
Diethyl phthalate	--	--	940	3	--	--	2,944	3.4
1,2 Dichlorobenzene	--	--	1,120	763	--	--	1,970	--
Napthalene	--	--	2,300	620	--	--	2,350	--
Flourene	--	--	--	--	--	--	--	--
Volatile Organics								
Methylene chloride	--	--	--	--	--	--	--	--
Dimethyl-1, 4-dioxane	--	--	--	--	--	--	--	--
Acetone	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	980	--	--	--	540	--
1,2-(trans)dichloroethylene	--	--	11,600	--	--	--	224,000	--
1,1 Dichloroethane	--	--	980	--	--	--	540	--
Toluene	--	--	17,500	--	--	--	6,300	5,000
Hexachlorobenzene	--	--	250	50	--	--	160	129
Methyl Ethyl Ketone	--	--	--	--	--	--	--	--
1,2-Dichloroethylene	--	--	11,600	--	--	--	224,000	--
1,1,1-Trichloroethane	--	--	--	--	--	--	31,200	--
Chloroform	--	--	--	--	--	--	--	--
Trichloroethene	--	--	45,000	21,900	--	--	2,000	--
Hexachlorobenzene	--	--	250	50	--	--	160	129
Benzene	--	--	5,300	--	--	--	5,100	700
Tetrachloroethylene	--	--	5,280	840	--	--	10,200	450
1,1,2,2-Tetrachloroethane	--	--	--	2,400	--	--	9,020	--
Pesticides								
Gamma BHC	--	--	100	--			0.34	
Metals (ug/L)[1/]								
Zinc	180	47	--	--	170	58	--	--
Lead	74	0.75	--	--	--	--	668	25
Copper	12	5.6	--	--	23	4.0	--	--
Cadmium	1.5	0.012	--	--	59	4.5	--	--
Chromium[2/]	2,200	--	--	44	--	--	10,300	--
Arsenic	440	--	--	40	--	--	508	--
Nickel	1,100	56	--	--	140	7.1	--	--
Molybdenum	--	--	--	--	--	--	--	--
Beryllium	--	--	130	5.3	--	--	--	--
Silver	1.2	--	--	0.12	2.3	--	--	--
Thallium	--	--	1,400	40	--	--	2,130	--
Selenium	260	35	--	--	410	58	--	--
Antimony	--	--	9,000	1,600	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Total Mercury	.0017	.00057	--	--	3.7	.025	--	--
Tentitively Identified Organic Compounds								
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--
Thiobismethane	--	--	--	--	--	--	--	--

[1/] The metals criteria are based on the total recoverable form and a hardness of 50 as $CaCO_3$.

[2/] Total recoverable hexavalent chromium.

Table 5. Summary of recent trace metals data collected on the edible bay mussel (Mytalis edulis) in Puget Sound.

Study	Date Sampled	Metal (ug/g) Copper	Zinc	Nickel	Chromium	Cadmium	Lead	Mercury	Arsenic
Present Effort									
Lower Lincoln Ave. Drain	5/5/81	13	450	5.1	1.5	2.8	<5.0	0.097	56
Blair Waterway nr. L.A. Drain	5/5/81	13	330	2.7	1.6	2.3	<5.0	0.015	19
Olsen And Schell (1977)									
Puget Sound & Hood Canal	--	7.4[1] 4.9-12.6	169.7 77.9-317	-- --	6.4 0.93-11.9	3.7 2.8-5.5	6.6 2.5-14.8	.109 .016-.130	-- --
Price (1978)[2]									
Lower Puget Sound	6,7,8/77	9.7[3] 4.8-90.9	309.1 84.2-969.7	-- --	-- --	9.7 3.0-17.0	18.2 5.4-34.5	.194 .017-1.3	43.6 18.8-72.7
Commencement Bay									
Browns Point	--	--	303.0	--	--	--	13.3	0.37	45.4
Hylebos Mouth	--	11.0	969.7	--	--	3.9	26.8	0.19	44.8
S.W. Shore Com. Bay	--	25.4	369.7	--	--	17.0	34.5	0.29	60.6
ASARCO S.E.	--	90.9	545.5	--	--	10.3	33.9	1.03	54.5
ASARCO N.W.	--	24.2	848.5	--	--	12.1	30.3	0.36	72.7
Cloud (1979)[2]									
Near ASARCO (WDOE Lab)	9/20/78	297.0	472.7	<30	<6	7.9	35.2	--	4.6
Near ASARCO (ASARCO Lab)	9/20/78	407.9	407.9	--	--	4.6	29.7	--	15.8
Heffner (1981)									
Near ASARCO (WDOE Lab)	2/24-25/81	135	533	1.4	1.7	2.95	.89	--	16.2
Near ASARCO (ASARCO Lab)	2/24-25/81	278	642	<4.7	9.4	8.9	51.9	--	10.7
Nr. Hartstene Is. (WDOE Lab)	2/24-25/81	11	162	2.7	1.5	5.0	1.01	--	1.70
BWMP Stations[4]									
Dabob Bay	9/6/79	18	261	4.0	2.1	17.0	1.36	--	2.61
Dabob Bay	8/25/80	12	223	1.3	.99	10.5	1.77	--	1.04
Port Susan	7/9/80	6	81	1.4	.86	3.57	1.86	--	.98
Carr Inlet	7/10/80	7	148	.78	.82	5.92	1.33	--	.77
Case Inlet	7/9/80	7	141	1.1	.72	6.34	1.23	--	1.65

[1] 7.4 = mean; 4.9-12.6 = range

[2] Reported as ug/g wet weight; converted to dry weight using .165 dry/wet ratio used by Olsen and Schell (1977).

[3] 9.7 = median; 4.8-7.3 = range

[4] BWMP = Basic Water Monitoring Stations sampled by Department of Ecology (WDOE).