88-e32

BELLINGHAM POST POINT POLLUTION CONTROL PLANT
CLASS II INSPECTION

by
Don Reif

Washington State Department of Ecology
Water Quality Investigations Section
Olympia, Washington 98504-6811

February 1988

Waterbody No. WA-01-0050
(Segment No. 01-01-02)

ABSTRACT

A Class II inspection was performed at the city of Bellingham's Post Point Pollution Control Plant on August 25 and 26, 1987. The plant was running well, violated no NPDES permit parameters, and exceeded its designed removal efficiencies. Laboratory procedures and agreement of split sample results were excellent. Three effluent bioassays (rainbow trout, oyster larvae, and Microtox) indicated varying degrees of toxicity. Recommendations were made for influent sampler placement, further effluent bioassay testing, and minor laboratory adjustments.

INTRODUCTION

A Class II inspection was held at Bellingham's Post Point Pollution Control Plant (PPPCP) on August 25 and 26, 1987. The inspection was requested by John Glynn of Ecology's Northwest Regional Office. Conducting the survey was Don Reif, with assistance from Tim Determan and Will Kendra, all from the Water Quality Investigations Section. Assisting from the city of Bellingham were Bill McCourt, Superintendent of Public Works-Operations; Gary Hess, Chief Operator; and Susan Blake, Technical Supervisor-Water Quality.

The inspection objectives were to:

1. Collect samples and measure flows to determine plant loadings and efficiencies.
2. Perform a laboratory evaluation, including sample splits.
3. Determine compliance with the most recent NPDES permit.
4. Examine effluent toxicity by analyzing a series of effluent and sediment bioassays.

A receiving water survey was performed at the same time and will be available under separate cover.

LOCATION AND DESCRIPTION

The PPPCP is located in southwestern Bellingham, Whatcom County, in the northwestern corner of Washington (Figures 1 and 2). Design flow is 12 MGD from January through June, and 18 MGD during canning season (July through December).

Treatment begins with the headworks, consisting of bar screens, grit chambers, and shredders. The wastewater then undergoes primary clarification and chlorine

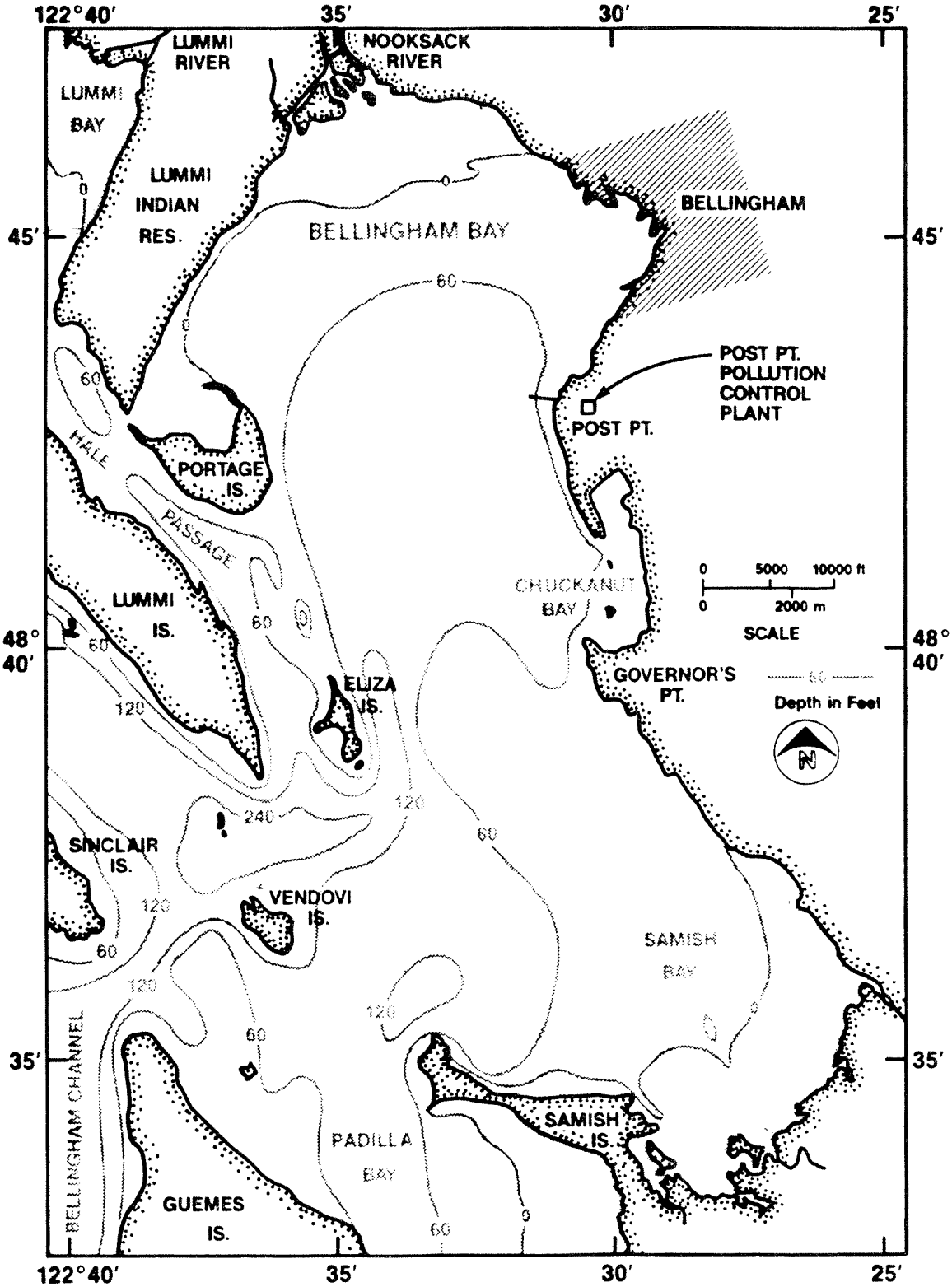

Figure 1. Location of Post Point Pollution Control Plant (from CH_2M Hill, Inc., 1984).

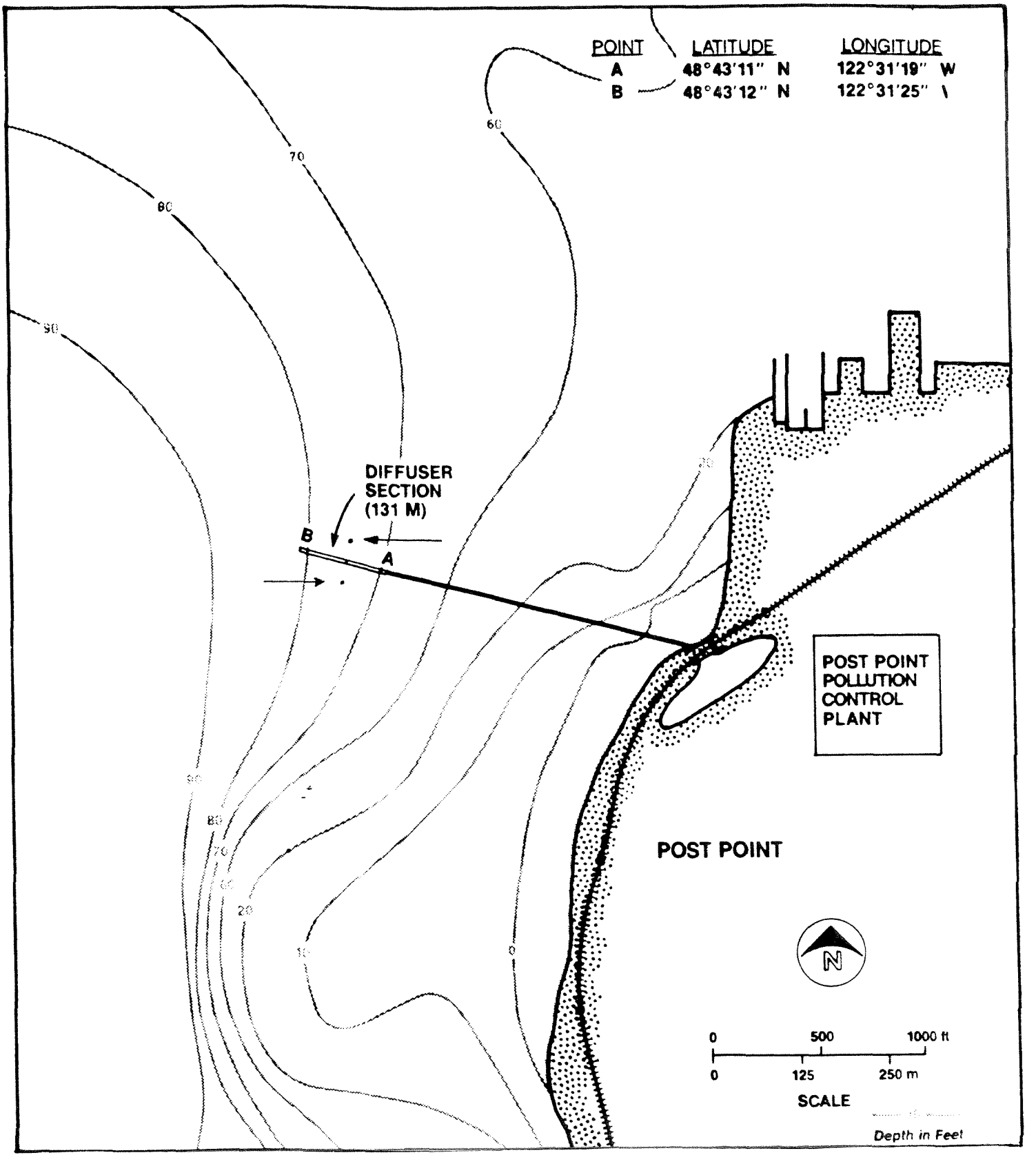

Figure 2: Post Point outfall location (from CH_2M Hill, Inc., 1984) and sediment sampling locations (denoted by arrows (———>).

disinfection (Figure 3). Final effluent is discharged into Bellingham Bay about 1500 feet offshore at a depth of 76 feet (depth below MLLW at diffuser midpoint). Primary sludge is gravity thickened, centrifuged to dewater, and incinerated.

The decision has been made to upgrade the current primary treatment facility to include secondary treatment. Secondary treatment should begin around 1992.

METHODS

The sampling schedule including field analysis, is listed in Table 1. Sampling locations are shown in Figure 3.

Twenty-four-hour composited samples were collected at two locations: (1) influent at the grit chamber effluent weir, and (2) final effluent at the Parshall flume. Approximately 200 mL of sample were collected at 30-minute intervals. General chemistry and priority pollutant scans were run on these samples. In addition, general chemistry parameters were run on influent and effluent grab samples. A two-grab composite of sludge ash was collected from the ash pile.

Most analyses were performed at Ecology's Manchester Laboratory. Priority pollutant scans were completed by Analytical Resources, Inc., of Seattle. Sludge ash, sediment metals, and EP TOX metals (EPA, 1986b) were analyzed by Sound Analytical Services, Inc., of Seattle, and Weyerhaeuser Company, Tacoma.

Effluent bioassays (four-grab composites) were conducted with juvenile rainbow trout, oyster larvae, and Microtox. The rainbow trout test was run at Manchester, in accordance with the department's procedure for "Static Acute Fish Toxicity Test" (State of Washington Department of Ecology, 1981). Biochem Environmental Services of Seattle performed the Microtox assay, following the Microtox System Operating Manual by Beckman. Oyster larvae (ASTM 1985: ASTM Method E 724-80) and Rhepoxinius abronius sediment bioassays (Tetra Tech, 1986a) were run by E.V.S. Consultants of Vancouver, B.C.

Two sediment samples were collected from the midpoint of the diffuser section of the outfall line: sample #1 about 100 feet to the north of the diffuser, and sample #2 at 100 feet to the south. The sediment field control sample was collected about three miles due west of Post Point, toward Point Francis on Portage Island. Sediments were collected using a 0.1 m2 Van Veen sampler, and conformed to procedures outlined in "Puget Sound Protocols" (Tetra Tech, 1986a). All three samples consisted of multiple grabs that were composited, mixed, and subsampled. Sediment percent solids and TOC were analyzed by Laucks Testing Laboratories, Inc. in Seattle. Parametrix, Inc. of Seattle ran sediment grain size analyses.

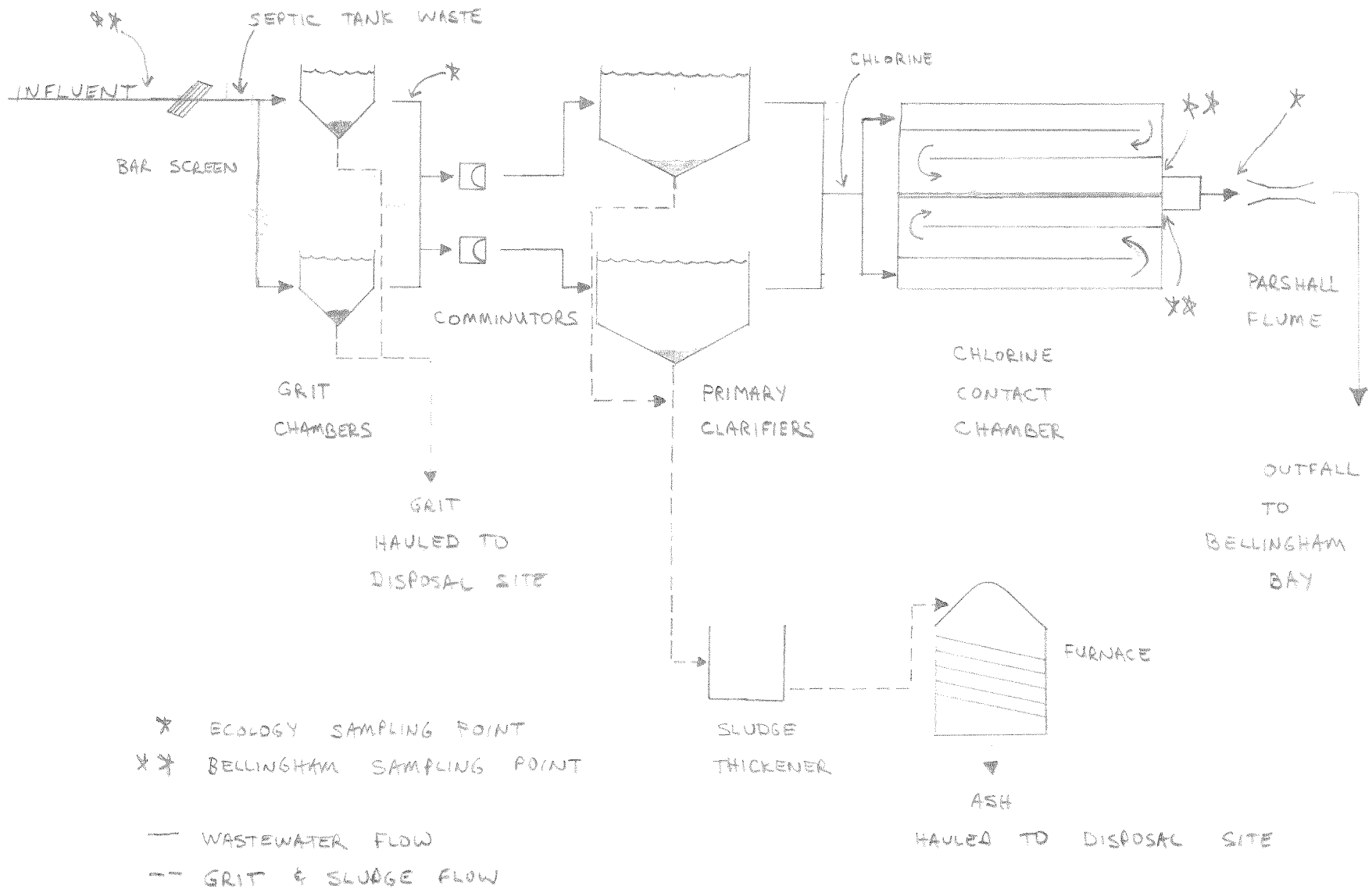

Figure 3. Flow diagram and sampling sites; Bellingham Class II Inspection, August 25-26, 1987.

Table 1. Ecology sampling schedule: Bellingham Class II inspection, August 25 and 26, 1987.

			Field Analysis				Laboratory Analysis																				Bioassay			
Sample Type	Date	Time	Temperature	pH	Conductivity	Chl. Resid.	pH	Turbidity	Conductivity	Alkalinity	NH_3	NO_3	Total Phos.	TSS	TVSS	Solids	COD	BOD_5	Fecal Coliform	Oil & Grease	TOC	Grain Size	Percent Solids	PP Scan	PP Metals	EP TOX	Trout	Oyster	Microtox	Rhepolynius
GRAB																														
Influent	8/25	1125	X	X	X		X	X	X	X	X	X	X	X	X		X			X										
	8/25	1525	X	X	X		X	X	X	X	X	X	X	X	X		X													
	8/26	0945	X	X	X		X	X	X	X	X	X	X	X	X		X													
Effluent	8/25	1105	X	X	X		X	X	X	X	X	X	X	X	X		X		X	X										
	8/25	1510	X	X	X		X	X	X	X	X	X	X	X	X		X		X	X										
	8/26	0905	X	X	X		X	X	X	X	X	X	X	X	X		X		X											
Sludge Ash	8/26	0850																							X	X				
Marine Sediment	8/26	1500-1600																			X	X	X	X	X					X
COMPOSITE																														
Influent																														
Ecology	8/25-8/26	0945-0915	X	X	X		X	X	X	X	X	X	X			X	X	X						X						
Bellingham	8/25-8/26	0930-0900					X	X	X	X	X	X	X			X	X	X												
Effluent																														
Ecology	8/25-8/26	1015-0945	X	X	X		X	X	X	X	X	X	X			X	X	X						X	X		X	X	X	
Bellingham	8/25-8/26	0930-0900					X	X	X	X	X	X	X			X	X	X												

RESULTS

Flow

An average flow rate of 9.42 MGD was obtained from the plant totalizer during the compositing period (Table 2). This value is used to calculate loadings during the compositing period. A check of flow height on the Parshall flume's staff gauge showed a value four percent greater than the plant flowmeter's instantaneous readout. This small discrepancy is well within an expected accuracy for this type of measurement.

NPDES Permit Compliance

Bellingham is currently operating without a specific and enforceable permit. The previous permit expired on July 5, 1982. An order containing interim limits was issued in 1979 but rescinded in 1986. A new permit is forthcoming. This permit will establish secondary treatment requirements and interim effluent limits until completion of the secondary facilities, perhaps around 1992.

In the meantime, PPPCP personnel have used the permit limits established by the rescinded order for DMR reporting purposes. These limits are therefore used to compare with inspection results, in Table 3. All permitted parameters were well within the limits established by the order, for both weekly and monthly averages. Fecal coliform counts were fairly low and well within permitted limits for primary effluent. However, a high chlorine residual seemed to be required, as compared to disinfection requirements for secondary treated effluent.

General Conditions

Inspection results are compared to design criteria for the PPPC plant in Table 4. Bellingham Frozen Foods, the main industrial contributor for both hydraulic and organic loading to PPPCP, was shut down during the inspection. This fact is reflected in Table 4, where the inspection results more closely match non-canning season criteria than the expected canning season loading rates. For the non-canning periods, the plant exceeded its designed removal efficiency.

General sampling results are listed in Table 5. The influent grab sample from the morning of August 26 indicated several elevated parameters, including turbidity, conductivity, ammonia, TSS, and COD. This effect was caused by waste from a septic tank pumper that dumped about five minutes prior to the sample collection. Although considerable dilution had already occurred, the effects of this strong waste were still quite evident.

Table 2. Plant flow data: Bellingham Class II inspection, August 25-26, 1987.

Date	Time	Ecology Instantaneous Measurement Height (ft.)	Ecology Instantaneous Measurement Flow (MGD)	Plant Meter (MGD) Instantaneous	Plant Meter (MGD) Totalizer
8/25-8/26	1015-1020				9.42a
8/26	0650	0.8	5.47[b]	5.7	
8/25	0000-2400				9.42c

a = This flow measurement is used in loading calculations.
b = Flow conversion from height; from Leupold and Stevens, Inc., 1978.
c = From PPPCP records.

Table 3. Comparison of inspection results to NPDES permit limits: Bellingham Class II inspection, August 25-26, 1987.

Parameter	Effluent Limitations Monthly Average	Effluent Limitations Weekly Average	Ecology Inspection Results
BOD_5, lbs/day	40,000	43,000	9,899
TSS, lbs/day	8,000	10,000	3,134
Fecal Coliform #/100 mL	700	1,500	32; 50; 60
pH	6.0 - 9.0		6.7; 6.7; 7.0
Flow, MGD	12	--	9.42

Table 4. Comparison of design criteria to inspection results: Bellingham Class II inspection, August 25-26, 1987.

		Design Criteria*	Inspection Results
Wastewater Flow (MGD)			
Average canning season		18	
Average non-canning season		12	9.42
Biochemical Oxygen Demand (BOD)			
Average canning season	(mg/L)	613	
	(lbs/day)	92,000	
Average non-canning season	(mg/L)	200	210
	(lbs/day)	20,000	16,500
Suspended Solids (SS)			
Average canning season	(mg/L)	240	
	(lbs/day)	36,000	
Average non-canning season	(mg/L)	200	190
	(lbs/day)	20,000	14,900
Efficiency			
Canning Season (percent)			
BOD Removal		23	
SS Removal		60	
Non-canning Season (percent)			
BOD Removal		35	40
SS Removal		60	79

*From CH_2M Hill, Inc., 1984.

Table 5. Ecology analytical results: Bellingham Class II inspection, August 25-26, 1987.

					Field Analysis					Laboratory Analysis															
								Chlorine Residual (ppm)							Nutrients (mg/L)			Solids (mg/L)							
Sample	Station	Sampler	Date	Time	Temp. (°C)	pH (S.U.)	Conductivity (umhos/cm)	Free	Total	pH (S.U.)	Turbidity (NTU)	Conductivity (umhos/cm)	Alkalinity (mg/L as $CaCO_3$)	NH_3-N	NO_3-N	Total P	Total	TNV	TS	TNVS	BOD_5 (mg/L)	COD (mg/L)	Oil & Grease (mg/L)	Fecal Coliform (#/100 mL)
Grab	Infl.	Eco.	8/25	1125	21.7	7.1	440			6.6	56	429	210	15.0	0.02	6.7			230	45		440	24	
			8/25	1525	21.3	7.1	530			6.7	64	511	140	14.0	0.02	7.3			210	33		480		
			8/26	0945	21.4	7.0	940			6.9	140	966	190	23.0	0.02	8.1			610	150		875		
Grab	Effl.	Eco.	8/25	1105	21.3	6.7	580	TR.	2.5	6.5	30	545	95	120	0.05	4.0			43	7		240	19	60
			8/25	1510	22.2	7.0	550	0.1	1.0	6.8	34	509	120	16.0	0.02	5.3			50	8		270	21	32
			8/26	0905	21.3	6.7	540	0.8	2.0	6.7	23	583	99	14.0	0.04	3.6			33	7		216		50
Comp.	Infl.	Eco.	8/25-26	0945-0915	7.8	7.2	600			6.8	60	589	150	15.0	0.04	6.8	600	260	190	40	210	455		
		Bell.	8/25-26	0930-0900	--	--	--			7.0	35	580	150	12.0	0.04	6.1	520	250	170	26	160	345		
Comp.	Effl.	Eco.	8/25-26	1015-0945	8.4	7.2	620			6.8	29	599	110	14.0	0.03	4.9	500	250	40	3	126	271		
		Bell.	8/25-26	0930-0900	--	--	--			7.0	27	605	130	17.0	0.20	5.0	420	230	58	12	126	290		

Effluent Metals

Effluent metals are listed in Table 6. Three metals exceeded EPA ambient water quality criteria. Mercury was 12 times greater than the saltwater and 25 times greater than the freshwater chronic levels (EPA, 1986a). Copper exceeded saltwater chronic and acute criteria by a factor of 15, and was 3.7 times the freshwater chronic level. Lead was 2.5 times the freshwater chronic criterion. These metals criteria are for ambient waters. Due to available dilution, receiving water quality criteria were probably not exceeded. The effluent bioassays, however, may have been affected.

Effluent Bioassays

Effluent bioassay results are listed in Table 7. No mortality was noted in the trout bioassay, but a "medium" level of toxicity occurred in the Microtox test. Variable results between bioassay tests are not unusual. Microtox was the more sensitive indicator of acute toxicity for PPPCP's effluent.

Exposure of oyster larvae to PPPCP's effluent caused a high percentage of developmental abnormalities. Statistically, a 50 percent rate of larval abnormality (EC_{50}) was predicted with a 3.5 percent effluent concentration. This test therefore indicated a high degree of chronic toxicity.

Cause of the apparent effluent toxicity is unknown. Several factors, alone or in combination, may have contributed. These include chlorine, ammonia, and metals. The total chlorine residual (TRC) LC_{50} of the eastern oyster is 26 ug/L (EPA, 1986a). Since the effluent TRC averaged about 2 mg/L, chlorine toxicity could have occurred at bioassay dilutions as low as 1 percent.

Effluent ammonia at 14 mg/L, could have affected the bioassays. For freshwater organisms (trout) at 12°C and pH 7.75, the four-day criteria for NH_3-N is about 2 mg/L (EPA, 1986a). However, the trout had no mortalities. Saltwater criteria for ammonia are unavailable due to lack of data.

Effluent metals, singly or together, could have exerted a toxic effect. Criteria are not sufficiently developed to make this determination.

Since conversion of the PPPC plant to secondary treatment is scheduled, extensive testing at this time is not recommended. However, one more round of bioassays is recommended to provide additional data on primary effluent toxicity at PPPCP. This information could be compared to secondary effluent bioassay results after the plant upgrade is completed.

Table 6. Effluent priority pollutant metals: Bellingham Class II inspection, August 25-26, 1987.

		EPA "Gold Book" Criteria+:			
		Saltwater*		Freshwater*	
Contaminant	Effluent	Chronic	Acute	Chronic	Acute
Antimony	<60				
Arsenic	<4				
Beryllium	<2				
Cadmium	<3				
Chromium	27				
Copper	44	/2.9/	/2.9/	/12/	/18/
Lead	8	/5.6/	140	/3.2/	82
Mercury	0.3	/0.025/	2.1	/0.012/	2.4
Nickel	<15				
Selenium	<3				
Silver	<6				
Thallium	<3				
Zinc	60				

+ = All values are ug/L.
* = A hardness of 100 mg/L was used.

/ / = Effluent concentration exceeds criteria.

Table 7. Effluent bioassay results: Bellingham Class II inspection, August 25-26, 1987.

Procedure	Results:
Trout	100 percent survival @ 65 percent effluent
Microtox	EC_{50}[1] = 45.9 percent effluent @ 15 min.; 34.7 percent @ 30 min. EPA defined as "medium toxicity"[2]
Oyster Larvae	EC_{50} = 3.5 percent effluent (based on abnormality)

[1] EC_{50}: Statistical estimates of effluent concentration that would adversely affect fifty percent of the test organisms.

[2] EPA, 1980.

Sludge Metals

Total metals in the sludge ash were compared to results from previous inspections (Heffner, 1985). For primary treatment plants, concentrations of cadmium, chromium, copper, lead, nickel, and zinc were all less than average. Analysis by EP TOX indicated that all metals tested were well below dangerous waste designation levels. Further bioassay data are included in Appendix 2.

Sediment Bioassays

Results of the sediment bioassays are listed in Table 8. Significant mortality occurred in all field sediment samples, as compared to the laboratory control sediment sample. However, the amount of mortality was similar in all field samples. Therefore, it appears that the mortality was not necessarily effluent-related.

Cause(s) of the mortality is unknown. No organic compounds were found at significant concentrations (see Appendix 3). Also, no metals were found at levels that exceeded the "apparent effects threshold" for amphipods (Tetra Tech, Inc., 1986b). However, chromium and nickel in all field samples exceeded the 90th percentile concentration for Puget Sound non-reference areas.

Further sediment data on metals, bioassay results, and organics are contained in Appendices 1, 2, and 3, respectively.

Further sediment testing is not recommended at this time.

Laboratory Review

Laboratory procedures and agreement of split sample results were excellent. Three suggestions are made. First, seed material for BODs should be kept in the 20°C incubator instead of the refrigerator. Second, the use of BOD test results having less than 2.0 mg/L of residual dissolved oxygen are discouraged. These should not be considered as valid results, for any use. Third, all compositor lines and bottles should be cleaned on a regularly scheduled basis. Compositor lines may be cleaned weekly by injection of a chlorine solution. Uncleaned lines can cause erratic test results.

Split sample results are compared in Table 9. Inter-laboratory correlation was very good, with the exception of TSS results from Ecology's influent sample. Consistent differences were noted between the Ecology and PPPCP samples, particularly for the influent. A higher strength Ecology influent sample is evident in Table 5 as well. This is believed to be due to the different influent sampling locations (and therefore the inclusion of septic tank waste in the Ecology sample), and the respective sampling regimes: flow-paced for PPPCP, and time-paced for Ecology.

Table 8. Sediment bioassay results: Bellingham Class II inspection, August 25-26, 1987.

Station Number	Sample Location	Mean Values ± Standard Deviation Survival[a]	% Mortality
1	Diffuser, north	14.4 ± 2.7	28
2	Diffuser, south	13.0 ± 2.0	35
	Field Control	12.8 ± 3.0	36
Lab Control[b]		19.0 ± 0.7	5

[a]Five replicates/sample: 20 organisms/replicate.

[b]Sample was from West Beach, Whidbey Island.

Table 9. Comparison of split sample analysis: Bellingham Class II inspection, August 25-26, 1987.

Sample	Sampler	Laboratory	BOD_5 (mg/L)	TSS (mg/L)	Fecal Coliform (#/100 mL)	Chlorine Residual (mg/L) Free	Chlorine Residual (mg/L) Total
Influent	Ecology	Ecology	210	190			
		Bellingham	200	236			
	Bellingham	Ecology	160	170			
		Bellingham	160	176			
Effluent	Ecology	Ecology	126	40	50	0.8	2.0
		Bellingham	116	35	--		
	Bellingham	Ecology	126	58	--		
		Bellingham	116	61	22	--	3.0

The location of PPPCP's influent sampler should be changed to include the effects of all influent sources, including septic tank waste. Besides being more representative, this change should favor Bellingham in meeting the 85 percent removal rates for BOD and TSS that will be required on the new permit. Occasionally, Bellingham reports very low removals or even increases in BOD and/or TSS through the treatment system. This phenomenon may also be caused by sampler location, since effects of septic tank waste are picked up by PPPCP's effluent compositor but not the influent sample.

CONCLUSIONS AND RECOMMENDATIONS

Bellingham's PPPC plant was operating well during the inspection. No permit violations occurred. The major food processor was temporarily shut down, so the general characteristics of the 9.42 MGD flow resembled the non-canning season. The plant exceeded its designed removal efficiency for non-canning seasons.

The laboratory appeared to be very well run, and had excellent agreement of sample splits with Ecology's lab. The following lab and sampling recommendations were made:

1. Seed material for BOD's should be kept in the 20°C incubator instead of the refrigerator.
2. BOD tests having less than 2.0 mg/L of residual dissolved oxygen should not be used.
3. Composite sampler lines should be cleaned regularly to prevent buildup of bacterial slime inside the lines.
4. The influent sampler should be relocated to include all influent sources. Missing the influent septic tank waste could account for occasional low or negative removal efficiencies, and favor the plant in meeting 85 percent removal efficiencies to be required with secondary treatment.

No significant levels of organic compounds were indicated by priority pollutant scans of either whole effluent or receiving water sediments. Mercury, copper, and lead concentrations in the effluent exceeded EPA's ambient water quality criteria.

The oyster larvae effluent bioassay indicated considerable chronic toxicity. A "medium" amount of toxicity was found with Microtox. No mortality occurred during the trout bioassay. A second round of bioassays are suggested prior to plant upgrade.

Incinerated sludge ash contained low concentrations of all metals analyzed. All parameters were below EP TOX designation as a dangerous waste.

REFERENCES

ASTM, 1985. Annual book of ASTM standards, Water and Environmental Technology. Volume 11.04. American Society for Testing and Materials, Philadelphia, PA.

CH_2M Hill, Inc., 1984. City of Bellingham, Washington Application for Variance From Secondary Treatment Requirements, Section 301(h) Clean Water Act. Submitted to U.S. Environmental Protection Agency, December 1984.

EPA, 1980. Level 1: Biological Testing Assessment and Data Formatting. EPA 600/7-80-079; April 1980.

EPA, 1985. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms. EPA 600/4-85/014; December 1985.

EPA, 1986a. Quality Criteria for Water 1986. EPA 440/5-86-001; May 1, 1986.

EPA, 1986b. Test Methods for Evaluating Solid Waste, Vol. 1C. EPA Office of Solid Waste and Emergency Response; September 1986.

Heffner, M., 1985. Metals Concentration Found During WDOE Inspections of Municipal Wastewater Treatment Plants. Ecology memorandum to John Bernhardt; April 11, 1985.

Leupold & Stevens, Inc., 1987. Stevens Water Resources Data Book. 3rd Edition, 1978.

State of Washington Department of Ecology, 1981. Biological Testing Methods. DOE 80-12; revised July 1981.

Tetra Tech, Inc., 1986a. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Final Report #TC-3991-04; March 1986.

Tetra Tech, Inc., 1986b. User's Manual for the Pollutant of Concern Matrix, Puget Sound Estuary Program. Prepared for US EPA, August 1986.

APPENDIX 1 - METALS DATA

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

"EFFLUENT"

EPA Sample Number
357487

Date: 10-28-87

INORGANIC ANALYSIS DATA SHEET

LAB NAME ..... WEYERHAEUSER
SOW NO..... 784
LAB SAMPLE ID. NO. 98549

CASE NO..... 16061
QC REPORT NO... 16061

Element Identified and Measured

Concentration ... LOW
Matrix ... WATER
Units ... ug/l

1	Aluminum			13	Magnesium		
2	Antimony	60U	P	14	Manganese		
3	Arsenic	4U	F	15	Mercury	0.3	C
4	Barium			16	Nickel	15U	P
5	Beryllium	2.0 U	P	17	Potassium		
6	Cadmium	3.0 U	P	18	Selenium	3U	F
7	Calcium			19	Silver	6.0 U	P
8	Chromium *	27	P	20	Sodium		
9	Cobalt			21	Thallium	3U	F
10	Copper	44	P	22	Tin		
11	Iron			23	Vanadium		
12	Lead	8	F	24	Zinc	60	P
	Cyanide				% Solids		

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comment:

Lab Manager Kari Dowsee

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

"SLUDGE ASH"

EPA Sample Number
357488

Date: 10-28-87

INORGANIC ANALYSIS DATA SHEET

LAB NAME ..... WEYERHAEUSER
SOW NO..... 784
LAB SAMPLE ID. NO. 98545

CASE NO..... 16061
QC REPORT NO... 16061

Element Identified and Measured

Concentration ... LOW
Matrix ... SOIL
Units ... mg/kg Dry Sample Basis

1	Aluminum			13	Magnesium		
2	Antimony	47U R	P	14	Manganese		
3	Arsenic	8.9	F	15	Mercury	0.04U	C
4	Barium			16	Nickel	76	P
5	Beryllium	1.6 U	P	17	Potassium		
6	Cadmium	[2.7]	P	18	Selenium	3U	F
7	Calcium			19	Silver	25	P
8	Chromium	108	P	20	Sodium		
9	Cobalt			21	Thallium	3U	F
10	Copper	668	P	22	Tin		
11	Iron			23	Vanadium		
12	Lead	194	F	24	Zinc	872	P
	Cyanide				% Solids	47	

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comment:

Lab Manager Kyle Dowsee

SOUND ANALYTICAL SERVICES, INC.

Wash. Dept. of Ecology
Manchester Lab
Lab No: A 2228
September 29, 1987

The following sludge samples were analyzed for EP Toxicity in accordance with EPA SW-86, 2nd Edition, July 1982.

Contaminant	"SLUDGE ASH" Concentration, mg/l	
Sample No.	357488	347435
Arsenic	< 0.1	< 0.1
Barium	< 2.0	< 2.0
Cadmium	< 0.1	< 0.1
Chromium	< 0.1	< 0.1
Lead	< 0.1	< 0.1
Mercury	0.05	< 0.05
Selenium	< 0.1	< 0.1
Silver	< 0.1	< 0.1
Zinc	-----	< 0.1

SOUND ANALYTICAL SERVICES

STAN P. PALMQUIST

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

"OUTFALL SEDIMENT #1"

EPA Sample Number
357491

Date: 10-28-87

INORGANIC ANALYSIS DATA SHEET

LAB NAME ..... WEYERHAEUSER
SOW NO..... 784
LAB SAMPLE ID. NO. 98546

CASE NO..... 16061
QC REPORT NO... 16061

Element Identified and Measured

Concentration ... LOW
Matrix ... SOIL
Units ... mg/kg Dry Sample Basis

1	Aluminum			13	Magnesium		
2	Antimony	32U R	P	14	Manganese		
3	Arsenic	"	F	15	Mercury	0.66	C
4	Barium			16	Nickel	98	P
5	Beryllium	1.1 U	P	17	Potassium		
6	Cadmium	1.6 U	P	18	Selenium	2u	F
7	Calcium			19	Silver	3.2 U	P
8	Chromium	80	P	20	Sodium		
9	Cobalt			21	Thallium	2u	F
10	Copper	54	P	22	Tin		
11	Iron			23	Vanadium		
12	Lead	22	F	24	Zinc	123	P
	Cyanide				% Solids	32	

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comment:

Lab Manager Kaii Doysee

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

OUTFALL SEDIMENT #2

EPA Sample Number
357492

Date: 10-28-87

INORGANIC ANALYSIS DATA SHEET

LAB NAME ..... WEYERHAEUSER
SOW NO..... 784
LAB SAMPLE ID. NO. 98547

CASE NO..... 16061
QC REPORT NO... 16061

Element Identified and Measured

Concentration ... LOW
Matrix ... SOIL
Units ... mg/kg Dry Sample Basis

1	Aluminum			13	Magnesium		
2	Antimony	35U R	P	14	Manganese		
3	Arsenic	11	F	15	Mercury	0.38	C
4	Barium			16	Nickel	106	P
5	Beryllium	1.2 U	P	17	Potassium		
6	Cadmium	1.8 U	P	18	Selenium	2u	F
7	Calcium			19	Silver	3.5 U	P
8	Chromium	80	P	20	Sodium		
9	Cobalt			21	Thallium	2u	F
10	Copper	55	P	22	Tin		
11	Iron			23	Vanadium		
12	Lead	18	F	24	Zinc	126	P
	Cyanide				% Solids	29	

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comment:

Lab Manager Kaye Dowsee

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

"FIELD SEDIMENT CONTROL"

EPA Sample Number
357493

Date: 10-28-87

INORGANIC ANALYSIS DATA SHEET

LAB NAME ..... WEYERHAEUSER
SOW NO..... 784
LAB SAMPLE ID. NO. 98548

CASE NO..... 16061
QC REPORT NO... 16061

Element Identified and Measured

Concentration ... LOW
Matrix ... SOIL
Units ... mg/kg Dry Sample Basis

1	Aluminum			13	Magnesium		
2	Antimony	37U R	P	14	Manganese		
3	Arsenic	8.9	F	15	Mercury	0.46	C
4	Barium			16	Nickel	97	P
5	Beryllium	1.2 U	P	17	Potassium		
6	Cadmium	1.8 U	P	18	Selenium	2U	F
7	Calcium			19	Silver	3.7 U	P
8	Chromium	77	P	20	Sodium		
9	Cobalt			21	Thallium	2U	F
10	Copper	50	P	22	Tin		
11	Iron			23	Vanadium		
12	Lead	18	F	24	Zinc	119	P
	Cyanide				% Solids	29	

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comment:

Lab Manager Karin Dorsee

APPENDIX 2 - BIOASSAYS

ANDREA BEATTY RINIKER
Director

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

Post Office Box 346 • Manchester, Washington 98353-0346 • (206) 895-4740

M_E_M_O_R_A_N_D_U_M

September 8, 1987

To: Don Reif

From: Margaret Stinson, Manchester Laboratory

Subject: Bellingham WWTP
96-Hour Bioassay Information.

Sample Identification

Laboratory Reference Number:	35-7489
Date Sample Collected:	August 26, 1987
Date Sample Received:	August 27, 1987
Sample Submitted by:	Don Reif
Sample Description:	"Composite Un-Cl2 Eff" -A murky liquid

Test Procedure

The sample was tested for toxic properties in accordance with the Department of Ecology procedure for "Static Acute Fish Toxicity Test."

Test Results

The test data are tabulated in detail on the following page(s).

Test Details

The sample was tested at 65% effluent concentration in water.

The test organisms were rainbow trout (*Salmo gairdneri*). The organism length ranged from 25 to 38 mm, giving a short-to-long ratio of 1:1.5. The mean length was 31.2 mm. The average weight was 0.51 grams.

Ten trout were added to ten liters of sample/water mixture in each aquarium. This gave a flesh-to-mixture ratio of 0.51 gram/liter.

The test was started on August 29, 1987, at 1030 hours and completed on September 2, 1987, at 1030 hours.

Conclusions

65% Effluent-	0/30 fish died=	0% mortality.
Control-	0/40 fish died=	0% mortality.

cc: Merley McCall

State of Washington
Department of Ecology

DATA SHEET FOR STATIC BASIC ACUTE FISH TOXICITY TEST*

Laboratory: Manchester
Analyst: M. Stinson

Industry/Toxicant: Bellingham [illegible]
Address: Bellingham WA
Collector: [illegible]
Date Sample Collected: 8/26/87

Beginning Date: 8/29/87 Time: 1030
Ending Date: 9/2/87 Time: 1030
Test Organism: Rainbow Trout (Salmo gairdneri)
Required Test Temperature Range: 12 ± .5 °C

Laboratory Reference Number	Test Container No	Conc (mg/l)	Number of Cumulative Deaths 0	24	48	72	96	Dissolved Oxygen (mg/l) 0	24	48	72	96	pH 25 C 0	24	48	72	96	Temperature (C) 0	24	48	72	96	Total Hardness (mg/l as $CaCO_3$) 0	96	Total Alkalinity (mg/l as $CaCO_3$) 0	96	Conductivity uMHOS/cm 0	96
35-7484	6	65%	0	0	0	0	0	7.9	-	7.5	8.5	5.8	7.70	-	7.40	7.70	7.42	12°	-	12	12	12	61	68	86	123	477	485
	7		0	0	0	0	0	8.4	-	6.1	8.8	9.8	7.81	-	7.64	7.83	7.89		-				56	73	130	119	484	481
	8		0	0	0	0	0	8.5	-	6.3	8.5	8.6	7.82	-	7.51	7.84	7.84		-				75	66	112	119	477	483
Control	3	Dechlorinated	0	0	0	0	0	9.15	8.4	8.8	-	8.7	8.25	7.88	8.0	-	7.78		-				79	87	87	91	257	265
(8/27-8/31)	4	Manchester	0	0	0	0	0	9.15	8.9	-	-	8.9	8.38	8.00	-	-	7.89		-				73	80	95	89	256	267
	5	City Water	0	0	0	0	0	9.15	8.9	-	-	9.5	8.37	7.99	-	-	7.99		-				87	90	90	91	255	267
(8/[illegible])	10	"	0	0	0	0	0	8.5		9.3	8.3	8.5	7.87	-	7.91	7.93	7.81		-				137	87	86	100	-	282

Sample Description: "Composite Unkle Eff" - a murky liquid
Average Weight: .51 gm Mean Length: 31.2 mm Longest: 38 mm Shortest: 25 mm Ratio (long/short): 1.5
Number of organisms per chamber: 10 Ratio of flesh to water: .51 gm/L Comments: Very high oxygen demand; required 2 days of aerating before introduction of test organisms; & throughout test. Controls aerated as well. On fourth control tank was added at the time the test was begun.

* Method on file with the Department of Ecology
GENERAL PROCEDURE FOR STATIC BASIC ACUTE FISH TOXICITY TEST

DATA VERIFIED BY: Pam Corey DATE: 9/9/87

EHW > 10/30
DW > 11/30

ECY 030-1-40

BIOCHEM
ENVIRONMENTAL SERVICES, INC.

September 16, 1987

Ms. Margaret Stinson, MSPH
Environmentalist
Washington State Dept. of Ecology
Manchester Laboratory
7411 Beach Drive East
Pt. Orchard, WA 98366

Dear Ms. Stinson:

On September 2, 1987, BIOCHEM ENVIRONMENTAL SERVICES, INC. received a water sample labelled DOE # 357489, Station un-Cl_2 Eff. The sample was collected from Bellingham on 8-26-87, and was delivered in an I-CHEM bottle, lot #06168708. We were requested to analyze the sample in the Microtox Assay.

The sample as received was light amber, with a slight amout of turbidity (turbidity was not measured nephelometrically). Upon centrifugation, the sample was clear and non-turbid. Sample pH was 7.12, and did not receive any adjustment.

Results of the Microtox Assay are presented in the accompanying DATA SHEET. The sample exhibited EC_{50} values for both 15- and 30-minute exposures. The level of toxicity was determined to be MEDIUM, as defined by EPA in the manual, Level 1 Biological Testing Assessment and Data Formatting (EPA-600/7-80-079).

In the past, some staff members of DOE have requested EC values of other than 50% population (e.g., EC_{20} or EC_{25}). If you require EC values different from those reported, please call me at the number below. It is quite likely that other EC values can be calculated from our raw data.

If you have any questions regarding this report, please do not hesitate to telephone us.

Sincerely,

Gregory J. Ma, MSPH
Laboratory Director

Theodore F. Wetzler, PhD, MPH
Research Director & C.E.O.

1432 ELLIOTT AVE. WEST SEATTLE, WASHINGTON 98119 (206) 281-9099

BIOCHEM
ENVIRONMENTAL SERVICES, INC.

ANALYTICAL DATA SHEET

CLIENT: Margaret Stinson, MSPH
Manchester Lab, Dept. of Ecology

BIOCHEM ID: D0351

SAMPLE ID: DOE # 357489
SAMPLE SITE: Water sample from Bellingham (TP?) Station Un-Cl_2 Eff.

ASSAY: Microtox Test
EXTRACTION: None required

DATE ASSAYED: 9/3/87

VISUAL COLOR: amber
CORRECTION REQUIRED: No
VISUAL TURBIDITY: slight
CORRECTION REQUIRED: Yes
INITIAL PH: 7.12 PH ADJUSTED TO: n/a WITH: n/a

STARTING CONCENTRATION: 100% sample (neat, plus osmotic adjustment)

PROCEDURE REFERENCE: Microtox System Operating Manual (Beckman)

RESULTS:

EC_{50}(15 MIN)VALUE: 45.9% sample

EC_{50}(30 MIN)VALUE: 34.7% sample

LEVEL OF TOXICITY: MEDIUM, as defined in EPA Manual (EPA-600/7-80-079) Level 1 Biological Testing Assessment and Data Formatting.

CONTROLS: Sodium Arsenate was used as a positive control, yielding an EC_{50}(30 min)Value of 21.9 mg/L which is within the range for this compound.

COMMENTS:

The sample was slightly colored and turbid upon receipt. Both of these physical charateristics were removed upon centrifugation of the sample.

REPORT DATE: Sept. 16, 1987

Gregory J. Ma, MSPH
Laboratory Director

1432 ELLIOTT AVE. WEST SEATTLE, WASHINGTON 98119 (206) 281-9099

E.V.S. Consultants
Environmental Services

2335 Eastlake Avenue East
Seattle, Washington 98102
(206) 328-4188

Our File: 2/294-03

October 28, 1987

Margaret Stinson
WA. Dept. of Ecology,
Manchester Lab
7411 Beach Drive E.
Port Orchard, WA 98366

Dear Margaret:

Re: One Effluent Bioassay with Oyster Larvae and Three Amphipod Sediment Bioassays

---

Toxicity testing has been completed on one (1) effluent and three (3) sediment samples received September 01, 1987.

The oyster larva bioassay was carried out according to ASTM Method E 724-80: "Standard Practice for Conducting Static Acute Toxicity Tests with Larvae of Four Species of Bivalve Molluscs".

The amphipod sediment bioassays were carried out in accordance with E.P.A. P.S.E.P.'s "Recommended protocols for conducting laboratory bioassays on Puget Sound Sediments" (1986).

The results are summarized below for your convenience and test data are appended.

SAMPLE INFORMATION:

A/ Oyster Larvae Bioassay

Sample I.D.	pH	Initial Salinity (ppt)	pH	Adjusted Salinity (ppt)
357489	7.0	2	8.0	28

Summary of Results:

Test Organism	Exposure Period	End Point	EC50 (95% Confidence Limit)
Pacific oyster (*Crassostrea gigas*)	48h exp. of embryos to toxicant	larval abnormal.	3.5%

B/ Amphipod (*Rhepoxynius abronius*) Bioassays

Sample I.D.	Mean Values ± S.D. Survival[1]	Avoidance[2]
357491	14.4 ± 2.7*	0.2 ± 0.5
357492	13.0 ± 2.0*	0.2 ± 0.5
357493	12.8 ± 3.0*	0.1 ± 0.5
Control	19.0 ± 0.7	0.4 ± 0.5

1. n=5; A value of 20.0 = 100%. Asterisks denote values significantly less than (P0.05) the control (collected from West Beach, Whidbey Island, Washington).

2. Number of amphipods on the surface per jar per day (out of a maximum of 20.0).

C/ Amphipod (*Rhepoxynius abronius*) Reference Toxicant Control

Toxicant	96-h LC50 (ppb)
NaPCP	180 (C.L. = 113-250)

Should you have any questions or comments, please do not hesitate to contact the undersigned or Roxanne Rousseau at (604) 986-4331.

Yours truly,

E.V.S. CONSULTANTS

Sandra L. Jarvis, B.Sc.,
Aquatic Toxicologist

SLJ:arn

OYSTER LARVAE RAW DATA

Oyster Larvae Bioassay - Raw Data

Conc. (% v/v)	Rep.	Total Larvae	Normal Larvae Total	Normal Larvae %	Abnormal Larvae Total	Abnormal Larvae %	Mean % Abnormal	Adjusted Test Response
56	A	22	9	40.9	13	59.1		
	B	11	5	45.5	6	54.5		
	C	2	1	50.0	1	50.0	57.1	55.5
32	A	1	0	0.0	1	100.0		
	B	0	0		0			
	C	0	0		0		100.0	100.0
18	A	1	0	0.0	1	100.0		
	B	3	0	0.0	3	100.0		
	C	3	0	0.0	3	100.0	100.0	100.0
10	A	12	0	0.0	12	100.0		
	B	13	0	0.0	13	100.0		
	C	11	0	0.0	11	100.0	100.0	100.0
4.6	A	68	5	7.4	63	92.6		
	B	76	29	38.2	47	61.8		
	C	75	19	25.3	56	74.7	75.8	74.9
2.2	A	102	80	78.4	22	21.6		
	B	95	84	88.4	11	11.6		
	C	51	43	84.3	8	15.7	16.5	13.4
1	A	34	29	85.3	5	14.7		
	B	91	81	89.0	10	11.0		
	C	111	93	83.8	18	16.2	14.0	10.8
0.1	A	49	44	89.8	5	10.2		
	B	64	54	84.4	10	15.6		
	C	97	83	85.6	14	14.4	13.8	10.6
Seawater Control	A	29	28	96.6	1	3.4		
	B	31	30	96.8	1	3.2		
	C	19	18	94.7	1	5.3		
	D	47	45	95.7	2	4.3		
	E	42	41	97.6	1	2.4	3.6	

Oyster Larvae Bioassay - Water Quality After 48-h

Concen. (% v/v)	Replicate	Temperature (°C)	pH	Salinity (ppt)	Dissolved Oxygen (mg/L)
56	A	20.5	7.5	28.0	2.5
	B	20.5	7.5	28.0	2.5
	C	20.5	7.5	28.0	2.5
32	A	21.0	7.5	28.0	3.2
	B	21.0	7.5	28.0	3.4
	C	21.0	7.5	28.0	3.0
18	A	20.5	7.5	28.0	4.0
	B	21.0	7.4	28.0	4.0
	C	20.5	7.5	28.0	4.1
10	A	20.5	7.6	28.0	5.2
	B	20.5	7.6	28.0	5.2
	C	20.5	7.6	28.0	5.1
4.6	A	20.5	7.7	28.0	5.3
	B	20.5	7.7	28.0	5.4
	C	20.5	7.7	28.0	5.3
2.2	A	20.5	7.7	28.0	6.2
	B	20.5	7.7	28.0	6.2
	C	20.0	7.7	28.0	6.1
1.0	A	20.0	7.8	28.0	6.5
	B	20.5	7.8	28.0	6.5
	C	20.5	7.8	28.0	6.4
0.1	A	20.5	7.8	28.0	6.7
	B	20.0	7.8	28.0	6.8
	C	20.5	7.8	28.0	6.7
Seawater Control	A	20.0	7.9	28.0	6.9
	B	20.0	7.9	28.0	6.8
	C	20.0	7.9	28.0	6.9
	D	20.0	7.9	28.0	6.8
	E	20.0	7.9	28.0	6.8

B.V.S. CONSULTANTS
LC50 TOXDAT MULTI-METHOD CALCULATION RESULTS
****

Oyster Larvae Bioassay - W. D. G. E./E. P. A. Effluent

CONCENTRATION EXPRESSED AS : % (VOL/VOL)

CONCENTRATION	NUMBER EXPOSED PER TREATMENT	NUMBER AFFECTED PER TREATMENT	PERCENT AFFECTED
56.0 %	50	28	56 %
32.0 %	50	50	100 %
18.0 %	50	50	100 %
10.0 %	50	50	100 %
4.6 %	50	37	74 %
2.2 %	50	7	14 %
1.0 %	50	5	10 %
0.1 %	50	5	10 %

THE BINOMIAL TEST SHOWS THAT 1.2 AND + INFINITY CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, SINCE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS 100.0 %

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 3.5 PERCENT.

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD.

SPAN	G	LC50	95% CONFIDENCE LIMITS	
7	0.000	0	0	0
6	0.000	0	0	0
5	0.023	2	2	3
4	0.031	3	2	4
3	0.029	3	3	4
2	0.031	4	3	4
1	0.094	3	3	4

SINCE THE PROBABILITY IS LESS THAN 5 PERCENT, THE PROBIT METHOD WILL NOT GIVE ANY STATISTICALLY SOUND RESULTS.

END OF REPORT.

AMPHIPOD BIOASSAY, RESULTS AND RAW DATA

1.0 AMPHIPOD BIOASSAY

The infaunal amphipod Rhepoxynius abronius was collected subtidally from West Beach, a relatively remote site on Whidbey Island (Washington State), using a bottom trawl. A short haul (20 m) was used to minimize potential damage to animals during collection. Amphipods were maintained and transported in clean coolers with ice, and were returned to the E.V.S. Consultants Laboratory within 12 h of collection.

Following their arrival in the laboratory, the amphipods were kept in holding containers filled with fresh seawater (28 $\pm$ 2 ppt salinity) and maintained at 15 $\pm$ 1°C under continuous light until used in testing. Cultures were aerated but not fed during acclimation and were held for seven days before testing. Prior to testing, amphipods were hand sorted from sediments and identifications were confirmed using a Wild M5 dissecting microscope. Damaged, dead or unhealthy individuals were discarded.

Acute lethality of whole fresh (unfrozen) sediments was measured by the methodology of Swartz et al. (1982, 1985) as amended by Chapman and Becker (1986), which involved a 10-d exposure to the test sediments. A 2 cm layer of test sediment was placed in 1 L glass jars and covered with 800 mL of clean seawater (28 $\pm$ 2 ppt salinity). The jars were then covered with clean plastic lids. The interstitial salinities of all test containers were measured after seawater addition and found to be 28 $\pm$ 2 ppt. Each jar was seeded (randomly and blindly) with 20 amphipods and aerated. Six replicates (20 amphipods each) were run per station. Five jars were used to determine toxicity, while the sixth jar served as a reference for daily measurement of water chemistry (pH, DO, salinity, temperature). The total sample volume submitted for station 357492 allowed for three replicates to be run instead of five replicates. The containers were checked daily to establish trends in mortality and sediment avoidance, and also to gently sink any amphipods which had left the sediment overnight and become trapped by surface tension at the air/water interface. A negative (clean) control sediment (from West Beach, the amphipod collection site) was run concurrently with the test sediments.

Bioassay tests were terminated after 10-d when sediments were sieved (0.5 mm screen), and live and dead amphipods removed and counted. Amphipods were considered dead when there was no response to physical stimulation and microscopic examination revealed no evidence of pleopod or other movement. Missing amphipods were assumed to have died and decomposed prior to the termination of the bioassay (Swartz et al., 1982, 1985).

At the end of the 10-d exposure surviving amphipods were transferred to a fingerbowl containing a 2-cm deep layer of control sediment and clean bioassay water. The number of individuals able to rebury after one hour was recorded.

Amphipod avoidance response was also determined from daily counts of numbers of amphipods that had emerged from the sediments. Data were pooled at the end of the 10-d exposure period to calculate mean and standard deviations.

Any significant difference in survival between the test sediments and control sediment was determined by analysis of variance using the Statistix computer program (NH Analytical Software, Copyright 1986). Specific differences in mean survival were determined by Dunnett's procedure (Steel and Torrie, 1960). One-tailed t-tables (P0.05) were used to determine if mean survival was significantly less in each test sediment than the control value.

2.0 AMPHIPOD RESULTS

Mean survival in the test sediments ranged from a low of 12.8 out of 20 (64%) for station 357493 to a high of 14.4 out of 20 (72%) for 357491. Mean survival in the sediment control was 19.0 (95%). Results of the analysis of variance indicated that significant differences in survival occurred ($F=7.4$, $P=0.05$). Mean survival at all the stations was significantly lower ($P=0.05$) than the control.

Over 90% of surviving amphipods from each station tested were able to rebury after a one-hour exposure to clean control sediment and bioassay water.

Water quality parameters during testing (Appendix B) ranged from: temperature, 15 $\pm$ 1°C; salinity, 30-32 ppt; pH, 7.7-8.2; D.O, greater than 7.0 mg/L.

3.0 REFERENCE CITED

Chapman, P.M. and S. Becker. 1986. Recommended protocols for conducting laboratory bioassays on Puget Sound sediments. Puget Sound Estuary Program, U.S. Environmental Protection Agency, Seattle, Washington. 55 pp.

Steel, R.G.D. and J.H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.

Swartz, R.C., W.A. DeBen, J.K. Phillips, J.O. Lamberson and F.A. Cole. 1985. Phoxocephalid amphipod bioassay for marine Purdy and R.C. Bahner (eds.), Aquatic Toxicology and Hazard Assessment: Proceedings of the Seventh Annual Symposium ASTM STP 854.

SAMPLE 357491

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A		0	0	0	0	0	0	0	0	2	0	16	1	14.5	30	7.9	8.0
	B		0	0	0	1	2	0	0	0	0	0	17	0	14.5	30	7.8	8.1
	C		0	0	0	1	0	0	0	0	0	0	16	0	14.5	30	8.0	8.1
	D		0	0	0	0	0	0	2	1	0	0	12	0	14.5	30	7.8	8.0
	E		0	0	0	0	0	0	0	0	0	0	11	0	14.5	30	7.2	7.8

14.4 + 2.7

#organisms (missing : dead) => Rep. A (0:4) ; Rep. B (2:1) ; Rep. C (4:0)
Rep. D (6:2) ; Rep. E (9:0).

SAMPLE 357492

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A		1	1	1	0	0	0	0	0	2	0	13	0	14.5	30	8.0	8.1
	B		0	0	0	0	0	0	0	0	1	1	15	0	14.5	31	8.0	8.0
	C		0	0	0	0	0	0	0	0	0	0	11	0	14.5	30	8.1	8.2
	D																	
	E																	

13.0 + 2.0

#organisms (missing : dead) => Rep. A (3:4) ; Rep. B (1:4) ; Rep. C (5:4)
There was not enough sample present to run 5 replicates.

SAMPLE 357493

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A		0	0	0	1	0	1	0	0	0	0	12	0	14.5	31	8.0	8.1
	B		0	0	0	0	0	0	0	0	0	0	14	0	14.5	30	8.1	8.1
	C		0	0	1	0	0	0	0	0	0	0	12	0	14.5	30	8.1	8.1
	D		0	0	0	0	0	0	0	0	0	0	9	0	14.5	30	8.1	8.1
	E		0	0	0	0	0	0	0	0	0	0	17	0	14.5	30	7.6	7.8

12.8 + 3.0

#organisms (missing : dead) => Rep. A (8:0) ; Rep. B (6:0) ; Rep. C (1:7)
Rep. D (9:2) ; Rep. E (2:1)

AMPLE Control (EVS)

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A		0	0	0	0	0	1	1	0	0	0	19	0	14.5	30	8.0	8.1
	B		0	0	0	1	1	1	1	1	1	1	18	0	14.5	30	8.0	8.1
	C		0	0	0	0	0	0	0	0	0	0	20	0	14.5	30	8.0	8.1
	D		0	0	0	0	1	1	1	1	1	1	19	0	14.5	31	8.1	8.1
	E		0	0	0	0	1	1	1	1	0	0	19	0	14.5	30	8.0	8.1

19.0 + 0.7

#organisms (missing: dead) => Rep. A (1:0); Rep. B (0:2); Rep. C (0:0)
Rep. D (0:1); Rep. E (1:0)

SAMPLE

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A																	
	B																	
	C																	
	D																	
	E																	

SAMPLE

LAB NO.	REP.	NUMBER OF AMPHIPODS EMERGED FROM SEDIMENTS AT DAYS 0-10											NUMBER ALIVE AT 10 DAYS	NUMBER FAILING TO REBURROW	WATER CHEMISTRY AT 10 D			
		0	1	2	3	4	5	6	7	8	9	10			TEMP (°C)	SAL (ppt)	D.O. (mg/L)	pH
	A																	
	B																	
	C																	
	D																	
	E																	

Sample I.D.	Observation
357491	Sieving after day 10 revealed variable grain size and seastar sp.
357492	Sieving after day 10 revealed variable grain size, shells, organic debris and worm sp.
357493	Sieving after day 10 revealed variable grain size, shells, organic debris, crabs and worm sp.

Sieve ?

E.V.S. CONSULTANTS

AMPHIPOD BIOASSAYS

DAILY WATER CHEMISTRY MONITORING

LAB NO.	SAMPLE I.D.	TEMPERATURE (°C)											SALINITY (ppt)											DISSOLVED OXYGEN (mg/L)											pH										
		0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
EPA-1	357191	16	15.5	15.5	15	15	15	15	15	15	15	14.5	30	31	32	32	30	30	30	30	31	31	32	6.9	8.2	8.3	8.4	8.0	7.7	7.2	8.0	8.0	7.9	8.0	7.7	8.0	8.2	8.2	7.8	7.9	7.9	8.0	8.0	8.2	8.2
EPA-2	357192	16	15.5	15.5	15	15	15	15	15	15	15	14.5	30	31	32	32	30	30	30	30	31	32	31	7.8	8.2	8.2	8.3	8.1	8.1	8.0	8.1	8.0	7.8	7.0	7.7	8.0	8.1	8.1	7.9	8.0	8.0	7.9	8.0	8.2	8.2
EPA-3	357193	16	15.5	15.5	15	15	15	15	15	15	15	14.5	30	31	32	32	31	30	30	30	31	32	31	7.8	8.2	8.2	8.4	8.1	8.1	8.1	8.2	8.0	7.8	8.1	8.0	8.1	8.1	8.1	7.8	7.9	8.0	7.9	8.0	8.1	8.1
EPA-4	CONTROL (EVS)	15	15.5	15.5	15	15	15	15	15	15	15	14.5	30	31	32	32	31	30	30	30	31	30	31	7.8	8.2	8.2	8.4	8.2	8.2	8.1	8.1	8.0	8.0	8.0	7.9	8.0	8.2	8.1	7.9	8.0	8.0	8.0	8.0	8.1	8.1

E.V.S. CONSULTANTS

ACUTE LETHALITY BIOASSAY DATA

SAMPLE: NaPCP - reference toxicant

DATE COLLECTED:

E.V.S. PROJECT NO.: 21328-01

WORK ORDER NO.:

LAB NO.	TEST DATE & TIME	NO. FISH/ VOL.	(ppb) CONC.	PERCENT SURVIVAL (1 to 96 hours) 1	2	4	8	18	24	48	72	96	DISSOLVED OXYGEN (mg/L) 0	24	48	72	96	TEMPERATURE (°C) 0	24	48	72	96	pH 0	24	48	72	96	CONDUCTIVITY (umhos/cm) 0	96		Salinity (‰) 0	96	HARD mg/L 0	96
	Sept 15 AM	10/1L	1000						20	0	—		8.3	8.3	8.2	—		15	14.5	15	—		10.1	9.8	9.2	—					26	27		
	"	"	560						100	80	10	0	8.3	8.2	8.1	8.2	8.1	14.5	14.5	15	15	15	9.6	9.3	9.1	8.6	8.4				29	28		
	"	"	320						100	90	60	30	8.3	8.2	8.1	8.2	8.1	14.5	14.5	15	15	15	8.9	8.3	8.3	8.1	8.1				29	29		
	"	"	180						100	100	70	60	8.4	8.2	8.1	8.2	8.1	14.5	14.5	15	15	15	8.5	8.2	8.3	8.1	8.1				30	30		
	"	"	100						100	100	80	70	8.3	8.2	8.1	8.1	8.1	15	14.5	15	15	15	8.2	8.0	8.1	8.0	8.0				30	30		
	"	"	control						100	100	100	100	8.4	8.0	8.2	8.1	8.3	15	14.5	15	15	15	7.8	8.0	8.0	8.0	8.0				30	30		

SAMPLE DESCRIPTION

COMMENTS

MEAN FISH LENGTH (mm) _____ RANGE _____

MEAN FISH WEIGHT (g) _____ RANGE _____

DATA VERIFIED BY R. Rauen E.V.S. CONSULTANTS

DATE September 15/87

E.V.S. CONSULTANTS

[illegible] MULTI-METHOD CALCULATION RESULTS

****

AMPHIPOD REFERENCE TOXICANT (NaPCP)

CONCENTRATION EXPRESSED AS : P.P.B. (WT/VOL)

CONCENTRATION	NUMBER EXPOSED PER TREATMENT	NUMBER AFFECTED PER TREATMENT	PERCENT AFFECTED
1000 PPB	10	10	100 %
560 PPB	10	10	100 %
320 PPB	10	7	70 %
180 PPB	10	4	40 %
100 PPB	10	3	30 %

THE BINOMIAL TEST SHOWS THAT 0 AND 560 CAN BE USED AS STATISTICALLY SOUND CONSERVATIVE 95 PERCENT CONFIDENCE LIMITS, SINCE THE ACTUAL CONFIDENCE LEVEL ASSOCIATED WITH THESE LIMITS IS 99.9 %

AN APPROXIMATE LC50 FOR THIS SET OF DATA IS 218 P.P.B.

----------RESULTS CALCULATED USING THE MOVING AVERAGE METHOD.

SPAN	G	LC50	95% CONFIDENCE LIMITS	
4	0.000	0	0	0
3	0.269	191	115	268
2	1.308	207	ZERO	+INFINITY.
1	2.353	218	ZERO	+INFINITY.

----------RESULTS CALCULATED USING THE PROBIT METHOD.

ITERATIONS	G	H	GOODNESS OF FIT PROBABILITY
11	.2598265	1	.5574263

SLOPE = 3.19

95 PERCENT CONFIDENCE LIMITS = 1.56 AND 4.82

LC50 = 180.22

95% CONFIDENCE LIMITS = 113.06 AND 249.95

END OF REPORT.

APPENDIX 3 - EFFLUENT AND SEDIMENT ORGANIC ANALYSIS

Effluent priority pollutant scan results: Bellingham Class II inspection, August 25-26, 1987.

Parameter	Station Location				
	Influent	Effluent	Sed. #1	Sed. #2	Field Control
Chloromethane	10u	10u	30u	38u	37u
Bromomethane	10u	10u	30u	38u	37u
Vinyl Chloride	10u	10u	30u	38u	37u
Chloroethane	10u	10u	30u	38u	37u
Methylene Chloride	**2mb**	**1mb**	**8jb**	**21b**	**8jb**
Acetone	**740k**	**210**	**91**	**160**	**98**
Carbon Disulfide	5u	5u	15u	19u	19u
1,1-Dichloroethene	5u	5u	15u	19u	19u
1,1-Dichloroethane	5u	5u	15u	19u	19u
Trans-1,2-Dichloroethene	5u	5u	15u	19u	19u
Chloroform	**11**	**13**	15u	19u	19u
1,2-Dichloroethane	5u	5u	15u	19u	19u
2-Butanone	10u	10u	30u	38u	37u
1,1,1-Trichloroethane	5u	5u	15u	19u	19u
Carbon Tetrachloride	5u	5u	15u	19u	19u
Vinyl Acetate	10u	10u	30u	38u	37u
Bromodichloromethane	5u	5u	15u	19u	19u
1,2-Dichloropropane	5u	5u	15u	19u	19u
Trans-1,3-Dichloropropene	5u	5u	15u	19u	19u
Trichloroethene	5u	5u	15u	19u	19u
1,1,2-Trichloroethane	5u	5u	15u	19u	19u
Benzene	2j	2j	15u	19u	19u
cis-1,3-Dichloropropene	5u	5u	15u	19u	19u
2-Chloroethylvinylether	10u	10u	30u	38u	37u
Bromoform	5u	5u	15u	19u	19u
4-Methyl-2-Pentanone	10u	10u	30u	38u	37u
2-Hexanone	10u	10u	30u	38u	37u
Tetrachloroethene	5u	5u	15u	19u	19u
1,1,2,2-Tetrachloroethane	5u	5u	15u	19u	19u
Toluene	**33**	**17**	15u	19u	19u
Chlorobenzene	5u	5u	15u	19u	19u
Ethylbenzene	**1j**	**1m**	15u	19u	19u
Styrene	5u	5u	15u	19u	19u
Total Xylenes	**16**	**8**	15u	19u	19u
Phenol	14u	18u	76u	98u	83u
bis(2-Chloroethyl)Ether	14u	18u	880u	880u	880u
2-Chlorophenol	14u	18u	970u	970u	970u
1,3-Dichlorobenzene	14u	18u	33u	43u	36u
1,4-Dichlorobenzene	14u	18u	86u	110u	93u
Benzyl Alcohol	**11j**	**15j**	100u	130u	110u
1,2-Dichlorobenzene	14u	18u	23u	29u	25u
2-Methylphenol	14u	18u	110u	150u	120u

Parameter	Station Location				
	Influent	Effluent	Sed. #1	Sed. #2	Field Control
bis(2-chloroisopropyl)ether	14u	18u	250u	320u	270u
4-Methylphenol	**17**	**84**	57u	74u	62u
N-Nitroso-Di-n-Propylamine	14u	18u	150u	190u	160u
Hexachloroethane	14u	18u	150u	190u	160u
Nitrobenzene	14u	18u	100u	130u	110u
Isophorone	14u	18u	230u	290u	250u
2-Nitrophenol	14u	18u	300u	390u	330u
2,4-Dimethylphenol	14u	18u	270u	350u	290u
Benzoic Acid	71u	89u	320u	410u	350u
bis(2-Chloroethoxy)Methane	14u	18u	230u	290u	250u
2,4-Dichlorophenol	14u	18u	310u	400u	340u
1,2,4-Trichlorobenzene	14u	18u	180u	230u	190u
Naphthalene	2j	18u	310u	400u	330u
4-Chloroaniline	14u	18u	170u	210u	180u
Hexachlorobutadiene	14u	18u	170u	220u	190u
4-Chloro-3-Methylphenol	14u	18u	180u	230u	190u
2-Methylnaphthalene	2j	18u	170u	210u	180u
Hexachlorocyclopentadiene	14u	18u	160u	210u	180u
2,4,6-Trichlorophenol	14u	18u	58u	75u	63u
2,4,5-Trichlorophenol	71u	89u	70u	90u	76u
2-Chloronaphthalene	14u	18u	14u	18u	15u
2-Nitroaniline	71u	89u	300u	390u	330u
Dimethyl Phthalate	14u	18u	92u	120u	100u
Acenaphthylene	14u	18u	19u	25u	21u
3-Nitroaniline	71u	89u	180u	230u	190u
Acenaphthene	14u	18u	110u	140u	120u
2,4-Dinitrophenol	71u	89u	610u	780u	660u
4-Nitrophenol	71u	89u	190u	250u	210u
Dibenzofuran	14u	18u	160u	200u	170u
2,4-Dinitrotoluene	14u	18u	93u	120u	100u
2,6-Dinitrotoluene	14u	18u	260u	330u	280u
Diethylphthalate	5j	18u	76u	97u	82u
4-Chlorophenyl-phenylether	14u	18u	140u	180u	150u
Fluorene	14u	18u	110u	140u	120u
4-Nitroaniline	71u	89u	350u	460u	380u
4,6-Dinitro-2-Methylphenol	71u	89u	630u	820u	690u
N-Nitrosodiphenylamine	14u	18u	310u	390u	330u
4-Bromophenyl-phenylether	14u	18u	120u	160u	130u
Hexachlorobenzene	14u	18u	170u	210u	180u
Pentachlorophenol	71u	89u	120u	160u	130u
Phenanthrene	14u	18u	160u	210u	170u
Anthracene	14u	18u	87u	110u	94u
Di-n-Butylphthalate	4j	4m	150u	190u	160u
Fluoranthene	14u	18u	340u	440u	370u
Pyrene	14u	18u	310u	400u	340u
Butylbenxylphthalate	14u	18u	390u	500u	420u
3,3'-Dichlorobenzidine	29u	36u	160u	200u	170u

Parameter	Station Location				
	Influent	Effluent	Sed. #1	Sed. #2	Field Control
Benzo(a)Anthracene	14u	18u	240u	310u	260u
bis(2-Ethylhexyl)Phthalate	23	23	370u	480u	400u
Chrysene	14u	18u	76u	98u	82u
Di-n-Octyl Phthalate	3m	18u	310u	400u	340u
Benzo(b)Fluoranthene	14u	18u	96u	120u	100u
Benzo(k)Fluoranthene	14u	18u	400u	510u	430u
Benzo(a)Pyrene	14u	18u	170u	210u	180u
Indeno(1,2,3-cd)Pyrene	14u	18u	41u	53u	45u
Dibenz(a,h)Anthracene	14u	18u	190u	250u	210u
Benzo(ghi)Perylene	14u	18u	180u	230u	190u

Qualifiers:

u = Compound was analyzed for but not detected at the given detection limit.

j = Estimated value when result is less than the specified detection limit.

b = Analyte was found in blank as well as a sample, and indicates possible/probable blank contamination.

k = Quantitated value fell above the limit of the calibration curve.

m = Estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.