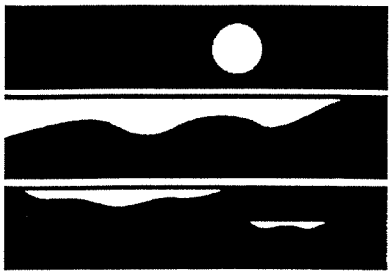

BOISE CASCADE'S WEST TACOMA MILL (STEILACOOM) CLASS II INSPECTION AUGUST 24-26, 1989

by
Don Reif

Washington Department of Ecology
Environmental Investigations and Laboratory Services Program
Compliance Monitoring Section
Olympia, Washington 98504-8711

Water Body No. WA-PS-0080
(Segment No.'s 05-12-07 & 05-12-09)

August 1990

INTRODUCTION

A Class II inspection was conducted at Boise Cascade's (BC's) West Tacoma Mill in Steilacoom on April 24-26, 1989. The inspection was requested by Ecology's Industrial Section. Don Reif and Keith Seiders of Ecology's Environmental Investigations Section, Compliance Monitoring Unit conducted the inspection. Ken Campbell, Engineering Services Manager, and Skip Thompson with laboratory services provided assistance from Boise Cascade.

Objectives of the inspection are as follows:

- Assess plant compliance with NPDES permit parameters.
- Characterize effluent and outfall near-field sediment toxicity by chemical and bioassay testing.
- Review mill lab procedures for conformance with standard procedures.
- Provide baseline data for future inspections.

LOCATION AND DESCRIPTION

Boise Cascade is located at the mouth of Chambers Creek, just northeast of Steilacoom (Figure 1). The thermo-mechanical pulp mill produces 150,000 tons of newsprint annually. An average 4.8 MGD of process wastewater is treated in an aerated lagoon (aerated stabilization basin, or ASB) following primary clarification (Figure 2). Primary sludge is burned in the hog fuel boiler after being thickened in a press. Final effluent discharges to Puget Sound at about 35 feet MLLW through a 96 foot diffuser section about 350 feet from shore.

METHODS

Composite samples of the primary and final effluents were taken. Ecology's ISCO automatic samplers composited 400 mL every 30 minutes for 24 hours. Two compositors collected effluent samples. One was used for conventional samples only; the other was used for priority pollutant organic analyses. Effluent bioassay samples were a combination of automatic and grab composite samples due to the volume required. Also, grab samples were collected from primary influent and effluent, final effluent, and filter backwash from the process water treatment system. Composite samples were split between the mill and Ecology to assess interlaboratory correlation. The sampling schedule with sites and parameters is shown in Table 1. Sampling sites are shown on Figure 2.

Two near-field sediment samples were collected. Sediment sample #1 was taken from the north side of the diffuser's midpoint. Sediment

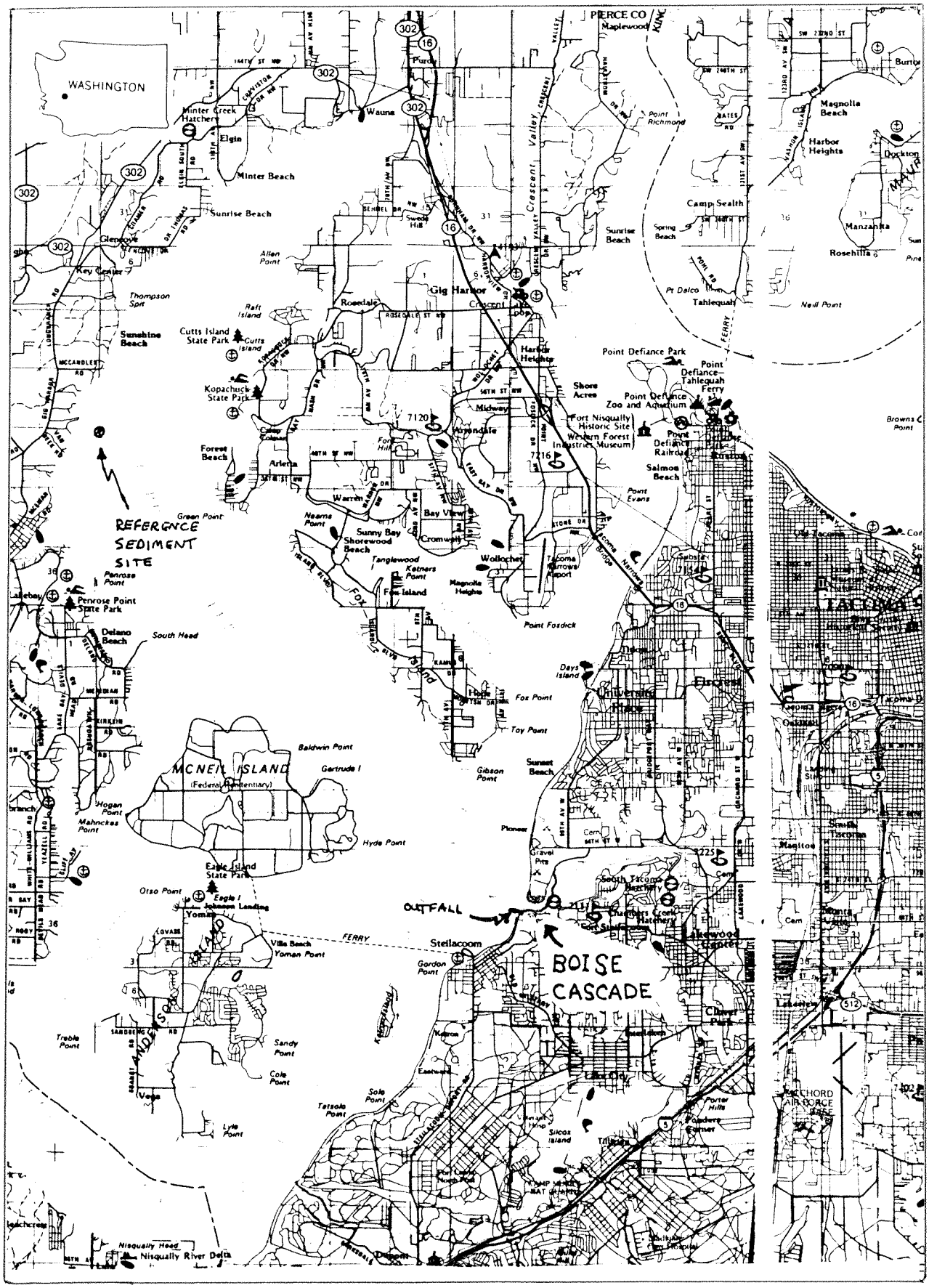

Figure 1. Plant location with outfall and reference sediment locations - Boise Cascade, Steilacoom Class II Inspection: April 24-26, 1989.

sample #2 was collected approximately 200 feet to the north of the diffuser, just outside the dilution zone as defined in the mill's permit. Also, a field reference sample was collected in Carr Inlet about nine miles northwest of the outfall. This site corresponds to Ecology's sediment ambient monitoring station #F43. Samples were collected with a 0.1 m^2 Van Veen clamshell sampler. Each of the three samples consisted of three grabs that were composited, homogenized, and subsampled. Sampling procedures conformed to Puget Sound Protocols (Tetra Tech, 1986). Upon collection, all samples were immediately iced and delivered to Ecology's Manchester Lab within 24 hours. Most analyses were run by commercial laboratories. A listing of methods, references, and labs used for analytical work are shown in Appendix 4.

A doppler-type portable flowmeter was used to attempt to verify the accuracy of Boise Cascade's magnetic flowmeter. Ecology's meter was installed in the mill's effluent flowmeter vault, attached to the downstream side of the 20-inch pipe.

RESULTS AND DISCUSSION

Flow

The accuracy of BC's flowmeter was not assessed because Ecology's flowmeter failed during the night. BC's flowrate appeared to be quite constant during the inspection. One instantaneous check showed good correlation between the two meters. This flowmeter should be checked at the next inspection. BC's flowmeter total of 4.46 MGD is used in subsequent discussions and calculations.

General Conditions

Overall, BC's wastewater treatment system achieved significant reductions of BOD, COD, total solids, and total suspended solids: 84%, 81%, 44%, and 89%, respectively. Much of these reductions took place in the secondary part of the treatment process. An exception was final effluent suspended solids, which were 2.3 times greater than the primary effluent (150 mg/L versus 65 mg/L). This apparent anomoly is related to the ASB secondary treatment system at BC, which does not include a final clarifier.

NPDES Permit Compliance

All NPDES permit conditions were met during the inspection (Table 3). BOD and TSS were 54% and 57%, respectively, of the daily average limits. The trout bioassay had 93% survival at 65% effluent, well above the 80% minimum.

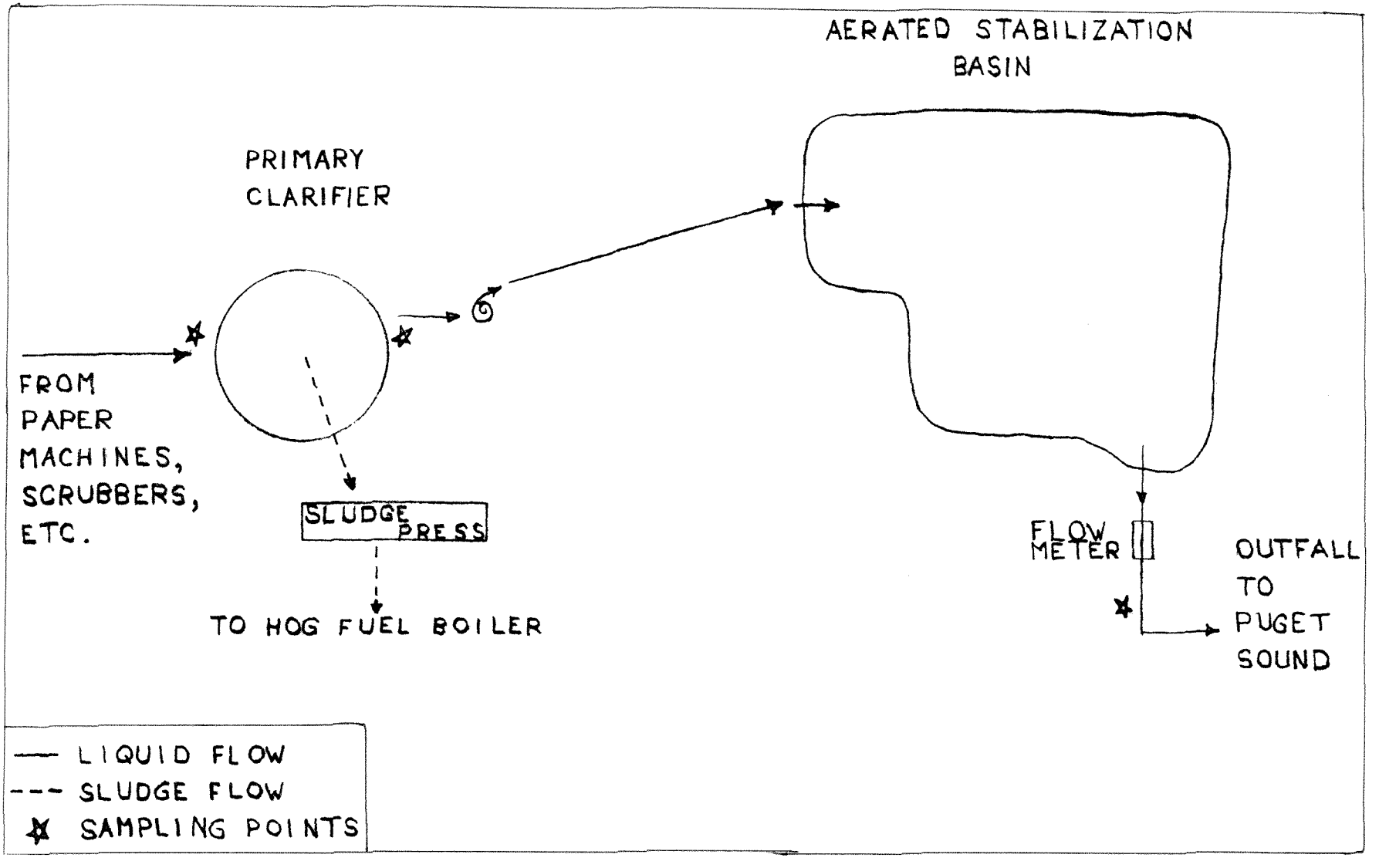

Figure 2. Flow schematic with sampling locations - Boise Cascade Class II Inspection: April 24-26, 1989.

Effluent Bioassays

Various amounts of toxicity were found in the effluent bioassays (Table 4). Very little toxicity was indicated in all but two tests. The Microtox, fathead minnow, and *Daphnia magna* bioassays all had EC_{50}'s (concentration that adversely affects 50% of the test population) of greater than 100% effluent. Juvenile rainbow trout had a seven percent mortality at 65% effluent. The echinoderm and oyster larvae bioassays were, as is fairly typical, the most sensitive. For the echinoderm test, the effluent NOEC (No Observed Effects Concentration) was 3.0%, and the EC_{50} was 18.8%. The salinity control, by contrast, had an NOEC of 12.5% and an EC_{50} of 32.4%. An EC_{50} of 9.7% effluent was estimated for the oyster bioassay. However, mortality data for both the sample and salinity control were highly variable and it was therefore impossible to calculate EC_{50}'s, NOEC's, and LOEC's for them. Abnormality data for the salinity controls indicated on NOEC of 1%, LOEC of 3.2%, and sufficient variability to make an EC_{50} calculation impossible. The reason for the apparent toxicity in the salinity controls is unknown. Salinity should not have been a problem, even at the highest effluent concentration (18% with 31 ppt). Because of this, however, the oyster larvae results should be used only with great caution.

Effluent Chemistry

Several volatile and base/neutral organics and resin acids were detected in BC's final effluent, although most were found at relatively low concentrations. Acetone was detected at 290 ppb but may have been related to compositor cleaning solvents (Table 5). Several resin acids were detected in the effluent although the secondary treatment system reduced these compounds from 47 to greater than 95%. No guaiacols, polychlorinated biphenyls, or priority pollutant pesticides were detected in the primary or final effluents.

Several metals were detected in BC's effluent (Table 5). Of these, nickel, lead, and copper exceeded one or more of the freshwater and/or saltwater ambient criteria at the hardness level of the effluent (EPA 1986). However, only copper exceeded a criterion to any appreciable degree. Effluent copper was 3.5 and 5.3 times greater than the freshwater acute and chronic criteria, respectively, while the saltwater criterion was exceeded by 20 times. Therefore, a dilution factor of at least 20 in BC's mixing zone would be necessary to prevent an exceedance of water quality criteria.

A complete listing of the organics and metals analyses is found in Appendices 1 and 2.

Sediment Bioassays

Results of two bioassays (marine amphipod and Microtox) indicated no apparent toxicity in the two near-field outfall sediments or the reference site in Henderson Bay (Table 6).

Sediment Chemistry

Most of the priority pollutant organics detected in the sediment samples were found in sample #1 (Table 7). Of these, most were higher molecular weight (PAH's) polynuclear aromatic hydrocarbons. All organics were well below Ecology's criteria except for (PCB's) polychlorinated biphenyls. PCB's in sediment #1, collected near the outfall, were twenty-three times greater than Ecology's criterion (280 versus 12 mg/kg as organic carbon). Therefore, this sediment would be "predicted to have an adverse effect on Puget Sound biological resources" based on total PCB concentration (Betts, 1989). Following this evaluation process, however, this prediction can be overridden when biological testing indicates no toxic effect. The full biological testing needed to confirm or override the chemical data was not done; only one of the two acute tests (amphipod) in addition to the one chronic test (Microtox) were run. Of the available results, however, sediment #1 would have passed the biological portion of the testing since no adverse effects were noted.

Laboratory Evaluation

A review of lab procedures during the inspection indicated several areas of potential improvement to comply with accepted lab protocols. An earlier memorandum addressed the major concerns (Reif, 1989a). These included initial (zero day) D.O. determination in all BOD bottles, proper seed BOD determination and calculation, and proper TSS procedures.

Items not mentioned in the earlier memo are as follows:

- Composited sample temperatures should be checked periodically to be sure that proper refrigeration is maintained (four degrees C.) during collection.

- Composite sampling lines should be rinsed with a chlorine solution every three months, or the hose replaced.

- For any D.O. determinations, the D.O. meter should be calibrated daily. For BODs, a minimum of 2.0 mg/L D.O. depletion and 1.0 mg/L D.O. remaining must be strictly adhered to.

- For the BOD incubator, a thermometer in a water bath is recommended to measure temperatures. Also, a certified

thermometer should be available to periodically check the accuracy of all thermometers.

- For TSS, an approved filter paper should be used, such as the Whatman 934AH. Filters need to be dried at least one hour, and the time period should be consistent.

- Dessicant in the dessicators must be maintained to preserve its effectiveness.

- A standard reference, such as Standard Methods, must be used consistently and completely.

Comparison of Sample Splits

Samples split between Boise Cascade and Ecology's labs showed good agreement for TSS, as shown in Table 8. In both BOD analyses, BC's BOD value was approximately twenty-five percent higher than Ecology's. Since many changes have occurred within BC's lab since the inspection, another set of splits may yield useful information.

SUMMARY AND RECOMMENDATIONS

BC's flowmeter appeared to be accurate but could not be confirmed due to mechanical failure of Ecology's portable flowmeter. The flowmeter should be rechecked during the next inspection.

BC was within all permitted discharge parameters during the inspection. Effluent suspended solids were high, but are related to the type of secondary treatment system used at BC.

Effluent biological toxicity did not appear elevated as measured by bioassays. Rainbow trout, fathead minnow, *Daphnia magna*, *Ceriodaphnia dubia*, and Microtox had EC_{50}'s greater than 100% effluent. The pacific oyster bioassay had an EC_{50} of 9.7% effluent, but was clouded by a low apparent effect of salinity. The echinoderm bioassay had an EC_{50} of 19% effluent. Both of these results are relatively mild compared to other pulp mill effluents (Reif, 1989b).

Several organics and metals were found at low concentrations in the final effluent. Only copper notably exceeded EPA's criteria for ambient water quality. A dilution factor of twenty would have been necessary to prevent an exceedance of water quality criteria in BC's mixing zone.

No measureable adverse effects were seen in the two sediment bioassays (Microtox and *Rhepoxinius abronius*). Of the priority pollutants detected in the outfall sediment samples, one--total PCBs--exceeded Ecology's proposed criterion for sediments. Since no adverse biological effect was apparent, this sediment would

probably not be classified under Ecology sediment guidelines.

Splits between the Ecology and BC's labs agreed well for TSS, but were marginal for BOD. From the lab evaluation, it was noted that BC's lab was not following approved protocols for the BOD and TSS tests. These items were noted in an earlier memo and in the Lab Evaluation section. Most of these concerns have all ready been addressed by BC's lab. Sample split evaluations are recommended for future Class II inspections.

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TABLES

Table 1. Sampling schedule - Boise Cascade Class II inspection: April 24-26, 1989.

		Water Samples														Sediment Samples		
	Station:	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Eff.	Eff.	Eff.	F.B.W.	Cha.Ck.	P.Eff.	Eff-Eco	Eff-BC	Test #1	Test #2	Refer
	Date:	4/25	4/25	4/25	4/25	4/25	4/25	4/26	4/26	4/26	4/26	4/26	4/26	4/25-26	4/25-26	4/25-26	4/24	4/24	4/24
	Time:	am	am	am	pm	pm	pm	am	am	am	noon	am	pm						
	Type:	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	comp	comp	comp	grab	grab	grab
Analysis	Lab ID#:	178133	178134	178135	178136	178137	178138	178140	178139	178141	178146	178142	-	178143	178144	178145	178130	178131	178132
GENERAL CHEMISTRY																			
Turbidity		E	E	E	E	E	E	E	E	E		E		E	E	E			
pH		E	E	E	E	E	E	E	E	E		E		E	E	E			
Conductivity		E	E	E	E	E	E	E	E	E		E		E	E	E			
Alkalinity		E	E	E	E	E	E	E	E	E		E		E	E	E			
Hardness														E	E				
Cyanide														E	E		E	E	E
Solids(4)		E	E	E	E	E	E	E	E	E		E		E	E,BC	E,BC			
BOD_5												E		E	E,BC	E,BC			
COD		E	E	E	E	E	E	E	E	E		E		E	E	E			
Nutrients(4)																			
NH_3		E	E	E	E	E	E	E	E	E		E		E	E	E			
NO_3+NO_2		E	E	E	E	E	E	E	E	E		E		E	E	E			
T-Phosphate		E	E	E	E	E	E	E	E	E		E		E	E	E			
Fecal Coliform							E												
% Kleb							E												
% Solids																	E	E	E
Grain Size																	E	E	E
ORGANICS + METALS																			
pp metals														E	E		E	E	E
ABN (water)														E	E				
ABN (solids)																	E	E	E
VOA (water)								E		E									
Pest/PCB (water)														E	E				
Pest/PCB (solids)																	E	E	E
Resin Acids/Guaiacol														E	E		E	E	E
Phenols														E	E				
Grease & Oils										E	E								
TOC																	E	E	E

Table 1. Continued.

		Water Samples														Sediment Samples		
	Station:	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Eff.	Eff.	Eff.	F.B.W.	Cha.Ck.	P.Eff.	Eff-Eco	Eff-BC	Test #1	Test #2	Refer
	Date:	4/25	4/25	4/25	4/25	4/25	4/25	4/26	4/26	4/26	4/26	4/26	4/26	4/25-26	4/25-26	4/25-26	4/24	4/24	4/24
	Time:	am	am	am	pm	pm	pm	am	am	am	noon	am	pm						
	Type:	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	comp	comp	comp	grab	grab	grab
Analysis	Lab ID#:	178133	178134	178135	178136	178137	178138	178140	178139	178141	178146	178142	-	178143	178144	178145	178130	178131	178132
BIOASSAYS																			
Trout																E			
Microtox															E		E	E	E
Fathead Minnow															E				
Pacific Oyster															E				
Ceriodaphnia dubia															E				
Echinoderm															E				
Daphnia magna															E				
Rhepoxinius abronius																	E	E	E
FIELD ANALYSES																			
pH		E	E	E	E	E	E	E	E	E		E	E	E	E	E			
Temperature		E	E	E	E	E	E	E	E	E		E	E	E	E	E			
Conductivity		E	E	E	E	E	E	E	E	E		E	E	E	E	E			

E - analysis by Ecology
BC - analysis by Boise Cascade

Table 2. General chemistry results- Boise Cascade Class II inspection: April 24-26, 1989.

Sample:	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Eff.	Eff.	P.Inf.	P.Ef	Eff.	Eff.	P.Eff.	Eff-Eco	Eff-BC	F.B.W.	Cha.Ck.
Type:	grab	grab	grab	grab	grab	grab	grab	grab	grab	grab	comp	comp	comp	grab	grab
Date:	4/25	4/25	4/25	4/25	4/25	4/25	4/26	4/26	4/26	4/26	4/25-26	4/25-26	4/25-26	4/26	4/26
Time:	1045	1040	1140	1605	1605	1540	1140	1150	1020	1200	1000-0930	1000-0930	1000-0930	1350	1352
Laboratory Analyses:															
Turbidity (NTU)	270	97	69	240	95	70	95	97	66		96	68	62	4	
pH (std. units)	6.66	5.18	6.3	6.61	5.31	6.29	7.87	5.34	6.60		5.38	6.46	6.47	7.00	
Conductivity (umhos/cm)	784	707	604	651	717	520	629	829	546		759	587	549	136	
Alkalinity (mg/L $CaCO_3$)	84	81	35	75	85	37	120	87	45		81	38	40	54	
Hardness (mg/L $CaCO_3$)											105	90	86		
Cyanide, total (mg/L)											<0.002	<0.002			
Total Solids (mg/L)	2600	1400	850	2000	1300	790	3300	1400	830		1400	790	790	150	
Total NV Solids (mg/L)	630	530	370	530	490	420	530	580	390		560	400	360	84	
TSS (mg/L)	1100	96	175	810	59	180	2100	64	200		65	150	140	10	
TNVSS (mg/L)	80	4	35	60	12	19	50	<1	<1		<1	<1	<1	<1	
BOD_5 (mg/L)											500	95	81	5	
COD (mg/L)	2880	1250	529	2100	1120	479	3540	1310	536		1700	548	522	20	
NH_3-N (mg/L)	0.07	0.04	0.03	0.06	0.04	0.03	0.16	0.04	0.03		0.04	0.03	0.02	0.01	
NO_3+NO_2-N (mg/L)	PNQ	PNQ	PNQ	PNQ	PNQ	PNQ	NAR	NAR	NAR		NAR	NAR	NAR	NAR	
T-Phosphate (mg/L)	7.7	5.4	3.0	5.4	5.4	3.2	>6.9	8.6	3.6		6.0	3.3	3.1	0.11	
Fecal Coliform (#/100 ml)						>20,000									
% KES						100									
% Solids															
Grease & Oils (mg/L)										3.8					
Field Analyses:															
pH (std. units)	6.74	5.62	6.68	6.77	5.63	6.76	7.92	5.70	7.40	-	5.67	6.79	6.87	7.07	7.57
Temperature (°C)	37.6	34.6	26.3	34.6	34.8	25.9	32.8	33.3	26.3	-	11.0	6.4	13.0	14.1	14.0
Conductivity (umhos/cm)	770	855	640	730	832	660	740	920	660	-	960	750	616	195	175

NAR - no analytical result
PNQ - present but not quanitified

Table 3. Comparison of inspection results to NPDES permit limits - Boise Cascade Steilacoom Class II inspection: April 24-26, 1989.

Parameter	Daily Average	Daily Maximum	Inspection Results
BOD_5: lbs/day	6500	12,500	3500
TSS: lbs/day	9900	18,500	5600
pH	6.0-9.0		6.68, 6.76, 7.40
Trout Bioassay	>/= 80% survival at 65% effluent concentr.		93% survival

Table 4. Effluent bioassay summary- Boise Cascade Class II Inspection: April 24-26, 1989.

96-hour Rainbow trout (*Oncorhyncus mykiss*)	Microtox
% Mortality	EC50 (15 minutes at 15 deg. C): >100% sample
65% Effluent 7	
Control 0	

	NOEC	LOEC	EC_{50}
Fathead Minnow (*Pimephales promelas*- 7 day)	50%	100%	>100% (96 hr)
Ceriodaphnia dubia (7 day)	12.5%	25%	>1000% (48hr)
Daphnia magna (7 day)	100%	>100%	>100% (48hr)
Oyster Larvae (*Crassostrea gigas*)	<0.1%	0.1%	9.7%
Echinoderm Sperm Cell Toxicity (Green Sea Urchin- *Strongylocentrotus droebachiensis*)	3.0%	6.0%	18.8%

Table 5. Summary of influent and effluent organics and metals, with effluent metals compared to EPA criteria- Boise Cascade Class II inspection: April 24-26, 1989 (all units in ug/L).

	Sample:	Pri. Eff.	Eff-Eco	EPA Water Quality Criteria for protection of ambient water quality*:			
	Type:	composite	composite				
	Date:	4/23-24/89	4/23-24/89				
Priority pollutant metals				FW Acute	FW Chronic	SW Acute	SW Chronic
Antimony		1.6	1.0	9000	1600	-	-
Arsenic		1.2	8.1	-	-	-	-
Chromium		6	5 U	1590	190	10,300	-
Copper		64	57	16.1	10.8	2.9	2.9
Lead		8.4	7.7	71.4	2.8	140	5.6
Nickel		20	20	1300	144	75	8.3
Zinc		88	70	107	96.9	95	86
VOA Compounds		ug/L	ug/L				
Methylene Chloride		8.5 B	73 B				
Acetone		60	290 K				
Carbon Disulfide		18	1.2 U				
Chloroform		1.3	1.1 M				
Toluene		1.5	0.8 U				
Phenols, Total		40	6				
BNA Compounds							
Benzyl Alcohol		4 J	5 U				
4-Methylphenol		10	1 U				
2,4-Dimethylphenol		1 M	2 U				
Bis(2-Ethylhexyl)phthalate		1	1				
Resin Acids							
Pimaric Acid		57	30				
Sandacopimaric Acid		130	27				
Isopimaric Acid		330	79				
Palustric Acid		500	25 U				
Dehydroabietic Acid		460	85				
Abietic Acid		290	68				
Neoabietic Acid		1,100	87				

U indicates compound was analyzed for but not detected at the given detection limit

J indicates an estimated value when result is less than specified detection limit

B This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable blank contamination

M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

K quantitated value fell above the limit of the calibration curve

* - effluent hardness of 90 mg/L $CaCO_3$ used for hardness-dependent metals criteria.

Table 6. Sediment bioassay results- Boise Cascade Class II inspection: April 24-26, 1989.

Amphipod (*Rhepoxynius abronius*)	Mean Values +/- S.D. Survival[1]	Avoidance[2]	% Reburial[3]
Sediment #1	19.2+/-0.4	0.9+/-2.1	100
Sediment #2	18.4+/-1.8	0.8+/-2.2	100
Reference	18.2+/-0.8	0.5+/-0.9	99
Lab Control[4]	18.4+/-1.5	0.8+/-1.3	100
Microtox (saline extraction)	Results: No measureable toxicity in any sample.		

[1] n=5; a value of 20.0 = 100%. There were no significant differences (p=0.05) between the test sediments and the control sediment, or between the reference and sediments #1 & 2.

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

[3] Percentage of surviving amphipods able to rebury in clean sediment and seawater within 1 hour after the 10 day exposure.

[4] Negative control sediment collected from West Beach, Whidbey Island, the amphipod collection site.

Table 7. Sediment organics and metals compared to criteria- Boise Cascade Class II inspection: April 24-26, 1989. (dry weight basis)

Sample: / Date:	Sed. #1 4/22/90	Sed. #2 4/22/90	Reference 4/22/90	Interim Sed. Quality Criteria[1]
Cyanide, Total (ug/Kg)	0.029	0.026U	0.032U	
BNAs (ug/Kg)				
Phenol	110J	250	90U	420
4-Methylphenol	57U	49	44U	670
Phenanthrene	18J	41U	44U	
Fluoranthene	43J	41U	44U	
Pyrene	25J	41U	44U	
Benzo(a)Anthracene	14M	41U	44U	
Chrysene	24M	41U	44U	
Benzo(b&k)Fluoranthene	30M	41U	44U	
Benzo(a)Pyrene	16M	41U	44U	
Pest/PCB Compounds (ug/Kg)				
Aroclor-1254	270	40U	40U	
Aroclor-1260	70	40U	40U	
Total PCBs	340 (280*)			12*
Priority pollutant metals (mg/Kg)				
Arsenic	3.75	3.95	2.49	57
Chromium	23.4	20.8	10.7	260
Copper	10.1	7.81	3.83	390
Lead	6.8	5.0	3.2	450
Mercury	0.05U	0.05	0.05U	0.41
Nickel	20.0	18.9	8.6	-
Zinc	34.9	27.5	13.3	410

U indicates compound was analyzed for but not detected at the given detection limit

J indicates an estimated value when result is less than specified detection limit

B This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable blank contamination

M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

K quantitated value fell above the limit of the calibration curve

[1] Betts, Brett 1989. Interim Sediment Quality Evaluation Process for Puget Sound. Wash. St. Dept. of Ecology, October 1989.

* - expressed as mg/kg organic carbon (ppm carbon).

Table 8. Comparison of laboratory results- Boise Cascade Class II inspection: April 24-26, 1989.

Sample	Sampler	Laboratory	BOD_5 (mg/L)	TSS (mg/L)
Composites:				
Effluent:	Ecology	Ecology	95	150
	Ecology	BC	87	204
	BC	Ecology	81	140
	BC	BC	75	198

APPENDICES

Appendix 1. Results of VOA, BNA, Pest/PCB and metal priority pollutant scans- Boise Cascade Class II inspection: April 24-26, 1989.

Sample:	Pri. Eff.	Eff-Eco	Sed. #1	Sed. #2	Reference
Lab Log #:	178143	178144	178130	178131	178132
Type:	composite	composite	composite	composite	composite
Date:	4/23-24/89	4/23-24/89	4/22/90	4/22/90	4/22/90
VOA Compounds	ug/L	ug/L	ug/Kg dry	ug/Kg dry	ug/Kg dry
Chloromethane	3.8U	3.8U			
Bromomethane	3.1U	3.1U			
Vinyl Chloride	2.0U	2.0U			
Chloroethane	3.3U	3.3U			
Methylene Chloride	8.5B	73 B			
Acetone	60	290 K			
Carbon Disulfide	18	1.2U			
1,1-Dichloroethene	0.7U	0.7U			
1,1-Dichloroethane	0.6U	0.6U			
1,2-Dichloroethene (total)	0.8U	0.8U			
Chloroform	1.3	1.1M			
1,2-Dichloroethane	0.5U	0.5U			
2-Butanone	6.2U	6.2U			
1,1,1-Trichloroethane	0.6U	0.6U			
Carbon Tetrachloride	0.9U	0.9U			
Vinyl Acetate	3.1U	3.1U			
Bromodichloromethane	0.3U	0.3U			
1,2-Dichloropropane	0.7U	0.7U			
trans-1,3-Dichloropropene	1.8U	1.8U			
Trichloroethene	0.6U	0.6U			
Dibromochloromethane	0.7U	0.7U			
1,1,2-Trichloroethane	0.7U	0.7U			
Benzene	1.0U	1.0U			
cis-1,3-Dichloropropene	1.9U	1.9U			
2-Chloroethylvinylether	2.7U	2.7U			
Bromoform	2.5U	2.5U			
4-Methyl-2-Pentanone	3.5U	3.5U			
2-Hexanone	3.2U	3.2U			
Tetrachloroethene	0.5U	0.5U			
1,1,2,2-Tetrachloroethane	2.7U	2.7U			
Toluene	1.5	0.8U			
Chlorobenzene	0.9U	0.9U			
Ethylbenzene	0.8U	0.8U			
Styrene	1.1U	1.1U			
Total Xylenes	1.8U	1.8U			
Cyanide, Total	0.002U	0.002U	29	26 U	32 U
Phenols, Total	40	6			

Appendix 1. Continued.

Sample:	Pri. Eff.	Eff-Eco	Sed. #1	Sed. #2	Reference
Lab Log #:	178139	178144	178130	178131	178132
Type:	composite	composite	composite	composite	composite
Date:	4/23-24/89	4/23-24/89	4/22/90	4/22/90	4/22/90
BNA Compounds	ug/L	ug/L	ug/Kg dry	ug/Kg dry	ug/Kg dry
Phenol	8U	2U	110J	250	90U
Bis(2-Chloroethyl)Ether	1U	1U	57U	41U	44U
2-Chlorophenol	1U	1U	57U	41U	44U
1,3-Dichlorobenzene	1U	1U	57U	41U	44U
1,4-Dichlorobenzene	1U	1U	57U	41U	44U
Benzyl Alcohol	4J	5U	280U	210U	220U
1,2-Dichlorobenzene	1U	1U	57U	41U	44U
2-Methylphenol	1U	1U	57U	41U	44U
Bis(2-chloroisopropyl)ether	1U	1U	57U	41U	44U
4-Methylphenol	10	1U	57U	49	44U
N-Nitroso-Di-n-Propylamine	1U	1U	57U	41U	44U
Hexachloroethane	2U	2U	110U	80U	90U
Nitrobenzene	1U	1U	57U	41U	44U
Isophorone	1U	1U	57U	41U	44U
2-Nitrophenol	5U	5U	280U	210U	220U
2,4-Dimethylphenol	1M	2U	110U	80U	90U
Benzoic Acid	10U	10U	570U	410U	440U
Bis(2-Chloroethoxy)Methane	1U	1U	57U	41U	44U
2,4-Dichlorophenol	3U	3U	170U	120U	130U
1,2,4-Trichlorobenzene	1U	1U	57U	41U	44U
Naphthalene	1U	1U	57U	41U	44U
4-Chloroaniline	3U	3U	170U	120U	130U
Hexachlorobutadiene	2U	2U	110U	80U	90U
4-Chloro-3-Methylphenol	2U	2U	110U	80U	90U
2-Methylnaphthalene	1U	1U	57U	41U	44U
Hexachlorocyclopentadiene	5U	5U	280U	210U	220U
2,4,6-Trichlorophenol	5U	5U	280U	210U	220U
2,4,5-Trichlorophenol	5U	5U	280U	210U	220U
2-Chloronaphthalene	1U	1U	57U	41U	44U
2-Nitroaniline	5U	5U	280U	210U	220U
Dimethyl Phthalate	1U	1U	57U	41U	44U
Acenaphthylene	1U	1U	57U	41U	44U
3-Nitroaniline	5U	5U	280U	210U	220U
Acenaphthene	1U	1U	57U	41U	44U
2,4-Dinitrophenol	10U	10U	570U	410U	440U
4-Nitrophenol	5U	5U	280U	210U	220U
Dibenzofuran	1U	1U	57U	41U	44U

Appendix 1. Continued.

Sample:	Pri. Eff.	Eff-Eco	Sed. #1	Sed. #2	Reference
Lab Log #:	178143	178144	178130	178131	178132
Type:	composite	composite	composite	composite	composite
Date:	4/23-24/89	4/23-24/89	4/22/90	4/22/90	4/22/90
BNA Compounds	ug/L	ug/L	ug/Kg dry	ug/Kg dry	ug/Kg dry
2,4-Dinitrotoluene	5U	5U	280U	210U	220U
2,6-Dinitrotoluene	5U	5U	280U	210U	220U
Diethyl Phthalate	1U	1U	57U	41U	44U
4-Chlorophenyl-Phenylether	1U	1U	57U	41U	44U
Fluorene	1U	1U	57U	41U	44U
4-Nitroaniline	5U	5U	280U	210U	220U
4,6-Dinitro-2-Methylphenol	10U	10U	570U	410U	440U
N-Nitrosodiphenylamine	1U	1U	57U	41U	44U
1,2-Diphenylhydrazine	1U	1U	57U	41U	44U
4-Bromophenyl-Phenylether	1U	1U	57U	41U	44U
Hexachlorobenzene	1U	1U	57U	41U	44U
Pentachlorophenol	5U	5U	280U	210U	220U
Phenanthrene	1U	1U	18J	41U	44U
Anthracene	1U	1U	57U	41U	44U
Di-n-Butyl Phthalate	1U	1U	57U	41U	44U
Fluoranthene	1U	1U	43J	41U	44U
Pyrene	1U	1U	25J	41U	44U
Butylbenzylpthalate	1U	1U	57U	41U	44U
3,3'-Dichlorobenzidine	5U	5U	280U	210U	220U
Benzo(a)Anthracene	1U	1U	14M	41U	44U
Chrysene	1U	1U	24M	41U	44U
Bis(2-Ethylhexyl)phthalate	1	1	57U	41U	44U
Di-n-Octyl Phthalate	1U	1U	57U	41U	44U
Benzo(b&k)Fluoranthene	1U	1U	30M	41U	44U
Benzo(a)Pyrene	1U	1U	16M	41U	44U
Indeno(1,2,3-cd)Pyrene	1U	1U	57U	41U	44U
Dibenzo(a,h)Anthracene	1U	1U	57U	41U	44U
Benzo(g,h,i)Perylene	1U	1U	57U	41U	44U
Pest/PCB Compounds					
alpha-BHC	0.03U	0.03U	3.0U	2.0U	2.0U
beta-BHC	0.03U	0.03U	3.0U	2.0U	2.0U
delta-BHC	0.03U	0.03U	3.0U	2.0U	2.0U
gamma-BHC (Lindane)	0.03U	0.03U	3.0U	2.0U	2.0U
Heptachlor	0.03U	0.03U	3.0U	2.0U	2.0U
Aldrin	0.03U	0.03U	3.0U	2.0U	2.0U
Heptachlor Epoxide	0.03U	0.03U	3.0U	2.0U	2.0U

Appendix 1. Continued.

Sample:	Pri. Eff.	Eff-Eco	Sed. #1	Sed. #2	Reference
Lab Log #:	178143	178144	178130	178131	178132
Type:	composite	composite	composite	composite	composite
Date:	4/23-24/89	4/23-24/89	4/22/90	4/22/90	4/22/90
Pest/PCB Compounds (continued)					
Endosulfan I	0.03U	0.03U	3.0U	2.0U	2.0U
Dieldrin	0.05U	0.05U	4.5U	3.0U	3.0U
4,4'-DDE	0.05U	0.05U	4.5U	3.0U	3.0
Endrin	0.05U	0.05U	4.5U	3.0U	3.0U
Endosulfan II	0.05U	0.05U	8.0U	3.0U	3.0U
4,4'-DDD	0.09U	0.09U	9.0U	6.0U	6.0U
Endosulfan Sulfate	0.09U	0.09U	9.0U	6.0U	6.0U
4,4'-DDT	0.06U	0.06U	6.0U	4.0U	4.0U
Methoxychlor	0.12U	0.12U	12U	8.0U	8.0U
Endrin Ketone	0.05U	0.05U	4.5U	3.0U	3.0U
alpha-Chlordane }	0.03U	0.03U	3.0U	2.0U	2.0U
gamma-Chlordane }	0.03U	0.03U	4.0U	2.0U	2.0U
Toxaphene	4.5U	4.5U	450U	300U	300U
Aroclor-1016 and 1242	0.06U	0.06U	60U	40U	40U
Aroclor-1248	0.06U	0.06U	60U	40U	40U
Aroclor-1254	0.06U	0.06U	270	40U	40U
Aroclor-1260	0.06U	0.06U	70	40U	40U
Priority pollutant metals	ug/L	ug/L	mg/Kg dry	mg/Kg dry	mg/Kg dry
Antimony	1.6	1.0	0.115U	0.115U	0.122U
Arsenic	1.2	8.1	3.75	3.95	2.49
Beryllium	1U	1U	0.11U	0.12U	0.13U
Cadmium	2U	2U	0.22U	0.24U	0.25U
Chromium	6	5U	23.4	20.8	10.7
Copper	64	57	10.1	7.81	3.83
Lead	8.4	7.7	6.8	5.0	3.2
Mercury	0.1U	0.1U	0.05U	0.05	0.05U
Nickel	20	20	20.0	18.9	8.6
Selenium	2.0U	2.0U	0.22U	0.24U	0.25U
Silver	3U	3U	0.34U	0.36U	0.38U
Thallium	1.0U	1.0U	0.112U	0.122U	0.126U
Zinc	88	70	34.9	27.5	13.3

U indicates compound was analyzed for but not detected at the given detection limit
J indicates an estimated value when result is less than specified detection limit
B This flag is used when the analyte is found in the blank as well as the sample. Indicates possible/probable blank contamination
M indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters
K quantitated value fell above the limit of the calibration curve

Appendix 2. Resin Acids & Guaiacols, with sediment general chemistry data- Boise Cascade Class II inspection: April 24-26, 1989.

Sample:	Pri. Eff.	Eff-Eco	Sed. #1	Sed. #2	Reference
Lab Log #:	178143	178144	178130	178131	178132
Type:	composite	composite	composite	composite	composite
Date:	4/23-24/89	4/23-24/89	4/22/90	4/22/90	4/22/90
Pimaric Acid	57	30	15 U	75	13 U
Sandacopimaric Acid	30	27	8.5M	100	13 U
Isopimaric Acid	330	79	16 M	360	27 U
Palustric Acid	500	25 U	300 U	390 U	270 U
Dehydroabietic Acid	460	85	38	470	13 U
Abietic Acid	290	68	15 U	250	13 U
Neoabietic Acid	1,100	87	60 U	210	54 U
Chloro Dehydroabietic Acid	40 U	5.0U	60 U	78 U	54 U
Dichloro Dehydroabietic Acid	20 U	2.5U	30 U	39 U	27 U
1,2-Dimethoxybenzene	10 U	1.3U	15 U	19 U	13 U
4,5-Dichlorodimethoxybenzene	20 U	2.5U	30 U	39 U	27 U
4,5,6-Trichlorodimethoxybenzen	40 U	5.0U	60 U	78 U	54 U
Tetrachlorodimethoxybenzene	40 U	5.0U	60 U	78 U	54 U
% Solids			78	77	77
TOC, % C, dry			0.12	0.55	0.24
Grain Size (%, dry basis):					
Gravel (>2mm)			3	3	<2
Sand (2mm-62um)			89.8	96.2	98.9
Silt (62um-4um)			7.2	0.7	0.9
Clay (<4um)			<0.1	0.1	0.2

U - indicates compound was analyzed for but not detected at the given detection limit

M - indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters

Appendix 3. Effluent bioassay results - Boise Cascade Class II Inspection: June 24-26, 1989.

96-hour Rainbow trout (*Oncorhyncus mykiss*)

	# of live test organisms: Initial	Final	Percent Mortality
Effluent*	30	28	7
Control	30	30	0

* - 65% effluent concentration

Fathead Minnow (*Pimephales promelas*) - 7 days

Effluent test concentration:	# exposed	% survival	Mean Wt. per fish (mg)
0% (control)	30	86	0.39
6.25%	30	90	0.42
12.5%	30	96	0.36
25%	30	90	0.38
50%	30	86	0.37
100%	30	76	0.22

NOEC - 50.0%
LOEC - 100%
96 hr. LC_{50} - >100%

Ceriodaphnia dubia (7 day)

Concentrations:	Total # Exposed	Survival %	Mean # of Young per Orig.Females
Control	10	100	20
6.25 %	10	100	31
12.5 %	10	90	26
25 %	10	80	15
50 %	10	90	12
100 %	10	100	2.7

NOEC: 12.5%
LOEC: 25.0%
48hr. EC_{50}: >100%

Microtox

EC_{50} (15 minutes at 15 deg. C): >100% sample

Appendix 3. Continued.

Echinoderm Sperm Cell Toxicity
Green Sea Urchin - *Strongylocentrotus droebachiensis*

	% Unfertilized Eggs		
		Salinity	
Dilution	Effluent	Control	Seawater +
0.1%	6.6	2.5	
1%	4	20	
3%	8	1	
6%	12	12	
12.5%	17	13	
25%	80	21	
50%	100	98	
100%	-	-	4.7
NOEC:	3 %	12.5 %	
LOEC:	6 %	25 %	
EC_{50}:	18.8 %	32.4 %	

* - mean of three replicates
** - seawater diluted with deionized water
\+ - negative control

Daphnia magna (7 days)

Concentrations:	Total # Exposed	Survival %	Mean # of Young per Orig. Females
Control		10	100181%1010021
3%	10	90	24
10%	10	100	31
30%	10	100	28
100%	10	100	17

NOEC: 100%
LOEC: >100%
48hr. EC_{50}: >100%

Appendix 3 Continued.

Oyster Larvae (*Crassostrea gigas*)

	Sample		Salinity Control+	
Sample	Mean % Mortality	Weighted Mean % Abnormality	Mean % Mortality	Weighted Mean % Abnormality
0 %(Control*)	18	8.8	-	-
0.1 %	17	15	15	14
0.5 %	21	17	8.4	15
1 %	5.6	24	11	16
3.2 %	8.9	27	25	24
5.6 %	12	35	9.9	19
10 %	9.9	57	0	17
18 %	24	99	18	21
NOEC:	-	<0.1%	-	1%
LOEC:	-	0.1%	-	3.2%
EC_{50}:	-	9.7%	-	-

* - dilution seawater control from Yaquina Bay, Oregon
\+ - seawater plus distilled water

Equations:

a) $$\text{Mean Larval Mortality (\%)} = \frac{\text{Mean \# of Embryos Introduced - Mean \# of Larvae Surviving}}{\text{Mean \# Embryos Introduced}} \times 100$$

b) $$\text{Weighted Mean Larval Abnormality (\%)} = \frac{\text{\# Larvae Surviving in Replicate \#1}}{\text{\# Larvae Surviving in Replicates 1 \& 2}} \times \text{Larval Abnormality in Replicate 1 (\%)} + \frac{\text{\# Larvae Surviving in Replicate 2}}{\text{\# Larvae Surviving in Replicates 1 \# 2}} \times \text{Larval Abnormality in Replicate 2 (\%)}$$

where,
$$\text{Larval Abnormality (\%)} = \frac{\text{\# Abnormal Larvae}}{\text{\# Normal \& Abnormal Larvae}} \times 100$$

Appendix 4. Analytical methods- Boise Cascade Class II inspection: April 24-26, 1989.

Laboratory Analyses	Method used for Ecology Analyses	Laboratory performing analysis
Grain Size	Tetra Tech, 1986	Laucks Testing Labs; Seattle, Wa.
% Solids	APHA, 1985: 209F	Laucks Testing Labs; Seattle, Wa.
TOC	APHA, 1985: 505	Analytical Resources, Inc., Seattle Wa.
VOA (water)	EPA #624	Analytical Resources, Inc., Seattle Wa.
VOA (solids)	EPA #8240	Analytical Resources, Inc., Seattle Wa.
BNA (water)	EPA #625	Analytical Resources, Inc., Seattle Wa.
BNA (solids)	EPA #8270	Analytical Resources, Inc., Seattle Wa.
Pest/PCB (water)	EPA #608	Analytical Resources, Inc., Seattle Wa.
Pest/PCB (solids)	EPA #8080	Analytical Resources, Inc., Seattle Wa.
Resin Acids (water & solids)	NCASI, 1986	Analytical Resources, Inc., Seattle Wa.
Metals	EPA #200 series	Analytical Resources, Inc., Seattle Wa.
Total Phenols	EPA #420.2	Ecology; Manchester, Wa.
Cyanide	EPA #335.2-1	Ecology; Manchester, Wa.
Trout 96-hour	Ecology, 1981	Biomed Research Lab, Inc., Bellevue, Wa.
Microtox	Beckman (saline extraction)	Ecova, Redmond Wa.
Daphnia magna	EPA, 1987	E.V.S. Consultants; Seattle, Wa.
Oyster larvae	ASTM E724-80, 1986	E.V.S. Consultants; Seattle, Wa.
Rhepoxinius	Tetra Tech, 1986	E.V.S. Consultants; Seattle, Wa.
Echinoderm Sperm Cell	Dinnel, *et al*, 1987	E.V.S. Consultants; Seattle, Wa.
Ceriodaphnia dubia	EPA, 1985	ERCE Bioassay Lab, San Diego Ca.
Fathead Minnow	EPA, 1985	ERCE Bioassay Lab, San Diego Ca.