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Water Body No.: WA-19-0010
Segment No.: 27-00-01

DAISHOWA PULP AND PAPER MILL CLASS II INSPECTION PORT ANGELES, WASHINGTON NOVEMBER 14-16, 1988

by
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December 1989

ABSTRACT

Ecology conducted a Class II inspection at the Daishowa Pulp and Paper Mill in Port Angeles on November 14-16, 1988. The effluent met NPDES permit limits for BOD, pH, oil and grease, and TSS. However, Rainbow trout, *Daphnia magna* and Pacific oyster bioassays indicated a high level of effluent toxicity. Elevated levels of zinc, cyanide, or possibly ammonia in the effluent may have been responsible for the toxicity. Additional monitoring requirements for these parameters in the mill's NPDES permit are recommended.

INTRODUCTION

Ecology conducted a Class II inspection at the Daishowa Pulp and Paper Mill in Port Angeles on November 14-16, 1988. Pat Hallinan and Keith Seiders from the Ecology Compliance Inspection Section and Don Nelson from the Ecology Industrial Section conducted the inspection. Pat O'Flaherty and John Polk of CH_2M Hill Consultants monitored the inspection for Daishowa. Mark Hannah, Technical Manager; John Boyd, Utilities Supervisor; and Dan Shideler, Laboratory Technician; also provided assistance.

The mill uses a thermo-mechanical process to produce newsprint and directory grade paper. An activated sludge system treats wastewater generated by the mill. Waste activated sludge and primary settled solids are de-watered by screw press, then used as hog boiler fuel. Treated effluent discharges to the Strait of Juan de Fuca, off the base of Ediz Hook, as regulated by NPDES Permit WA 000292-5.

Objectives of the inspection included:

- Verify effluent compliance with NPDES permit limits.
- Determine effluent toxicity using trout, Microtox, *Daphnia magna* and Pacific oyster bioassays.
- Characterize the mill effluent for toxic pollutants using a priority pollutant and resin acid scan.
- Characterize sediment samples near the mill outfall for toxic pollutants.
- Determine sediment toxicity using *Rhepoxynius* and Microtox bioassays.
- Review lab procedures at the mill to determine conformance to standard techniques. Samples were split with the permittee to determine the accuracy of laboratory results.

PROCEDURES

Ecology collected both untreated mill wastewater (influent) and final effluent 24-hour, iced composite samples. ISCO automatic samplers were set to collect about 330 mLs of sample every 30 minutes for 24 hours. The effluent sampler sampled from a tap on the effluent discharge pipe. The influent sampler was located at the main wastewater line to the treatment system (see Figure 1).

The Ecology composite samplers were fitted with teflon tubing and glass sampling bottles. This equipment was cleaned before use by washing with non-phosphate detergent and rinsing successively with tap water, 10 percent nitric acid, then three times with deionized water, pesticide-grade methylene chloride, and with pesticide-grade acetone. The equipment was then air dried and wrapped in aluminum foil until used.

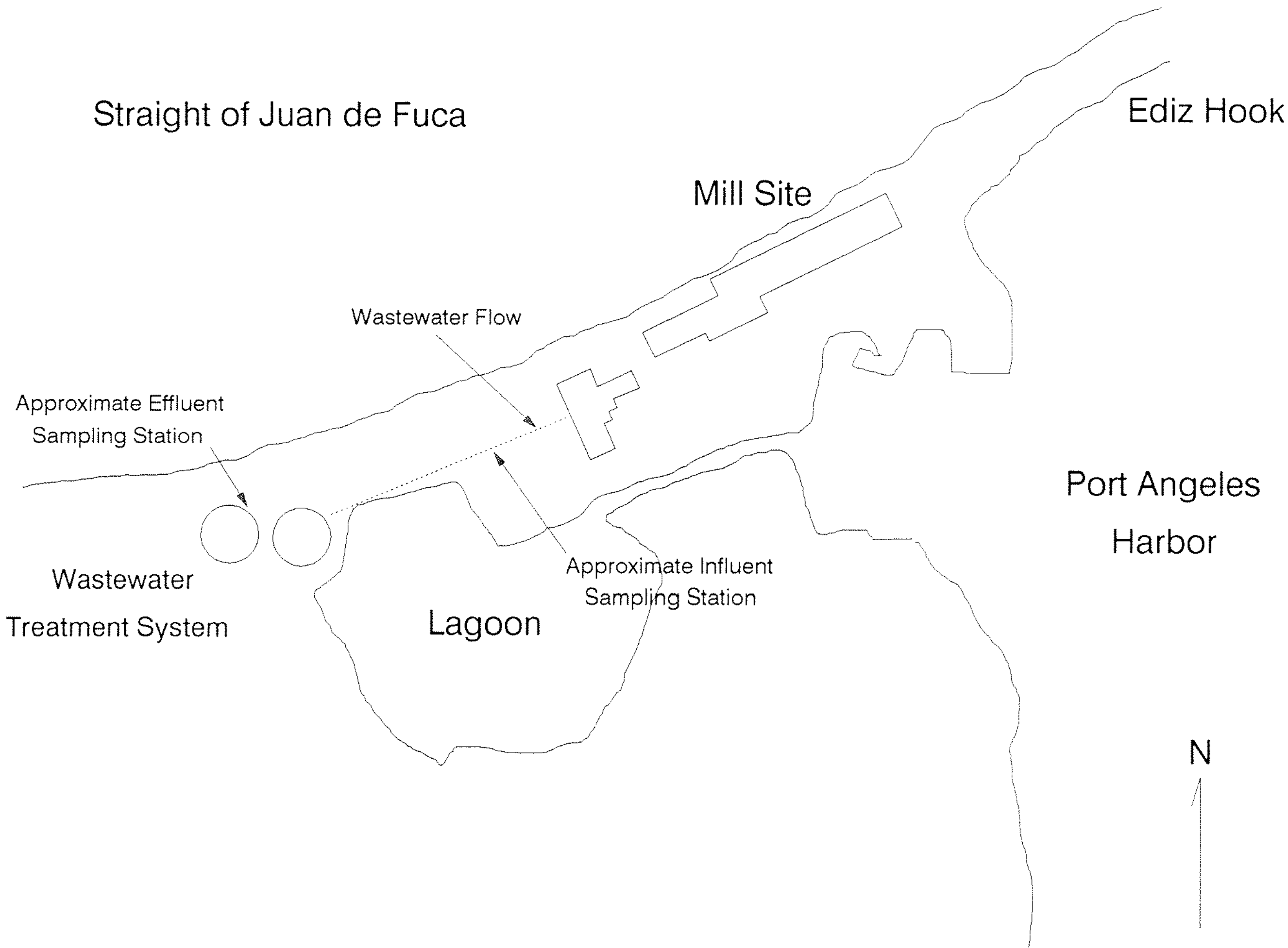

Figure 1. Site Location and Sampling Locations, Daishowa, 11/88.

The permittee also collected a 24-hour effluent composite sample. The sampler collected about 200 mLs every 20 minutes for 24 hours. The sampler sampled from the same tap as the Ecology sampler. Ecology also collected influent and effluent grab samples for field and laboratory analyses. Table 1 lists sampling times and parameters analyzed.

All samples collected by Ecology were split for analyses between Ecology and CH_2M Hill/Daishowa. In addition, the effluent composite sample collected by Ecology was split for permit parameter analyses between the Ecology and mill laboratories.

Columbia Analytical Services of Longview, Washington, conducted all analyses for the samples collected by Ecology and split with CH_2M Hill/Daishowa. For the Ecology samples, the Ecology Manchester Laboratory analyzed for general chemistry parameters and metals. Weyerhaeuser Analytical Chemistry Laboratory performed volatile organic, semi-volatile organic, pesticide/PCB and resin acid analyses. The Ecology laboratory also conducted the Microtox, 96-hour Rainbow trout, and 7-day survival and reproduction *Daphnia magna* bioassays. E.V.S. Consultants of Vancouver, B.C., completed the Pacific oyster embryo development bioassay. Appendix 1 lists the chemical and bioassay test methods used.

Ecology also attempted to collect marine sediments surrounding the wastewater outfall diffuser using a 0.1 meter square van Veen grab. However, the outfall was located in a non-depositional, rocky/gravelly area, and the van Veen was unable to collect a sediment sample suitable for analyses.

RESULTS AND DISCUSSION

Flow Measurements

Effluent flow is measured by a Parshall flume located just after final clarification. Because of limited access to the flume, Ecology could not verify the accuracy of the meter. However, the mill operations staff reported that the meter is calibrated quarterly. Table 2 summarizes flow data collected during the inspection. Access should be provided to the flume so its calibration and dimensions can be easily checked by Ecology.

Comparison of Effluent Parameters to NPDES Permit Limits

General chemistry data collected during the inspection is listed in Table 3. BOD, TSS, pH, and oil and grease were well below the daily average and daily maximum permit limits (Table 4). The wastewater treatment system operated very efficiently, removing over 90 percent of the influent BOD and TSS. However, the effluent failed the 96-hour Rainbow trout bioassay. At a 65 percent effluent concentration, 43 percent survival was observed. The permit calls for 80 percent survival.

Table 1 - Sampling Times and Parameters Analyzed - Daishowa 11/88.

Station:	Influent				Effluent			
Type:	Grab			Composite	Grab			Composite
Date:	11/15	11/15	11/16	11/15-16	11/15	11/15	11/16	11/15-16
Parameters / Time:	1150	1614	0855	0935-0935	1030	1550	0911	0910-0910
GENERAL CHEMISTRY								
Turbidity (NTU)				X				X
pH (S.U.)				X				X
Conductivity (umhos/cm)				X				X
Alkalinity (mg/L as $CaCO_3$)				X				X
Hardness (mg/L as $CaCO_3$)								X
Cyanide (mg/L)								X
Solids (mg/L)								
TS				X				X
TNVS				X				X
TSS	X	X	X	X	X	X	X	X
TNVSS				X				X
BOD_5 (mg/L)				X				X
COD (mg/L)	X	X	X	X	X	X	X	X
Nutrients (mg/L)								
NH_3-N					X	X	X	X
NO_3+NO_2-N					X	X	X	X
T-Phosphate					X	X	X	X
Fecal Coliform (#/100mL)							X	
% Kleb							X	
Phenols				X				X
Grease & Oils	X	X	X		X	X	X	
TOC				X				X
ORGANICS + METALS								
pp metals								X
ABN (water)								X
VOA (water)					X			
Pest/PCB (water)								X
Resin Acids (water)								X
Guaiacols (water)								X
BIOASSAYS								
Trout								X*
Microtox (water)								X*
Pacific Oyster								X*
Daphnia magna								X*
FIELD ANALYSES								
Temperature (°C)					X	X	X	
pH (S.U.)					X	X	X	
Conductivity (umhos/cm)					X	X	X	

* - 1/3 collected 11/15 at 1030, 1/3 collected 11/15 at 1550, 1/3 collected 11/16 at 0911.

Table 2 - Flow Measurements - Daishowa, 11/88.

Date	Time	Instantaneous flow (MGD)	Totalizer reading	Flow for time increment (MGD)
11/15	940	5.30	88156588	
				5.12
11/15	1048	5.25	88159006	
				5.21
11/15	1614	7.10	88170790	
				6.89
11/16	941	8.30	88220859	

Average flow during inspection = 6.42

Table 3 - Ecology Analytical Results for General Chemistry Parameters - Daishowa 11/88.

Station:	Influent				Effluent			
Type:	Grab			Composite	Grab			Composite
Date:	11/15	11/15	11/16	11/15-16	11/15	11/15	11/16	11/15-16
Parameters / Time:	1150	1614	0855	0935-0935	1030	1550	0911	0910-0910
GENERAL CHEMISTRY								
Turbidity (NTU)				75				15
pH (S.U.)				6.2				6.0
Conductivity (umhos/cm)				524				647
Alkalinity (mg/L as CaCO3)				46				24
Hardness (mg/L as CaCO3)								*
Cyanide (mg/L)								0.37
Solids (mg/L)								
TS				1800				540
TNVS				640				360
TSS	1700	740	930	1100	56	58	65	61
TNVSS				190				<1
BOD5 (mg/L)				300				25
COD (mg/L)	2400	1000	1500	1700	200	200	200	220
Nutrients (mg/L)								
NH3-N					9.9	10.0	3.3	7.4
NO3+NO2-N					9.9	11.0	6.4	9.7
T-Phosphate					1.2	1.4	1.3	1.2
Fecal Coliform (#/100mL)							8000	
% Kleb							4	
Phenols (ug/L)				20				2
Grease & Oils	180	320	5100		<10	<10	<10	
TOC				310				81
FIELD ANALYSES								
Temperature (C)					20.4	19.7	20.9	
pH (S.U.)					6.32	6.37	6.47	
Conductivity (umhos/cm)					800	620	486	

* - No result due to analytical interference.

Table 4 - Comparison of Effluent Parameters to NPDES Permit Limits - Daishowa, 11/88.

Parameter	NPDES Permit Limits: Daily Average*	NPDES Permit Limits: Daily Maximum	Inspection Data: Ecology Composite	Inspection Data: Grab Samples
BOD_5				
(mg/L)			25	
(lbs/D)	4,700	8,900	1,339	
TSS				
(mg/L)			61	
(lbs/D)	6,900	12,900	3,266	
Oil and Grease (mg/L)		15		<10,<10,<10
pH (S.U.)	5.0 to 9.0			6.3,6.4,6.5
Rainbow Trout Bioassay	80% survival in 65% effluent		43% survival	
Flow (MGD)			6.42	

* Defined as average over one month.

Other Effluent Bioassays

Both acute and chronic toxic effects were also noted in the other effluent bioassays performed (Table 5). In the Microtox test, effluent concentrations of 67.3 and 57.2 percent resulted in a 50 percent reduction in bacterial luminescence at exposure times of 15 and 30 minutes, respectively. This represents a medium level of toxicity (EPA, 1980).

A graphical presentation of both survival and reproduction for the *Daphnia* bioassay is shown in Figure 2. Mortality was observed in this bioassay, with a LC_{50} (lethal effluent concentration to 50 percent of the test organisms) of 48 percent. Reproduction increased compared to the control at lower effluent concentrations, then decreased at higher concentrations. This response pattern is typical when the effluent offers enhanced nutrition to the organism: Reproduction rates increase until the sample toxicity overwhelms the nutritional benefits (Stinson, 1989).

The Pacific oyster bioassay indicated a high level of effluent chronic toxicity (Table 5). The EC_{50} (effluent concentration resulting in 50 percent of the embryos developing abnormal shells) was 1.7 percent. Pacific oyster are known to be particularly sensitive to pulp mill effluents. Past Ecology biomonitoring inspections at Kraft and bleached sulfite mills yielded EC_{50}s ranging from 0.2 to 3.0 percent (Reif, 1989).

Effluent Chemistry

No semi-volatiles, pesticides/PCBs, or resin acids were detected in the effluent sample. Acetone, a common laboratory contaminate, was detected in the volatile analyses. Appendix 1 lists the complete effluent analyses for resin acids, volatiles, semi-volatiles, pesticides/PCBs, and metals.

Levels of metals and cyanide detected in the effluent are listed in Table 6. Lead, nickel, zinc, and cyanide possibly contributed the effluent's toxicity. Zinc exceeded both freshwater and saltwater acute limits by a factor of seven times. Cyanide exceeded freshwater and saltwater acute criteria by factors of 17 and 370 times, respectively. Lead slightly exceeded both saltwater and freshwater chronic criteria. Nickel also slightly exceeded saltwater chronic criteria.

Since the inspection, the source of the elevated levels of zinc was identified as tire chips burned as hog boiler fuel. This practice has been discontinued, and the mill has passed a series of nine subsequent 96-hour trout bioassays (Nelson, 1989). Recent effluent analyses for metals and cyanide detected zinc, copper, lead, and cyanide (Hannah, 1989). The levels of zinc and cyanide detected were significantly below levels seen for this inspection. However, cyanide, zinc, lead, and copper still exceeded various chronic criteria. Zinc approached the saltwater acute value, while copper exceeded saltwater acute criteria (Table 6).

Table 5 - Bioassay Results - Daishowa, 11/88.

96 hour Rainbow Trout (Oncorhyncus mykiss):

Sample	# of live test organisms Initial	Final	% Mortality
Effluent	30	13	56.7
Lab Control	30	30	0

7-day Daphnia magna:

Effluent Concentration	# of live test organisms Initial	Final	% Mortality	# of live offspring
Lab Control	10	10	0	25
1%	10	10	0	44
3%	10	8	20	86
10%	10	8	20	130
30%	10	8	20	32
100%	10	0	100	20

Microtox:

EC_{50} (15 minutes) = 67.3%
EC_{50} (30 minutes) = 57.2%

48-hour Pacific oyster (Crassostrea gigas):

EC_{50} (95% confidence limits) = 1.7% effluent

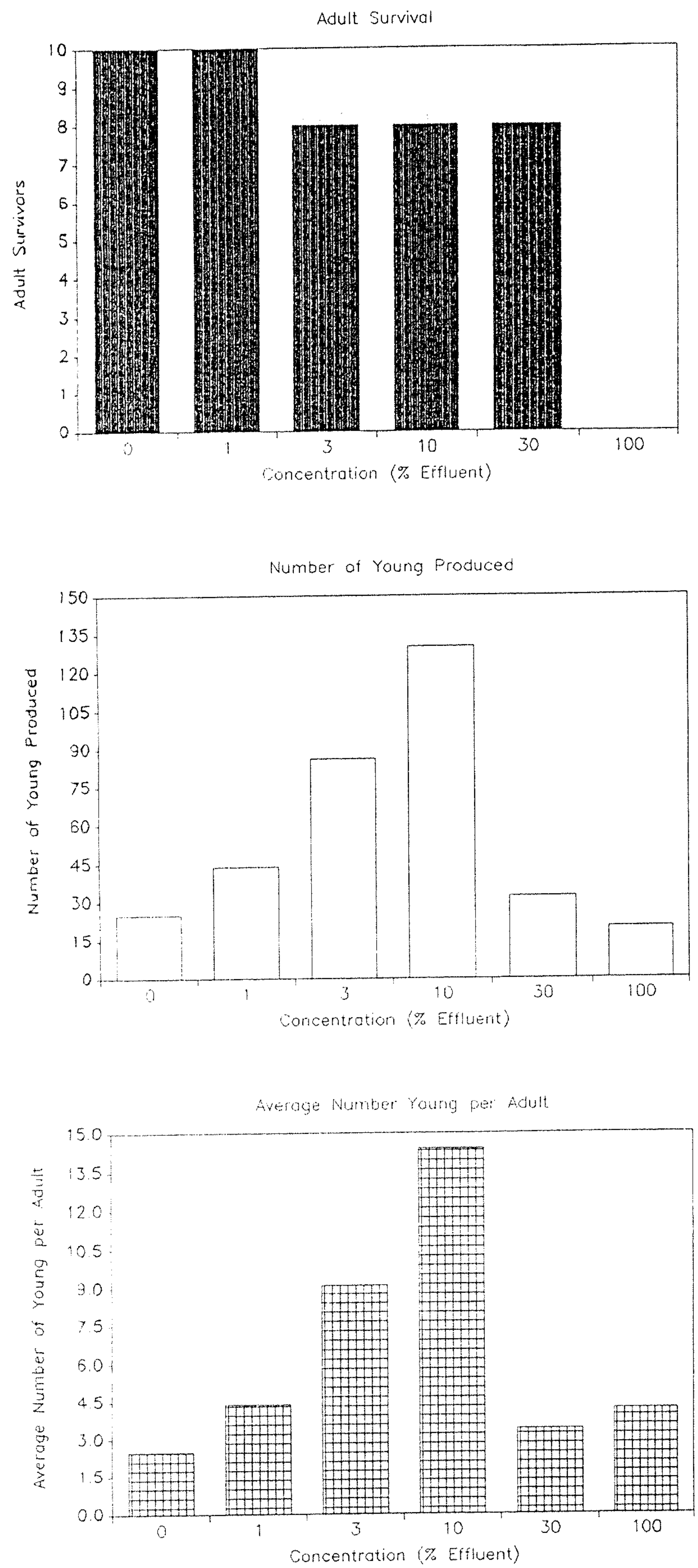

Figure 2. Graphical Presentation of Daphnia magna Bioassay Results - Daishowa, 11/88. (From Stinson, 1989)

Table 6 - Comparison of Effluent Metals and Cyanide with Water Quality Criteria - Daishowa, 11/88.

Metal (total)	Effluent (ug/L)	Effluent Sampled 6/12/89 (ug/L)	Water Quality Criteria* (EPA,1986) Saltwater		Freshwater	
			Chronic	Acute	Chronic	Acute
Arsenic	1.1	5U	36	69	190	360
Lead	10.3	12	5.6	140	3.2	82
Nickel	11	20U	8.3	75	160	1400
Zinc	714	94	86	95	110	120
Cyanide	370	36 (16)**	-	1.0	5.2	22
Copper	15 U	26	-	2.9	12	18

U - Not detected at detection limit shown
* - Concentrations in ug/L, hardness assumed to be 100 µg/L as $CaCO_3$
** - Value in parentheses is free available

It should be noted that the effluent was analyzed for total metals which may overestimate concentrations bioavailable to aquatic life. EPA recommends the use of the total recoverable method to compare results to water quality criteria. The total recoverable analytical method should be used in any future effluent monitoring for metals. The effluent should also be tested for hardness since the toxicity of metals are dependent on this parameter. In addition, the mill intake water should be analyzed to determine any influent metals loading.

Ammonia in the effluent may also have contributed to the effluent's toxicity. Ammonia is added as a nutrient to the wastewater treatment system to aid bacterial activity. Ammonia (as nitrogen) was found at relatively high levels in two grab samples (9.9 and 10.0 mg/L) and at a lower concentration in a third grab sample (3.3 mg/L). The toxicity of ammonia is temperature and pH dependent. At the trout bioassay conditions of 12 C and pH = 7.0 S.U., acute and chronic criteria are 20.2 and 1.8 mg/L, respectively (EPA, 1986).

Comparison of Laboratory Results

A comparison of conventional lab results from the inspection is summarized in Table 7. For the effluent samples, all permit parameters (BOD, TSS, pH, and oil and grease) compare very well between the Ecology, Daishowa (performed by Columbia Analytical) and mill laboratories. Ecology's results for oil and grease in the influent, COD of the influent and effluent, and fecal coliform and total phenolics in the effluent were significantly higher than the Daishowa results.

A comparison of metals analyses of the effluent is summarized in Table 8. Results for arsenic, lead, and zinc for the Ecology and Daishowa samples compare favorably. However, nickel measured by Ecology was roughly ten times lower than the Daishowa result. Quality assurance and quality controls (QA/QC) performed with the Ecology samples were all within EPA contract lab program limits (matrix spike and matrix spike duplicate percent recoveries; Table 8). No QA/QC was done as part of the Daishowa analyses. Therefore, the Ecology result for nickel is more reliable. In any future monitoring for metals by the permittee, appropriate QA/QC should be completed with every sample. This would include the use of a method blank, matrix spike, and laboratory control standard.

Volatile organic, semi-volatile organic, pesticide/PCB, and resin acid analyses between the two labs were in general agreement. In the Daishowa effluent analyses, dehydroabietic acid was detected in the resin acid scan at 2 ug/L. In the Ecology analyses, dehydroabietic acid was not detected at a detection limit of 10 ug/L. In general, detection limits for Daishowa volatile, semi-volatile, and resin acid analyses were about 5 to 10 times lower than the Ecology analyses. Complete results for these parameters by both Ecology and Daishowa are listed in Appendix 1.

Table 7 - Conventional Lab Results Comparison - Daishowa, 11/88.

Type:	Grab		Grab		Grab		Composite		Grab	
Date:	11/15		11/15		11/16		11/15-16		11/15	
Time:	1150		1614		0855		0935-0935		1150	
Sampler:	Ecology		Ecology		Ecology		Ecology		Ecology	
Laboratory:	Ecology	Daishowa	Ecology	Daishowa	Ecology	Daishowa	Ecology	Daishowa	Ecology	Daishowa
Sample I.D. #:	478088	DSA-INF-SP-1	478089	DSA-INF-SP-2	478096	DSA-INF-SP-3	478094	DSA-INF-SP4-C	478085	DSA-EF-SP-1
Parameter:										
Fecal Coliform (#/100ml)										
Oil and Grease (mg/L)	180	7.4	320	7.9	5100	9.1			<10	<1
BOD5 (mg/l)							300	297		
COD (mg/L)	2400	530	1000	417	1500	777	1700	544	200	169
TSS (mg/L)	1700	1630	740	710	930	928			56	50
Turbidity (NTU)							75	29		
Nutrients (mg/L)										
NH3-N									9.9	10
NO2+NO3									9.9	12
Total P									1.2	0.8
pH (S.U.)							6.2	6.3		
Conductivity (umnos/cm)							524	456		
Alkalinity (mg/L as CaCO3)							46	39		
Phenols (ug/L)										
Cyanide (mg/L)										
TOC (mg/L)							310	552		

Type:	Grab		Grab		Composite		
Date:	11/15		11/16		11/15-16		
Time:	1614		0855		0935-0935		
Sampler:	Ecology		Ecology		Ecology		
Laboratory:	Ecology	Daishowa	Ecology	Daishowa	Ecology	Daishowa	
Sample I.D. #:	478087	DSA-EF-SP-2	478087	DSA-EF-SP-3	478096	DSA-EF-SP-4-C	Daishowa Mill
Parameter:							
Fecal Coliform (#/100ml)			8000	127			
Oil and Grease (mg/L)	<10	1.6	<10	<1			
BOD5 (mg/l)					25	32	33
COD (mg/L)	200	140	200	127	220	203	
TSS (mg/L)	58	51	65	68	61	56	57
Turbidity (NTU)							
Nutrients (mg/L)							
NH3-N	10.0	10	3.3	3.7	7.4	18	
NO2+NO3	11.0	15.6	6.4	8.4	9.9	12	
Total P	1.4	0.83	1.3	0.73	1.2	0.95	
pH (S.U.)							5.8
Conductivity (umnos/cm)							
Alkalinity (mg/L as CaCO3)							
Phenols (ug/L)					2.0	<10	
Cyanide (mg/L)					0.37	0.27	
TOC (mg/L)							

Table 8 - Comparison of Metal Analytical Results - Daishowa, 11/88.

			Ecology QA/QC Data			
	Daishowa (ug/L)	Ecology (ug/L)	Method Blank (ug/L)	Matrix Spike % Recovery	Matrix Spike Duplicate % Recovery	EPA Control Limits
Arsenic	2 U	1.1	1.0 U	91	90	75-125
Lead	7	10.3	2.0 U	111	111	75-125
Thallium	2 U	1.0 U	1.0 U	94	94	75-125
Silver	10 U	0.5 U	0.5 U	NA	NA	75-125
Antimony	50 U	6.0 U	6.0 U	106	101	75-125
Selenium	2 U	2.0 U	2.0 U	94	89	75-125
Mercury	0.2 U	0.06 U	0.06 U	90	96	75-125
Beryllium	5 U	1.0 U	1.0 U	102	97	75-125
Cadmium	5 U	5.0 U	5.0 U	94	104	75-125
Chromium	10 U	10 U	10 U	100	97	75-125
Copper	10 U	15 U	15 U	112	111	75-125
Nickel	130	11	10 U	107	103	75-125
Zinc	670	714	10 U	100	107	75-125

U - Not detected at detection limit shown.
NA - Not Analyzed.

LABORATORY REVIEW

A complete laboratory review report is included in Appendix 2 of this report. Circled items indicate where work is needed to bring procedures in conformance with standard techniques. Most laboratory procedures at the mill were good. An exception was the holding time for samples analyzed for BOD. Depending on the day of collection, some samples are held for two or three days before analysis. BOD samples should be analyzed within 24 hours of collection (Ecology, 1986, p42; APHA, 1985, p520 #2a).

CONCLUSIONS AND RECOMMENDATIONS

1. The mill met permit limits for BOD, TSS, oil and grease, and pH. However, the effluent failed the Rainbow trout bioassay. An access point to the effluent Parshall flume is needed so that the meter calibration can be easily verified.

2. The effluent exhibited acute and chronic toxicity in three bioassays: Microtox; 7-day survival and reproduction *Daphnia magna*; and 48-hour Pacific oyster embryo development bioassays.

3. No organics were detected in an effluent priority pollutant and resin acid scan. However, lead, nickel, zinc, cyanide, and ammonia were detected at levels above water quality criteria. Additional monitoring requirements for these parameters are recommended in the mill's NPDES permit. Any future metals monitoring should use the total recoverable analytic method and effluent hardness should be measured. Appropriate QA/QC should be completed with each sampling.

4. The wastewater outfall diffuser was located in a non-depositional area. The collection of a sediment sample suitable for analyses was unsuccessful.

5. Laboratory procedures at the mill were generally good. Specific recommendations are included in the Laboratory Review section of this report.

REFERENCES

APHA, 1985. APHA-AWWA-WPCF, Standard Methods for the Examination of Water and Wastewater, 16th ed, 1985.

Ecology, 1986. Department of Ecology Laboratory User's Manual, December, 1986.

EPA, 1980. Level I Biological Testing Assessment and Data Formatting. EPA-600/7-80-079.

Hannah, M.A., 1989. Summary of Results from November 14-16 Class II Inspection at Daishowa Mill in Port Angeles and Recent Analytical Report for Selected Chemicals and Metals. Letter to P. Hallinan.

Nelson, D., 1989. Washington State Department of Ecology, Industrial Section, personal communication.

Reif, D., 1989. Biomonitoring Report for FY89. Washington State Department of Ecology, Environmental Investigations and Laboratory Services, June, 1989.

Stinson, M., 1989. Daishowa Class II Inspection Results of *Daphnia Magna* Bioassay. Washington State Department of Ecology, February 9, 1989. Memorandum to P. Hallinan.

APPENDIX

Chemical Analytical Methods - Daishowa, 11/88.

Analyses	Method Used	Laboratory
TOC	EPA, 1983: #415	Ecology; Manchester, WA
Cyanide	EPA, 1983: #335.2-1	Ecology; Manchester, WA
Total Phenolics	EPA, 1983: #420.2	Ecology; Manchester, WA
Volatiles	EPA, 1984: #624	Weyerhaeuser Analytical, Tacoma, WA
Semivolatiles	EPA, 1984: #625	Weyerhaeuser Analytical, Tacoma, WA
Pest/PCB	EPA, 1984: #608	Weyerhaeuser Analytical, Tacoma, WA
Metals	EPA, 1983: #200 series	Ecology; Manchester, WA
Resin acids	NCASI, 1986	Ecology; Manchester, WA
Ammonia	EPA, 1983: #350.1	Ecology; Manchester, WA
Total Phosphorus	EPA, 1983: #353.2	Ecology; Manchester, WA
Nitrate/Nitrite	EPA, 1983: #365.1	Ecology; Manchester, WA

EPA, 1983. Methods for Chemical Analysis of Water and Wastes, 600/4/79-020, revised March 1983.

EPA, 1984. 40 CFR Part 136, October 26, 1984.

EPA, 1986. Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, 3rd ed., November 1986.

National Council for Air and Stream Improvement, 1986. Procedures for the Analysis for Resin and Fatty Acids in Pulp Mill Effluents. Tech. Bull. 501. New York, N.Y.

Effluent Bioassay Methods - Daishowa, 11/88.

Test Organism	Reference Method	Test Laboratory	Test Duration	Test Concentration	Type of Test	Endpoint Measured
Pacific Oyster (*Crassostrea gigas*)	1	E.V.S. Consultants Seattle, WA	48 hrs	0.1,1,2.2,4.6, 10,18%	Chronic	Development of abnormal larvae
Daphnia magna	2	Ecology	48 hrs	100%	Acute/ Chronic	Survival/Reproduction
Rainbow Trout (*Salmo gairdneri*)	3	Ecology	96 hrs	65%	Acute	Survival
Microtox (*Photobacterium phosphoreum*)	4	Ecology	15,30 mins	5.7,11.4,22.7, 45.5%	Acute/ Chronic	Reduction in bacterial luminescence

1 - ASTM Method E 724-80, "Standard Practice for Conducting Static Acute Tests with Larvae of Four Species of BiValve Molluscs."
2 - EPA/600/D-87/080, "A Short-Term Chronic Toxicity Test Using *Daphnia magna*."
3 - Department of Ecology procedure "Static Acute Fish Toxicity Test."
4 - Beckman Microtox System Operating Manual. Microbics Corp., Carslbad, CA.

Results of Resin Acid/Guaiacol Scan - Daishowa, 11/88.

Compound	Ecology Blank (ug/L)	Ecology Effluent (ug/L)	Daishowa Effluent (ug/L)
Guaiacol	10.0 U	10.0 U	NA
4,5,6-Trichloroguaicol	10.0 U	10.0 U	NA
3,4,5-Trichloroguaicol	10.0 U	10.0 U	NA
Tetrachloroguaicol	10.0 U	10.0 U	NA
Pimaric	10.0 U	10.0 U	2 U
Sandaracopimaric acid	10.0 U	10.0 U	2 U
Isopimaric acid	10.0 U	10.0 U	20 U
Dehydroabietic acid	10.0 U	10.0 U	2
Abietic acid	10.0 U	10.0 U	10 U
Neoabietic acid	10.0 U	10.0 U	3 U
14-Chlorodehydroabeitic acid	10.0 U	10.0 U	5 U
12-Chlorodehydroabeitic acid	10.0 U	10.0 U	5 U
Dichlorodehydroabeitic acid	10.0 U	10.0 U	5 U

Qualifiers:
U - Not Detected at Detection Limit Shown
NA - Not Analyzed

Results of Volatile Priority Pollutant Scan - Daishowa, 11/88.

	Ecology		Daishowa
	Blank (ug/L)	Effluent (ug/L)	Effluent (ug/L)
Chloromethane	10 U	10 U	5 U
Bromomethane	10 U	10 U	5 U
Vinyl Chloride	10 U	10 U	1 U
Chloroethane	10 U	10 U	1 U
Methylene Chloride	1 J	5 U	2 U
Acetone	6 UJ	2 UJ	1 U
Carbon Disulfide	5 U	5 U	1 U
1,1-Dichloroethene	5 U	5 U	1 U
1,1-Dichloroethane	5 U	5 U	1 U
1,2-Dichloroethene (total)	5 U	5 U	NA
Chloroform	5 U	5 U	1 U
1,2-Dichloroethane	5 U	5 U	1 U
2-Butanone	3 J	10 U	1 U
1,1,1-Trichloroethane	5 U	5 U	1 U
Carbon Tetrachloride	5 U	5 U	1 U
Vinyl Acetate	10 U	10 U	1 U
Bromodichloromethane	5 U	5 U	1 U
1,2-Dichloropropane	5 U	5 U	1 U
cis-1,3-Dichloropropene	5 U	5 U	1 U
Trichloroethene	5 U	5 U	1 U
Dibromochloromethane	5 U	5 U	1 U
1,1,2-Trichloroethane	5 U	5 U	1 U
Benzene	5 U	5 U	1 U
cis-1,3-Dichloropropene	5 U	5 U	1 U
Bromoform	5 U	5 U	1 U
4-Methyl-2-Pentanone	10 U	10 U	1 U
2-Hexanone	10 U	10 U	1 U
Tetrachloroethene	5 U	5 U	1 U
1,1,2,2-Tetrachloroethane	5 U	5 U	1 U
Toluene	5 U	5 U	1 U
Chlorobenzene	5 U	5 U	1 U
Ethylbenzene	5 U	5 U	1 U
Styrene	5 U	5 U	1 U
Total Xylenes	5 U	5 U	1 U
Trichlorofluoromethane	NA	NA	2 U
trans-1,2-Dichloroethene	NA	NA	1 U
2-Chloroethylvinylether	NA	NA	10 U
trans-1,3-Dichloropropene	NA	NA	1 U
1,2-Dichlorobenzene	NA	NA	1 U
1,3-Dichlorobenzene	NA	NA	1 U
1,4-Dichlorobenzene	NA	NA	1 U

Qualifiers:
U - Not Detected at Detection Limit Shown
UJ - Estimated Method Detection Limit

Results Pest/PCB and Metal Priority Pollutant Scans - Daishowa, 11/88.

Compound	Ecology Blank (ug/L)	Ecology Effluent (ug/L)	Daishowa Effluent (ug/L)
Alpha-BHC	0.05 U	0.05 U	0.07 U
Beta-BHC	0.05 U	0.05 U	0.3 U
Delta-BHC	0.05 U	0.05 U	0.1 U
Gamma-BHC (Lindane)	0.05 U	0.05 U	0.1 U
Heptachlor	0.05 U	0.05 U	0.1 U
Aldrin	0.05 U	0.05 U	0.1 U
Heptachlor Epoxide	0.05 U	0.05 U	0.1 U
Endosulfan I	0.05 U	0.05 U	0.1 U
Dieldrin	0.10 U	0.10 U	0.1 U
4,4'-DDE	0.10 U	0.10 U	0.2 U
Endrin	0.10 U	0.10 U	0.2 U
Endosulfan II	0.10 U	0.10 U	0.1 U
4,4'-DDD	0.10 U	0.10 U	0.2 U
Endosulfan Sulfate	0.10 U	0.10 U	0.2 U
4,4'-DDT	0.10 U	0.10 U	0.3 U
Methoxychlor	0.50 U	0.50 U	0.1 U
Endrin Ketone	0.10 U	0.10 U	0.2 U
alpha-Chlordane	0.50 U	0.50 U	NA
gamma-Chlordane	0.50 U	0.50 U	NA
Chlordane	NA	NA	0.1 U
Toxaphene	1.00 U	1.00 U	0.2 U
Aroclor-1016	0.50 U	0.50 U	0.2 U
Aroclor-1221	0.50 U	0.50 U	0.2 U
Aroclor-1232	0.50 U	0.50 U	0.2 U
Aroclor-1242	0.50 U	0.50 U	0.2 U
Aroclor-1248	0.50 U	0.50 U	0.2 U
Aroclor-1254	0.50 U	0.50 U	0.1 U
Aroclor-1260	0.50 U	0.50 U	0.1 U
Priority pollutant metal			
Arsenic	1.0 U	1.1	2 U
Lead	2.0 U	10.3	7
Thallium	1.0 U	1.0 U	2 U
Silver	0.5 U	0.5 U	10 U
Antimony	6.0 U	6.0 U	50 U
Selenium	2.0 U	2.0 U	2 U
Mercury	0.06 U	0.06 U	0.2 U
Beryllium	1.0 U	1.0 U	5 U
Cadmium	5.0 U	5.0 U	5 U
Chromium	10 U	10 U	10 U
Copper	15 U	15 U	10 U
Nickel	10 U	11	130
Zinc	10 U	714	670

Qualifiers:
U - Not Detected at Detection Limit Shown
NA - Not Analyzed

Results of Semi-Volatile Priority Pollutant Scan - Daishowa, 11/88.

Compound	Ecology Blank (ug/l)	Ecology Effluent (ug/l)	Daishowa Effluent (ug/l)
Phenol	10 U	40 U	5 U
bis(2-Chloroethyl)Ether	10 U	40 U	5 U
2-Chlorophenol	10 U	40 U	5 U
1,3-Dichlorobenzene	10 U	40 U	3 U
1,4-Dichlorobenzene	10 U	40 U	3 U
Benzyl Alcohol	10 U	40 U	NA
1,2-Dichlorobenzene	10 U	40 U	3 U
2-Methylphenol	10 U	40 U	NA
bis(2-chloroisopropyl)ether	10 U	40 U	3 U
4-Methylphenol	10 U	40 U	NA
N-Nitroso-Di-n-Propylamine	10 U	40 U	1 U
Hexachloroethane	10 U	40 U	NA
Nitrobenzene	10 U	40 U	1 U
Isophorone	10 U	40 U	1 U
2-Nitrophenol	10 U	40 U	10 U
2,4-Dimethylphenol	10 U	40 U	5 U
Benzoic Acid	50 U	200 U	NA
bis(2-Chloroethoxy)Methane	10 U	40 U	6 U
2,4-Dichlorophenol	10 U	40 U	8 U
1,2,4-Trichlorobenzene	10 U	40 U	1 U
Naphthalene	10 U	40 U	1 U
4-Chloroaniline	10 U	40 U	NA
Hexachlorobutadiene	10 U	40 U	3 U
4-Chloro-3-Methylphenol	10 U	40 U	5 U
2-Methylnaphthalene	10 U	40 U	NA
Hexachlorocyclopentadiene	10 U	40 U	30 U
2,4,6-Trichlorophenol	10 U	40 U	10 U
2,4,5-Trichlorophenol	50 U	200 U	NA
2-Chloronaphthalene	10 U	40 U	1 U
2-Nitroaniline	50 U	200 U	NA
Dimethylphthalate	10 U	40 U	2 U
Acenaphthylene	10 U	40 U	1 U
2,6-Dinitrotoluene	10 U	40 U	3 U
3-Nitroaniline	50 U	200 U	NA
Acenaphthene	10 U	40 U	1 U
2,4-Dinitrophenol	50 U	200 U	20 U
4-Nitrophenol	50 U	200 U	20 U
Dibenzofuran	10 U	40 U	NA
2,4-Dinitrotoluene	10 U	40 U	3 U
Diethylphthalate	10 U	40 U	2 U
4-Chlorophenyl-phenylether	10 U	40 U	2 U
Fluorene	10 U	40 U	1 U
4-Nitroaniline	50 U	200 U	NA
4,6-Dinitro-2-Methylphenol	50 U	200 U	20 U
N-Nitrosodiphenylamine	10 U	40 U	1 U
4-Bromophenyl-phenylether	10 U	40 U	2 U
Hexachlorobenzene	10 U	40 U	1 U
Pentachlorophenol	50 U	200 U	10 U
Phenanthrene	10 U	40 U	1 U
Anthracene	10 U	40 U	1 U
Di-n-Butylphthalate	10 U	40 U	5 U
Fluoranthene	10 U	40 U	1 U
Pyrene	10 U	40 U	1 U
Butylbenxylphthalate	10 U	40 U	5 U
3,3'-Dichlorobenzidine	20 U	80 U	30 U
Benzo(a)Anthracene	10 U	40 U	2 U
Chrysene	10 U	40 U	2 U
bis(2-Ethylhexyl)phthalate	10 U	70 B	5 U
Di-n-Octylphthalate	10 U	40 U	5 U
Benzo(b)Fluoranthene	10 U	40 U	2 U
Benzo(k)Fluoranthene	10 U	40 U	2 U
Benzo(a)Pyrene	10 U	40 U	2 U
Indeno(1,2,3-cd)Pyrene	10 U	40 U	2 U
Dibenz(a,h)Anthracene	10 U	40 U	2 U
Benzo(ghi)Perylene	10 U	40 U	2 U
Benzidine	NA	NA	50 U

Qualifiers:
U - Not Detected at Detection Limit Shown
B - Also Detected in Method Blank
NA - Not Analyzed