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WA-CR-1010

Segment No. 26-00-01

KALAMA CHEMICAL, INC.
CLASS II INSPECTION
MAY 1988

by
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Environmental Investigations and Laboratory Services
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ABSTRACT

A Class II inspection was conducted on May 2, 3, and 4, 1988, at Kalama Chemical, Inc (KC). KC is an organic chemical manufacturer discharging both noncontact cooling water and treated process wastewater through a common outfall line into the Columbia River as permitted by NPDES Permit No. WA-000028-1. Discharge during the inspection met most NPDES limits. The process wastewater discharge exhibited acute toxicity at the 100 percent concentration in the trout, *Daphnia,* and *Ceriodaphnia* bioassays. A clear cause was not determined. Bioassay (*Hyallela azteca*) survival in the inspection sediments equalled or exceeded control sediment survival in all three samples.

INTRODUCTION

A Class II inspection was conducted on May 2, 3, and 4, 1988, at Kalama Chemical, Inc. (KC). Follow-up field work to measure impacts on the receiving water temperature was conducted on September 2, 1988. The plant is located along the Columbia River at Kalama (Figure 1). KC is an organic chemical manufacturer with major products including benzaldehyde, benzoic acid, sodium benzoate, benzyl alcohol, K-flex plasticizers, nonyl phenol, and phenol. The plant discharges noncontact cooling water (discharge 001) and treated process wastewater (discharge 002) through a common outfall line into the Columbia River as permitted by NPDES Permit No. WA-000028-1. The process wastewater is treated using an activated sludge system.

The inspection was conducted by Pat Hallinan and Marc Heffner of the Ecology Compliance Monitoring Section. Randy Hahn, Johnny McDaniel, and Greg Conn represented KC and provided assistance on site. Objectives of the inspection included:

1. Assess NPDES permit limit compliance with independent sample collection and laboratory analysis.

2. Determine sampling and analytical accuracy by splitting samples for Ecology and KC analysis.

3. Characterize discharge and receiving water sediment toxicity with conventional parameter analysis, priority pollutant scans, and bioassays.

PROCEDURES

Ecology grab and composite samples of the river water (the cooling water source), the noncontact cooling water discharge (001), and the process wastewater discharge (002) were collected. The river water sample was collected at the cooling water intake pump house. The 002 samples were collected just upstream of the 001-002 sump while the 001 samples were collected from the sump after the 001 and 002 flows had been mixed (Figure 2).

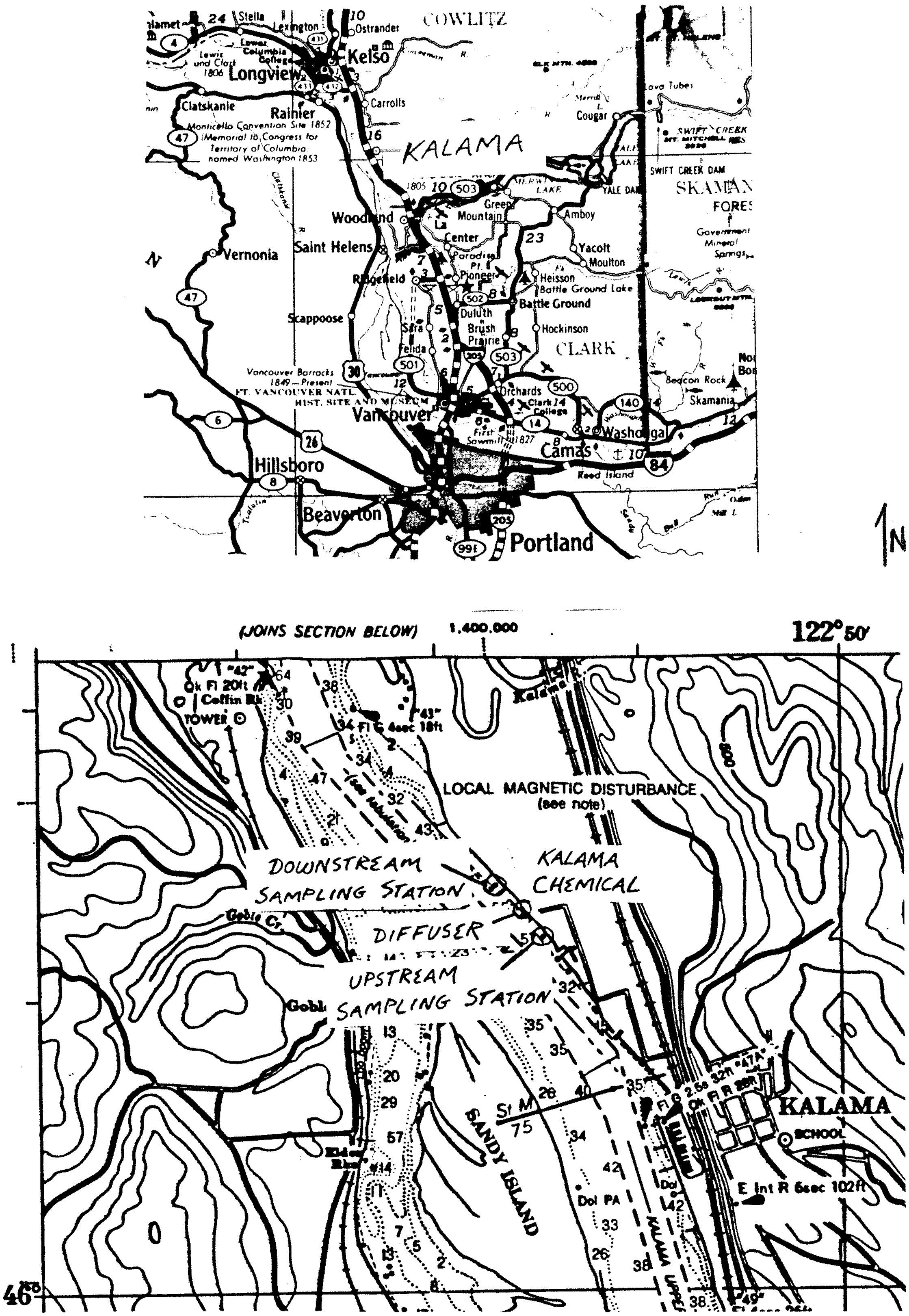

Figure 1. Location Map - Kalama Chemical, 5/88.

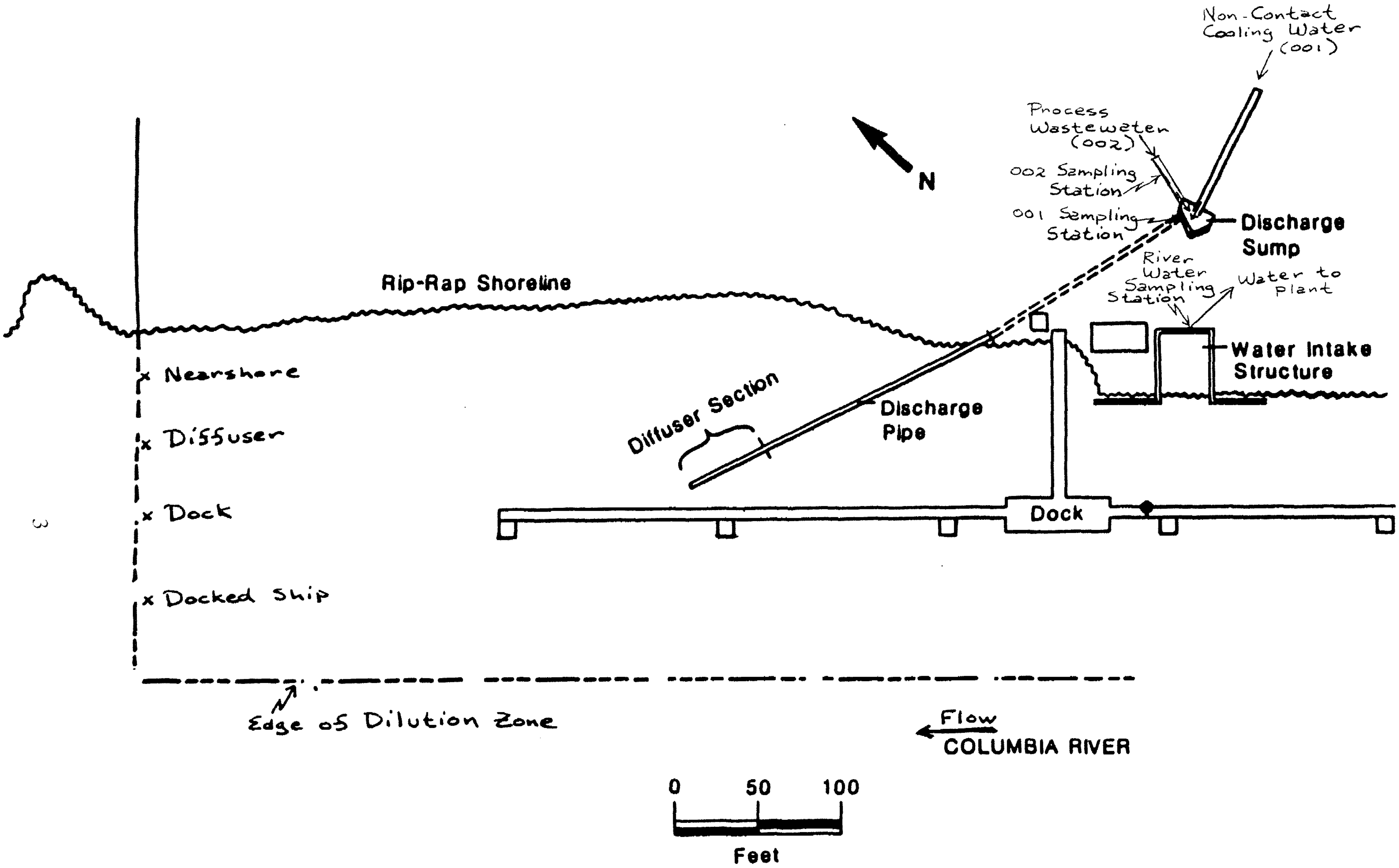

Figure 2. Sampling Stations - Kalama Chemical, 5/88.

Prior to the inspection Ecology ISCO composite samplers were cleaned for priority pollutant sampling (Table 1). On-site a field transfer blank sample was collected (Table 1). The samplers were set up to collect approximately 180 mLs of sample every 30 minutes for 24 hours. Sample collection jugs were iced to cool samples as they were collected. Composites consisting of three grab samples were collected by hand for bioassay testing. Grab samples of sand filter effluent and waste activated sludge (WAS) were also collected. The sand filter is a unit providing pretreatment to one of the waste streams sent to the activated sludge treatment system. Sampling times and parameters analyzed are included in Table 2.

KC collects a composite sample of the 002 discharge. An automatic sampler collects approximately 200 mLs of sample every 30 minutes. The KC composite and selected other samples were split for analysis by Ecology and KC laboratories (Table 2). KC maintains continuous pH and temperature monitoring of the 001 discharge.

Sediment samples were collected using a 0.1 m2 van Veen grab sampler from three stations:

1. Station 1 located approximately 100 yards upstream of the KC dock off a log storage yard.

2. Station 2 located just downstream of the KC diffuser.

3. Station 3 located approximately 100 yards downstream of the KC dock.

All three stations were located 50-100 feet from the east bank of the river. At each station two grab samples were collected. Only the top two centimeters of sediment were used from each grab. A bottle for VOA analysis was filled directly from the sampler; one-half from each of the two grabs. The remainder was composited. The composite was stirred until homogenous and placed in appropriate containers. Sampling times and parameters analyzed are summarized in Table 2.

Samples for analysis by Ecology were placed on ice and shipped to the Ecology/EPA Laboratory in Manchester. Ecology analytical methods are summarized in Table 3.

Grab samples of the 001 effluent were collected for independently conducted EPA bioassays on May 2, 4, and 6. A *Selenastrum* bioassay was run on the May 2 sample. Also, fathead minnow and *Ceriodaphnia* static renewal bioassays were run. The static renewal bioassays were run by starting the test with the May 2 sample, then replacing the water with the fresh May 4 and May 6 samples as the test progressed. Collection times are noted in Table 2.

Plant flow monitoring included the cooling water intake and the process wastewater discharge. The cooling water intake was measured with an in-line meter. The intake flow is assumed equal to the 001 discharge flow, with no allowance for losses during use. Thus, the intake flow is reported as the 001 discharge flow. The accuracy of the cooling water intake flow measurement could not be checked. The process wastewater was measured at a 30-degree V-notch weir before discharge into the cooling water stream. Ecology instantaneous checks of the process wastewater flow were made.

Table 1. Priority Pollutant Cleaning and Field Transfer Blank Procedures - Kalama Chemical, 5/88

PRIORITY POLLUTANT SAMPLING EQUIPMENT CLEANING PROCEDURES

1. Wash with laboratory detergent
2. Rinse several times with tap water
3. Rinse with 10 percent HNO_3 solution
4. Rinse three (3) times with distilled/deionized water
5. Rinse with high purity methylene chloride
6. Rinse with high purity acetone
7. Allow to dry and seal with aluminum foil

FIELD TRANSFER BLANK PROCEDURE

1. Pour organic-free water directly into appropriate bottles for analysis of parameters collected with grab samples (VOA).

2. Run approximately 1L of organic-free water through a compositor and discard.

3. Run approximately 6L of organic-free water through the same compositor and put the water into appropriate bottles for analysis of parameters collected with composite samples (BNA, Pesticide/PCB, and metals).

Table 2. Samples Collected and Parameters Analyzed - Kalama Chemical, 5/88

Sample:	River Intake			001 - Non-contact Cooling Water						002 - Process Wastewater				Sand Filter Effluent		WAS	Field Blank	Sediment1 (upstrm)	Sediment2 (diffuser)	Sediment3 (dwnstrm)
Lab Log #:	198109	198110	198115		198105	198106			198116	198107	198108	198117	198118	198111	198112	198113	198114	198119	198120	198121
Type:	Grab	Grab	ECO-Comp	Grab	Grab	Grab	Grab	Grab	ECO-Comp	Grab	Grab	ECO-Comp	KC-Comp	Grab	Grab	Grab				
Date:	5/3	5/4	5/3-4	5/2	5/3	5/4	5/4	5/6	5/3-4	5/3	5/4	5/3-4	5/3-4	5/3	5/4	5/4	5/3	5/2	5/2	5/2
Time:	1600	0930	1200-1200	1120	1550	0930	1050	0930	1200-1200	1555	0920	1200-1200	0100-0100	1540	0940	0900		1530&1550	1615&1635	1715&1740
Field Analyses																				
pH	E	E		E K	E K	E K	E	E K		E	E			E	E					
Conductivity	E	E		E	E	E	E	E		E	E			E	E					
Temperature	E	E		E K	E K	E K	E	E K		E	E			E	E					
Laboratory Analyses																				
Turbidity			E						E			E	E							
Conductivity			E						E			E	E	E	E					
Hardness			E						E			E	E	E	E					
NH3-N			E						E			E	E K	E	E					
Total-P			E						E			E	E K							
TSS												E	E K							
COD			E						E			E	E K							
BOD5												E	E K							
TOC																		E	E	E
% Solids																E K		E	E	E
Grain Size																		E	E	E
Cyanide	E	E			E	E				E	E	K++								
Phenols	E	E			E	E				E	E	K++								
VOA	E	E			E	E				E	E K+						E	E	E	E
ABN			E						E		K+	E					E	E	E	E
Pest/PCB			E						E			E					E	E	E	E
pp metals			E						E			E		E		E K+	E	E	E	E
Trout			E *						E *			E *								
Daphnia Magna			E *						E *			E *								
Microtox			E *						E *			E *								
Selenastrum				EPA																
Ceriodaphnia				EPA **			EPA **	EPA **												
Fathead Minnow				EPA **			EPA **	EPA **												
Hyallela																		E	E	E
Copper													K		E K					
Nickel													K		E K					
Zinc													K		E K					
Cobalt													K	E	E K	K				

* - bioassay samples were grab composites. Equal volumes were collected on 5/3 from 1200-1220, on 5/3 from 1440-1510, and on 5/4 from 1000-1045.
** - EPA ran static renewal bioassays. Grab samples were collected at the three times noted for the EPA tests.

\+ - partial scan by Kalama Chemical
++ - Kalama Chemical analysis on bioassay hand composite sample

E = Ecology Laboratory Analysis
K = Kalama Chemical Laboratory Analysis
EPA = EPA Laboratory Analysis

Table 3. Analytical Methods Used for Ecology Analysis (Ecology, 1986) - Kalama Chemical, 5/88

Laboratory Analyses	Method Used
Turbidity	APHA, 1985: #214A
Conductivity	APHA, 1985: #205
Hardness	APHA, 1985: #314B
NH3-N	EPA, 1983: #350.1
Total-P	EPA, 1983: #365.1
TSS	APHA, 1985: #209C
COD	APHA, 1985: #508C
BOD5	APHA, 1985: #507
TOC	APHA, 1985: #505
Cyanide	EPA, 1983: #335.2-1
Phenols	EPA, 1983: #420.2
% Solids	APHA, 1985: #209F
Grain Size	Tetra Tech, 1986
VOA (water)	EPA, 1984: #624
VOA (solids)	EPA, 1986a: #8240
ABN (water)	EPA, 1984: #625
ABN (solids)	EPA, 1986a: #8270
Pest/PCB (water)	EPA, 1984: #608
Pest/PCB (solids)	EPA, 1986a: #8080
Metals	EPA, 1983: #200 series
Microtox	Beckman, 1982
Salmonid (Trout)	Ecology, 1981
Daphnia magna	EPA, 1987
Ceriodaphnia dubia	EPA, 1985
Hyallela azteca	Nebeker, et al., 1984

Field Analyses	
pH	APHA, 1985: #423
Temperature	APHA, 1985: #212
Chlorine Residual	APHA, 1985: #408 E. (LaMotte Kit)

River temperature impacts were measured from a boat using a thermistor. The downstream border of the dilution zone was estimated and temperatures were measured at five foot depth increments at four stations along the border (Figure 2). Temperatures at a control station located approximately 100 yards upstream of the discharge were used for comparison. Measurements at the water surface were made above the dilution zone by drifting directly over the diffuser to the downstream border of the zone.

RESULTS AND DISCUSSION

Flow Measurement

Flow measurement data are summarized in Table 4. The cooling water intake meter was not checked during the inspection. Review of the calibration frequency for the meter should be done in the next inspection. Ecology instantaneous measurements were made of the process wastewater. The Ecology measurements compared closely with the KC measurements, although the KC instantaneous meter was not operating properly for a portion of the inspection. The meter was operating properly when rechecked on May 6, at the time the last EPA bioassay sample was collected.

Laboratory Review/Sample Split Comparison

KC analyzed many of the inspection parameters in-house. Organics, metals, and cyanide analyses were contracted with Laucks Testing Laboratories, Inc., in Seattle. KC BOD_5 and TSS procedures were reviewed and no major problems were found. Suggestions to bring procedures in compliance with approved techniques are circled on the lab review sheet included in the Appendix.

Ecology analytical results for conventional parameters and metals are summarized in Table 5. Table 6 compares the KC continuous pH and temperature measurements of the 001 outfall with corresponding Ecology field measurements. Both pH and temperature measurements by KC were higher than the Ecology measurements. The pH meter was repaired after the inspection and appeared to be operating properly during the May 6 recheck by Ecology, but the temperature measurements still appeared high. Continuous meter calibration and maintenance was the responsibility of the maintenance crew while daily grabs were collected by the lab. Routine comparison of the daily lab grab sample result with the continuous meter reading when the grab is collected is recommended as a check of the continuous monitors.

Results of samples split for analysis by Ecology and KC are summarized in Tables 6 and 7. Most results compare closely. The KC organics detection limits were generally higher, but were quite adequate for comparison with permit limits. The effluent ammonia and some of the metals results did not compare well. The cause is unknown.

Sand filter effluent and WAS data are also included in Tables 5 and 6. The May 3 sand filter effluent grab sample was collected with the help of an employee inexperienced with the sand filter operation and sample collection. This may have resulted in the wrong valve being opened for the May 3 sample collection, causing collection of an improper sample. Unfortunately, a

Table 4. Flow Measurements - Kalama Chemical, 5/88

001 - Non-contact Cooling Water (the cooling water intake is measured and assumed equal to the discharge)

Date	Time	Instantaneous Plant Meter Flow (gpm)
5/2	1120	11475
5/3	1550	11169
5/4	0920	11475

Inspection flow = 16.4 MGD

002 - Process Wastewater

Date	Time	Plant Meter		Ecology
		Instantaneous (MGD)	Totalizer	Instantaneous (MGD)
5/3	1550	0.16	372300	0.16
5/4	0920	Broken	373416	
	1205	Broken	373472	
5/6	0930	0.17		0.16

Inspection flow = 0.14 MGD

Table 5. Ecology Analytical Results for Conventional Parameters and Metals - Kalama Chemical, 5/88

Sample:	River Intake			001 - Non-contact Cooling Water						002 - Process Wastewater				Sand Filter Effluent		WAS	Field Blank	Method Blank
Lab Log #:	198109	198110	198115		198105	198106			198116	198107	198108	198117	198118	198111	198112	198113	198114	
Type:	Grab	Grab	ECO-Comp	Grab	Grab	Grab	Grab	Grab	ECO-Comp	Grab	Grab	ECO-Comp	KC-Comp	Grab	Grab	Grab		
Date:	5/3	5/4	5/3-4	5/2	5/3	5/4	5/4	5/6	5/3-4	5/3	5/4	5/3-4	5/3-4	5/3	5/4	5/4	5/3	
Time:	1600	0930	1200-1200	1120	1550	0930	1050	0930	1200-1200	1555	0920	1200-1200	0100-0100	1540	0940	0900		
Field Analyses																		
pH (S.U.)	7.9	7.9		8.4	7.7	8.2	8.2	8.2		8.2	8.2			6.7	7.3			
Conductivity (umhos/cm)	190	160		168	190	190	185	188		1000 U	2400			180	120			
Temperature (C)	12.2	12.0		22.8	22.5	22.5	22.4	22.2		15.8	15.6			14.3	12.8			
Laboratory Analyses																		
Turbidity (NTU)			3						3			6	7					
Conductivity (umhos/cm)			177						185			2400	2520	157	134			
Hardness (mg/l as CaCO3)			75.						80			100	110	46	48			
NH3-N (mg/L)			0.01 U						0.01 U			0.01	0.05	0.01U	0.66			
Total-P (mg/L)			0.02						0.03			0.17	0.23					
TSS (mg/L)												5	8					
COD (mg/L)			57						12			140	140					
BOD5 (mg/L)												17	12					
% Solids																2.5		
Cyanide (ug/L)	5 U	5 U			45	5 U				300	5 U							
Phenols (ug/L)	5 U	5 U			5 U	5 U				130	120							
Arsenic (ug/L)			4						2			3		4		7.8*	2 U	
Beryllium (ug/L)			1 U						1 U			1 U		1 U		0.05*	1 U	1 U
Cadmium (ug/L)			5						8			5 U		9		0.23*	5 U	5 U
Chromium (ug/L)			10						10 U			10 U		23		1.7*	10 U	10 U
Copper (ug/L)			19						22			119		24600	LAC	561*	60	4 U
Lead (ug/L)			20 U						20 U			20 U		26		1.6*	20 U	20 U
Mercury (ug/L)			0.074U						0.074U			0.088		0.26		9.68*	0.074U	
Nickel (ug/L)			37						21			62		94	LAC	53.7*	20 U	20 U
Selenium (ug/L)			1 U						1 U			1 U		1 U		0.1U*	1 U	
Thallium (ug/L)			1 U						1 U			1 U		1 U		0.5U*	1 U	
Zinc (ug/L)			3						4			15		493	LAC	37.5*	3 U	3 U
Cobalt (ug/L)														1130	430			

* - WAS sample results are in mg/Kg dry wt.
U = less than
LAC = laboratory accident, sample could not be analyzed.

Table 6. Ecology/Kalama Chemical Results Comparison - Kalama Chemical, 5/88

Sample:	001 - Non-contact Cooling Water												
Lab Log #:				198105			198106						
Type:	Grab	Cont **	Grab	Grab	Cont **	Grab	Grab	Cont **	Grab	Grab	Grab	Cont **	Grab
Date:	5/2	5/2	5/2	5/3	5/3	5/3	5/4	5/4	5/4	5/4	5/6	5/6	5/6
Time:	1120	1120		1550	1550		0930	0930		1050	0930	0930	
Lab:	ECO	KC	KC	ECO	KC	KC	ECO	KC	KC	ECO	ECO	KC	KC
Field Analyses													
pH (S.U.)	8.4	9.2	7.8	7.7	9.4	7.1	8.2	9.3	7.5	8.2	8.2	8.0	7.8
Temperature (C)	22.8	28.9	24	22.5	28.9	23	22.5	28.9	24	22.4	22.2	28.9	24

Sample:	002 - Process Wastewater						Sand Filter Effluent			WAS	
Lab Log #:	198107		198108			198117	198111	198112		198113	
Type:	Grab	Grab	Grab	Grab	Grab	ECO-Comp	Grab	Grab	Grab	Grab	Grab
Date:	5/3	5/3	5/4	5/4	5/4	5/3-4	5/3	5/4	5/4	5/4	5/4
Time:	1555		0920		0920	1200-1200	1540	0940	0940	0900	0900
Lab:	ECO	KC	ECO	KC	KC	ECO	ECO	ECO	KC	ECO	KC
Field Analyses											
pH (S.U.)	8.2	8.2	8.2	8.2							
Laboratory Analyses											
% Solids										2.5	3.3
Arsenic (ug/L)						3	4			7.8*	1.7*
Beryllium (ug/L)						1U	1U			0.05*	
Cadmium (ug/L)					2U	5U	9			0.23*	0.8*
Chromium (ug/L)						10U	23			1.7*	
Copper (ug/L)					120	119	24600	LAC	1500	561*	4100*
Lead (ug/L)						20U	26			1.6*	13*
Mercury (ug/L)						0.088	0.26			3.9*	0.5U*
Nickel (ug/L)					60	62	94	LAC	30	53.7*	390*
Selenium (ug/L)						1U	1U			0.1U*	
Thallium (ug/L)						1U	1U			0.5U*	
Zinc (ug/L)					27	15	493	LAC	230	37.5*	240*
Cobalt (ug/L)					22		1130	430	410		430*

* = WAS sample results are in mg/Kg dry wt.
** = measurements from KC continuous meters
U = less than
LAC = laboratory accident, sample could not be analyzed.

Table 7. NPDES Permit Limits - Ecology/Kalama Chemical Analytical Results Comparison - Kalama Chemical, 5/88

Outfall 001 - Non-contact Cooling Water

	NPDES Limits						
Type:			Grab	Grab	Grab	Grab	Grab
Date:	Daily	Daily	5/2	5/3	5/4	5/4	5/6
Time:	Average	Maximum	1120	1550	0930	1050	0930
pH (S.U.)	within 6.0-9.0		8.4	7.7	8.2	8.2	8.2
Temperature (C)	N/A	30 *	22.8	22.5	22.5	22.4	22.2
Flow (MGD)	18.0	20.0	inspection flow = 16.4 MGD				

* - Increase above ambient shall not be more than 0.3 degrees C when upstream temperature is greater than 20 degrees C.

Outfall 002 - Process Wastewater

Lab Log #:	NPDES Limits		198107	198108		198117	198118	
Type:			ECO-Grab	ECO-Grab	KC-Grab	ECO-Comp	KC-Comp	KC-Comp
Date:	Daily	Daily	5/3	5/4	5/4	5/3-4	5/3-4	5/3-4
Time:	Average	Maximum	1555	0920	0920	1200-1200	0100-0100	0100-0100
Lab:			ECO	ECO	KC	ECO	ECO	KC
pH (S.U.)	within 6.0-9.0		8.2	8.2				
NH3-N (mg/L)	30	50				0.01	0.05	2
Total-P (mg/L)	5	8				0.17	0.23	0.3
TSS (mg/L)	120	353				5	8	17
COD (mg/L)	--	--				140	140	134
BOD5 (mg/L)	58	146				17	12	6
Flow (MGD)	0.12	0.15				0.14		
Cyanide (ug/L)	180	410	300	5 U	8 ++			
Phenols (ug/L)	--	--	130	120	170 ++			
Salmonid Bioassay (% survival)	-----80%-----					0%		
----------[VOA Compounds (ug/L)]								
Chloromethane	--	50	1.9 U	1.9 U	1 U			
Bromomethane	--	50	1.6 U	1.6 U	1 U			
Chloroethane	--	50	1.7 U	1.7 U	3 U			
Methylene Chloride	--	50	0.5 JB	0.5 JB	1 U			
1,1-Dichloroethene	75	125	0.4 U	0.4 U	1 U			
1,1-Dichloroethane	125	225	0.3 U	0.3 U	1 U			
Chloroform	50	75	0.6 U	0.6 U	1 U			
1,2-Dichloroethane	100	150	0.3 U	0.3 U	1 U			
1,1,1-Trichloroethane	--	50	0.3 U	0.3 U	1 U			
Carbon Tetrachloride	--	50	0.5 U	0.5 U	1 U			
Bromodichloromethane	--	50	0.2 U	0.2 U	1 U			
Trichloroethene	50	75	0.3 U	0.3 U	1 U			
Benzene	75	125	0.5 U	0.5 U	1 U			
1,1,2-Trichloroethane	50	75	0.4 U	0.4 U	1 U			
Toluene	125	225	0.9	0.4 U	1 U			
Ethylbenzene	150	275	0.4 U	0.4 U	1 U			

Table 7. Kalama Chemical, 5/88 (Continued)

Outfall 002 - Process Wastewater

Lab Log #:	NPDES Limits		198107	198108		198117	198118	
Type:			ECO-Grab	ECO-Grab	KC-Grab	ECO-Comp	KC-Comp	KC-Comp
Date:	Daily	Daily	5/3	5/4	5/4	5/3-4	5/3-4	5/3-4
Time:	Average	Maximum	1555	0920	0920	1200-1200	0100-0100	0100-0100
Lab:			ECO	ECO	KC	ECO	ECO	KC
----------[BNA Compounds (ug/L)]								
Phenol	--	50			5 U	1 U		
2-Chlorophenol	50	75			5 U	1 U		
1,2-Dichlorobenzene	125	250			5 U	1 U		
Isophorone	--	50			5 U	1 U		
2-Nitrophenol	75	100			11 U	5 U		
2,4-Dimethylphenol	--	50			5 U	2 U		
2,4-Dichlorophenol	100	200			11 U	3 U		
1,2,4-Trichlorobenzene	125	225			5 U	1 U		
2,4,6-Trichlorophenol	100	175			11 U	5 U		
Dimethyl Phthalate	175	375			5 U	1 U		
Acenaphthylene	--	50			5 U	1 U		
Acenaphthene	--	50			5 U	1 U		
2,4-Dinitrophenol	100	150			53 U	10 U		
4-Nitrophenol	325	500			53 U	5 U		
Diethyl Phthalate	125	275			5 U	1 U		
Fluorene	--	50			5 U	1 U		
Pentachlorophenol	50	100			53 U	5 U		
Phenanthrene	--	50			5 U	1 U		
Di-n-Butyl Phthalate	150	300			5 U	1 U		
Bis(2-Ethylhexyl)phthalate	150	350			7 B	1 U		
----------[Metals (ug/L)]								
Antimony	370	780						
Cadmium	40	70			2 U	5 U		
Chromium	90	190				10 U		
Copper	70	150			120	119		
Lead	40	70				20 U		
Mercury	50	90				0.088		
Zinc	100	210			27	15		

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

++ - results of grab composite sample

laboratory accident with the May 4 grab prevented full Ecology analysis of that sample. The WAS sample results showed poor correspondence between Ecology and KC (Laucks) results. Rechecks of the sand filter effluent and WAS during the next inspection are suggested.

NPDES Permit Comparison

NPDES permit limits are compared to Ecology and KC laboratory results in Table 7. All parameters were within the daily maximum limits and most were within the daily average limits. Parameters which exceeded the daily average limits included:

1. Flow from the 002 outfall. The flow was .14 MGD which fell between the daily maximum of .15 MGD and the daily average of .12 MGD.

2. One of the two cyanide grab samples exceeded the daily average limit of 180 ug/L. However, when the two results were averaged, the average (150 ug/L) was less than the limit. The KC result from a grab composite, which was collected at different times than the Ecology grabs, was 8 ug/L.

3. The copper concentration of 119 ug/L exceeded the daily average limit of 70 ug/L. The result is supported by the KC grab sample result of 120 ug/L. Analysis of the transfer blank showed it to be contaminated at a concentration of 60 ug/L. The cause is unknown.

The salmonid (trout) bioassay had a mortality of 100 percent in the process wastewater. Survival was less than the 80 percent required for the screening test required in the permit. Bioassay results are discussed more thoroughly later in the report.

The receiving water temperature data were collected on September 2, 1988 (Table 8, Figure 2). The study found maximum changes along the estimated downstream border of the dilution zone to be 0.4^{o} C. The maximum increase in the surface water temperature above the dilution zone was $0.5\ ^{o}$ C. The receiving water criteria allow a maximum temperature increase of 0.3^{o} C (Ecology, 1988). The study suggested that collection of temperature data during the high receiving water temperature period (temperature greater than 20^{o} C) is appropriate. Data collection at the surface, one foot, five feet, and ten feet depths along the downstream border and on the surface above the dilution zone should prove adequate.

Priority Pollutant Results - Water Samples

Priority pollutants found in the water samples are summarized in Table 9. All priority pollutants analyzed for, including those that were not detected, are summarized in the Appendix.

Benzene and toluene were found in both 001 grab samples collected. The potential load to the river due to the high cooling water flow is a concern. Johnny McDaniel of KC theorized the benzene and toluene may have been related to the ground water cleanup project occurring during the inspection. At the time of the inspection, the cleanup was being done with an old steam stripper that discharged into the cooling water flow near the 001 sampling sampling station. Since the inspection, a new air stripper has been installed with discharges routed to

Table 8. Receiving Water Temperatures - Kalama Chemical, 5/88

Temperatures taken at the downstream border of the dilution zone.
Measurements were made on 9/2/88 between 1115 and 1200 hours.

		Downstream Station Temperature (C) *							
	Reference	Nearshore		Diffuser		Dock		Docked Ship	
Depth of Water (ft)	Upstream Station Temp (C)	Temp	Increase over Upstream	Temp	Increase over Upstream	Temp	Increase over Upstream	Temp	Increase over Upstream
0	20.6	20.8	0.2	21.0	0.4	21.0	0.4	20.9	0.3
1	20.6	20.9	0.3	21.0	0.4	20.9	0.3	20.8	0.2
5	20.6	20.9	0.3	20.9	0.3	20.7	0.1	20.7	0.1
10	20.6	20.9	0.3	20.8	0.2	20.6	0.0	20.7	0.1
15	20.6	20.9	0.3	20.6	0.0	20.6	0.0	20.6	0.0
20	20.5			20.6	0.1	20.6	0.1	20.6	0.1
25	20.5			20.6	0.1	20.5	0.0	20.6	0.1
30				20.6		20.5		20.6	
35						20.5		20.5	
40						20.5		20.5	
45						20.5		20.5	
50						20.5		20.5	
55						20.5		20.5	
60								20.5	
65								20.5	

* Station names are descriptive of the upstream feature in the discharge area (see Figure 2). The downstream border of the dilution zone (300 feet downstream of the diffuser) was estimated.

Surface water temperatures above the dilution zone. Measurements were made on 9/2/88 between 1200 and 1210 hours.

Station	Surface Temperature (C)	Increase over Upstream (C)
75' upstream	20.6	--
over diffuser	20.8	0.2
75' downstream	20.7	0.1
150' downstream	21.1	0.5
225' downstream	21.0	0.4
300' downstream	21.0	0.4

Table 9. Priority Pollutants Found in Water Samples - Kalama Chemical, 5/88

Sample:	River Intake		001 - Non-contact Cooling Water		002 - Process Wastewater		Method Blank	Field Blank	Toxicity Criteria (EPA, 1986b)	
Lab Log #:	198109	198110	198105	198106	198107	198108		198114		
Type:	Grab	Grab	Grab	Grab	Grab	Grab				
Date:	5/3	5/4	5/3	5/4	5/3	5/4		5/3		
Time:	1600	0930	1550	0930	1555	0920			Acute	Chronic
VOA Compounds (ug/L)										
Methylene Chloride	3.1 B	5.9 B	0.6 JB	0.7 JB	0.5 JB	0.5 JB	1.4 J	1.7 JB	--	--
Acetone	5.3	350	3.5 U	3.5 U	3.5 U	1.2 J	3.5 U	3.5 U	--	--
Benzene	0.5 U	0.5 U	11	5.7	0.5 U	0.5 U	0.5 U	0.5 U	5300	--
Toluene	0.4 U	0.4 U	170	170	0.9	0.4 U	0.4 U	0.4 U	17500	--
Cyanide (ug/L)	5 U	5 U	45 ##	5 U	300 ##	5 U			22	5.2

Sample:	River Intake	001 - Non-contact Cooling Water	002 - Process Wastewater	Method Blank	Field Blank	Acute	Chronic
Lab Log #:	198115	198116	198117		198114		
Type:	ECO-Comp	ECO-Comp	ECO-Comp				
Date:	5/3-4	5/3-4	5/3-4		5/3		
Time:	1200-1200	1200-1200	1200-1200				
BNA Compounds (ug/L)							
Benzyl Alcohol	5 U	5 U	71	5 U	5 U	--	--
2-Methylphenol	1 U	2 M	56	1 U	1 U	--	--
Dibenzofuran	1 U	1 U	1 M	1 U	1 U	--	--
Pyrene	1 U	2	1	1 U	1 U	--	--
Priority pollutant metals (ug/L)							
Arsenic	4	2	3		2 U	360 +	190 +
Cadmium	5 ##	8 ##	5 U	5 U	5 U	3.9 **	1.1 **
Chromium	10	10 U	10 U	10 U	10 U	16(1700)*	11(210) *
Copper	19 ##	22 ##	119 ##	4 U	60	18 **	12 **
Mercury	0.074 U	0.074 U	0.088 #		0.074 U	2.4	0.012
Nickel	37	21	62	20 U	20 U	1400 **	160 **
Zinc	3	4	15	3 U	3 U	120 **	110 **

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

* - chromium VI (chromium III)
** - criteria using a hardness of 100 mg/L as $CaCO_3$
\+ - criteria for arsenic (III)
\# - chronic toxicity criteria exceeded
\## - acute and chronic toxicity criteria exceeded

the process wastewater treatment system. Rechecks of the cooling water are suggested to determine if additional monitoring of the 001 outfall is appropriate.

A cyanide concentration of 300 ug/L was found in one of the 002 grab samples. Cyanide was also found in the corresponding 001 grab (45 ug/L). Benzyl alcohol and 2-Methylphenol, which are not included in the NPDES permit, were found in the 002 composite sample. A recheck or inclusion of these two compounds as parameters required for 002 discharge permit monitoring is suggested.

Acetone was found in both river samples which seems unusual.

Bioassay Results - Water Samples

Ecology bioassay results from water samples are included in Table 10. Acute test results for the river water indicated some toxicity to the Microtox, but no toxicity to the other organisms tested. Thus, any acute toxicity observed in the 001 or 002 samples to test organisms other than Microtox is assumed to be associated with KC plant activities. Effects on Microtox, at test concentrations less than the test concentration of river water having an effect, are also assumed to be due to KC plant activities.

The 001 discharge exhibited no acute toxicity to any of the organisms. An LC50 (concentration lethal to 50 percent of the organisms) of 30 percent for the *Daphnia* test was determined, but because there was 100 percent survival in the 100 percent concentration test, the LC50 is thought to be the result of outlier data. EPA bioassay results of 001 samples confirm the Ecology results (Table 11).

The 002 discharge exhibited acute toxicity to the trout, *Ceriodaphnia*, and *Daphnia* at the 100 percent concentration (Table 10). The no observable effects concentration (NOEC) for both the *Daphnia* and *Ceriodaphnia* was 10 percent. Microtox also showed a negative response to the 002 discharge at lower percent solutions than the river water. Table 9 includes available toxicity criteria for the priority pollutant compounds found (EPA, 1986b). Copper and one of the cyanide grab sample concentrations exceeded the criteria. Ammonia is another possible concern. At the high effluent pH (8.4) and bioassay temperature (12.8^{o} C), the acute toxicity criteria is 1.9 mg/L NH_3-N (EPA, 1986b). While the Ecology measurements were 0.01 and 0.05 mg/L, well below the criteria, the KC measurement was 2 mg/L. Additional sample splits for NH_3-N analysis are suggested for the next inspection. If the higher NH_3-N concentration is correct, reducing the discharge pH is suggested. The analyst expressed concern that the high sample alkalinity (1080 mg/L as $CaCO_3$) and conductivity (2600 umhos/cm) may have affected trout survival (Antrim, 1988). Greater than 95 percent of streams supporting good fish fauna have a conductivity less than 1100 unhos/cm; with 4000 umhos/cm being the upper tolerable limit (McKee and Wolf ed.,1963).

Chronic toxicity test results for the Ecology *Daphnia* and *Ceriodaphnia* tests are included in Table 10. The results are questionable due to poor reproduction in the control tests. EPA results indicated statistically significant inhibition of algal growth at the 50 percent 001 dilution (Table 11).

Table 10. Ecology Bioassay Results for Water Samples - Kalama Chemical, 5/88

Ceriodaphnia (Ceriodaphnia dubia)

Station	Statistical Analysis	Data: Concentration (percent)	Data: # Tested	Data: # Surviving	Data: Ave. # Young per Adult
Control		-	10	9	6.1
River Intake	Acute Test (Mortality)	1	10	10	11.5
	NOEC - 100%	3	10	10	5.8
	LC50 - >100%	10	10	6	0.0
	Chronic Test (Reproduction)	30	10	7	0.5
	NOEC - 3% **	100	10	8	1.8
	LOEC - 10% **				
001 - Non-contact Cooling Water	Acute Test (Mortality)	1	10	8	8.4
	NOEC - 100%	3	10	5	0.0
	LC50 - >100%	10	10	8	0.0
	Chronic Test (Reproduction)	30	10	9	3.4
	NOEC - 1% **	100	10	10	2.2
	LOEC - 3% **				
002 - Process Wastewater	Acute Test (Mortality)	1	10	10	13.5
	NOEC - 10%	3	10	9	15.7
	LOEC - 30%	10	10	9	5.4
	LC50 - 18.6%	30	10	3	0.0
	Chronic Test (Reproduction)	100	10	0	0.0
	NOEC - 10% **				

** Results should be used with caution because average reproduction was not 15 or more young per adult in the control.

Daphnia (Daphnia magna)

Station	Statistical Analysis	Data: Concentration (percent)	Data: # Tested	Data: # Surviving	Data: Ave. # Young per Adult**
Control		-	20	20	1.5
River Intake	Acute Test (Mortality)	1	10	9	3.1
	NOEC - 100%	3	10	10	4.0
	LC50 - >100%	10	10	10	4.8
	Chronic Test (Reproduction)	30	10	9	5.1
	NOEC - 100% *+	100	10	10	12.7
001 - Non-contact Cooling Water	Acute Test (Mortality)	1	10	10	2.2
	NOEC - 10% +	3	10	10	0.5
	LOEC - 30% +	10	10	10	5.5
	Chronic Test (Reproduction)	30	10	4	3.0
	NOEC - 10% *+	100	10	10	10.9
002 - Process Wastewater	Acute Test (Mortality)	1	10	10	0.4
	NOEC - 10%	3	10	10	3.5
	LOEC - 30%	10	10	10	1.4
	Chronic Test (Reproduction)	30	10	0	0.0
	NOEC - 10% *+	100	10	0	0.0

\+ - 100% survival in the 100% concentration test suggests that the 30% concentration data may be an outlier. If the 30% concentration data were eliminated the NOEC and LC50 would be 100% and >100%.

*+ - Results should be used with caution because of low reproduction in the control.

Microtox (Photobacterium phosphoreum)

Station	EC50 (percent solution) *: 5 min.	15 min.	30 min.
River Intake	76.0	75.0	51.6
001 - Non-contact Cooling Water	>100	>100	>100
002 - Process Wastewater	45.0	32.7	25.9

* - calculated using Microbics "Microtox Calculation Program for the IBM-PC"

Salmonid/Trout (Salmo gairdneri)

Station	# Tested	# Survived	Percent Mortality
Control	30	30	0
River Intake	30	30	0
001 - Non-contact Cooling Water	30	30	0
002 - Process Wastewater	30	0 *	100

* all deaths occured within the first 24 hours

NOEC - no observable effects concentration
LOEC - lowest observable effects concentration
LC50 - lethal concentration for 50% of the organisms
EC50 - effect concentration for 50% of the organisms

Table 11. EPA Bioassay Results for Outfall 001 (Non-contact Cooling Water) - Kalama Chemical, 5/88

Fathead Minnow (Pimephales promelas)

Concentration (percent)	# Tested	# Surviving	Percent Mortality	Mean Weight (mg)
Control	20	18	10	0.254
6.25	20	16	20	0.267
12.5	30	22	27	0.201
25	30	23	23	0.244
50	30	19	37	0.218
100	30	22	27	0.174

results are not statistically significant -
NOEC, LOEC, EC50, and LC50 are >100%

Ceriodaphnia (Ceriodaphnia dubia)

Concentration (percent)	# Tested	# Surviving	Percent Mortality	Ave. # Young per Adult
Control	10	9	10	14.4
6.25	10	10	0	17.8
12.5	10	8	20	17.0
25	10	8	20	15.2
50	10	9	10	14.8
100	10	9	10	19.8

results are not statistically significant -
NOEC, LOEC, EC50, and LC50 are >100%

Selenastrum (Selenastrum capricornutum)

Concentration (percent)	Cells/mL	% Inhibition
Control	2097	0.0
6.25	1599	23.8
12.5	1648	21.4
25	1560	25.6
50	1023	51.2 *
100	1732	17.4

* - 50% solution showed statistically significant inhibition using Dunnet's Test

NOEC - no observable effects concentration
LOEC - lowest observable effects concentration
LC50 - lethal concentration for 50% of the organisms
EC50 - effect concentration for 50% of the organisms

Priority Pollutant Results - Sediment Samples

Priority pollutants found in the sediment samples are summarized in Table 12. Results of all priority pollutants analyzed for, including those not detected, are presented in the Appendix.

The upstream sample contained the greatest number of organic compounds of all the samples collected. Several polynuclear aromatic hydrocarbon compounds (PAHs), as well as 1,1,1-Trichloroethane and Acetone, were found in the upstream sample. Also methylene chloride was detected in all samples as well as the method blank. The upstream sample was collected off of the log yard adjacent to the Kalama Chemical property.

Organic compounds at the outfall and downstream stations, when detected, were found at lower concentrations than at the upstream station. The only exception was toluene, which was not detected at the upstream station, but found in trace amounts at the lower stations. Toluene appeared to be the only compound whose presence in the sediments might be related to the discharge characteristics during the inspection.

Metals concentrations were similar at all three stations. Arsenic and zinc concentrations increased slightly through the discharge zone and downstream.

Bioassay Results - Sediment Samples

Hyallela azteca bioassay results on the sediments are presented in Table 13. All results showed survival in the inspection sediments to be greater than or equal to the control survival. Thus, there was no toxicity to *Hyallela* in the sediments collected. There are presently no sediment criteria for freshwater sediments so inferences about the absence or presence of effects on other species due to the chemical concentrations found in the sediments cannot be made.

CONCLUSIONS AND RECOMMENDATIONS

Flow Measurement

The 001 flow measurement could not be verified. Inquiry as to the frequency of calibration of the flow meter is recommended during the next inspection.

Lab Review/Results Comparison

1. BOD_5 and TSS procedures were generally acceptable. Recommendations to bring procedures into conformance with approved techniques are included in the Appendix.

2. The KC continuous pH and temperature monitors on the 001 outfall appeared to be poorly calibrated when the inspection began. Daily checks of the continuous monitors with the daily grab samples collected and analyzed by the lab are recommended.

Table 12. Priority pollutants found in sediment samples - Kalama Chemical, 5/88

Station Lab Log #	Sediment-1 Upstream 198119	Sediment-2 Outfall 198120	Sediment-3 Downstream 198121	Method Blank
Latitude (degree-min-sec)	46-01-14	46-01-18	46-01-22	
Longitude (degree-min-sec)	122-51-29	122-51-35	122-51-40	
Water depth (ft)	40	32	32	
Total solids (%)	69.7	73.2	66.6	
Grain size (% dry basis)				
Gravel	<2	<2	<2	
Sand	91.0	85.8	85.1	
Silt	7.8	12.4	12.5	
Clay	1.2	1.8	2.4	
TOC (% dry basis)	0.2	0.4	0.4	
---------- VOA Compounds (ug/Kg dry wt) ----------				
Methylene Chloride	25.0 B	13.0 B	12 B	8.2
Acetone	4.0 J	8.0 U	8.4 U	6.9 U
1,1,1-Trichloroethane	4.4	0.6 M	0.5 M	0.6 U
Trichloroethene	0.6 M	0.7 U	0.7 U	0.6 U
Toluene	1.1 U	0.8 J	0.7 J	0.8 U
---------- BNA Compounds (ug/Kg dry wt) ----------				
Naphthalene	99	63 U	72 U	67 U
Acenaphthene	21 M	63 U	72 U	67 U
Phenanthrene	198	63 U	35 M	67 U
Anthracene	37 M	63 U	72 U	67 U
Fluoranthene	160	51 M	62 M	67 U
Pyrene	160	56 M	58 M	67 U
Benzo(a)Anthracene	63 M	63 U	72 U	67 U
Chrysene	52	63 U	72 U	67 U
----------Priority pollutant metals (mg/Kg dry wt)----------				
Arsenic	2.8	3.2	5.4	
Beryllium	0.4	0.4	0.4	
Cadmium	1.1	1.7	0.8	
Chromium	7.1	7.6	8.4	
Copper	32.4	23.4	23.1	
Lead	6.5	7.9	8.6	
Mercury	0.01	0.01	0.03	
Nickel	24.7	26.6	29.3	
Selenium	0.1	0.1	0.1 U	
Zinc	69.2	86.1	105	

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

Table 13. Sediment Bioassay Results - Kalama Chemical, 5/88

Station	Percent Survival *
Control	83
Sediment1 (upstrm)	93
Sediment2 (outfall)	83
Seciment3 (dwnstrm)	90

* organism used was Hyallela azteca

3. Metals and ammonia results did not compare well in all cases. Splits for metals analysis of the sand filter effluent and WAS, and several effluent splits for ammonia analysis are recommended for the next inspection.

NPDES Permit Comparison

Discharge during the inspection met most NPDES limits. The receiving water temperature impacts appeared to be slightly greater than the 0.3^{o} C change allowed by the state water quality standards (Ecology, 1988). Weekly checks of the receiving water impacts during the critical high temperature months (receiving water temperature upstream greater than 20^{o} C) are recommended. Comparing temperature at the surface over the dilution zone and four stations along the downstream border of the dilution zone (surface, one foot, five feet, and ten feet depths) to an upstream background station is recommended.

Priority Pollutants - Water

1. Benzene and toluene were found in the noncontact cooling water discharge. Johnny McDaniel theorized this was due to a ground water cleanup technique used during the inspection; the technique has since been modified. A recheck of the 001 discharge for volatiles is suggested.

2. Benzyl alcohol and 2-methylphenol were found in the process wastewater discharge. A recheck or possible inclusion of the two compounds on the NPDES permit organic monitoring list is recommended.

Bioassay Results - Water

The 002 discharge exhibited acute toxicity at the 100 percent concentration to the trout, *Daphnia*, and *Ceriodaphnia.* A clear cause was not determined, although several possible causes are discussed in the text.

Priority Pollutants - Sediment

Trace amounts of toluene appeared to be the only priority pollutant found in the sediments that may be associated with KC discharge characteristics during the inspection.

Bioassay Results - Sediment

The inspection sediments demonstrated no acute toxicity to the test organism, *Hyallela azteca.*

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APPENDICES

Laboratory Procedure Review Sheet

Discharger: Kalama Chemical

Date: 5/3/88

Discharger representative: Randy Hahn

Ecology reviewer: Marc Heffner

Instructions

Questionnaire for use reviewing laboratory procedures. Circled numbers indicate work is needed in that area to bring procedures into compliance with approved techniques. References are sited to help give guidance for making improvements. References sited include:

Ecology = Department of Ecology Laboratory User's Manual, December 8, 1986.

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

SSM = WPCF, Simplified Laboratory Procedures for Wastewater Examination, 3rd ed., 1985.

Sample Collection Review

1. Are grab, hand composite, or automatic composite samples collected for influent and effluent BOD and TSS analysis?

2. If automatic compositor, what type of compositor is used? Manning
   The compositor should have pre and post purge cycles unless it is a flow through type. Check if you are unfamiliar with the type being used.

3. Are composite samples collected based on (time) or flow?

4. What is the usual day(s) of sample collection? daily

5. What time does sample collection usually begin? 1 Am

6. How long does sample collection last? 24 hrs

7. How often are subsamples that make up the composite collected? 30 min

8. What volume is each subsample? 200 mLs

9. What is the final volume of sample collected? ≈ 3 gal

10. Is the composite cooled during collection? yes

11. To what temperature? 4°C
The sample should be maintained at approximately 4 degrees C (SM p41, #5b: SSM p2).

12. How is the sample cooled?
Mechanical refrigeration or ice are acceptable. Blue ice or similar products are often inadequate.

13. How often is the temperature measured? occasionally
The temperature should be checked at least monthly to assure adequate cooling.

14. Are the sampling locations representative? OK

15. Are any return lines located upstream of the influent sampling location? —
This should be avoided whenever possible.

16. How is the sample mixed prior to withdrawal of a subsample for analysis? OK
The sample should be thoroughly mixed.

17. How is the subsample stored prior to analysis? analyzed immediately
The sample should be refrigerated (4 degrees C) until about 1 hour before analysis, at which time it is allowed to warm to room temperature.

18. What is the cleaning frequency of the collection jugs? rinse
The jugs should be thoroughly rinsed after each sample is complete and occasionally be washed with a non-phospate detergent.

19. How often are the sampler lines cleaned? seldom
Rinsing lines with a chlorine solution every three months or more often where necessary is suggested.

pH Test Review

1. How is the pH measured? continuous + lab meter
A meter should be used. Use of paper or a colorimetric test is inadequate and those procedures are not listed in Standard Methods (SM p429).

2. How often is the meter calibrated? lab meter daily
The meter should be calibrated every day it is used.

3. What buffers are used for calibration? 4-7-10
Two buffers bracketing the pH of the sample being tested should be used

If the meter can only be calibrated with one buffer, the buffer closest in pH to the sample should be used. A second buffer, which brackets the pH of the sample should be used as a check. If the meter cannot accurately determine the pH of the second buffer, the meter should be repaired.

BOD Test Review

1. What reference is used for the BOD test?
Standard Methods or the Ecology handout should be used.

2. How often are BODs run? daily
The minimum frequency is specified in the permit.

3. How long after sample collection is the test begun? immediately
The test should begin within 24 hours of composite sample completion (Ecology Lab Users Manual p42). Starting the test as soon after samples are complete is desirable.

4. Is distilled or deionized water used for preparing dilution water?

5. Is the distilled water made with a copper free still? purchased
Copper stills can leave a copper residual in the water which can be toxic to the test (SSM p36).

6. Are any nitrification inhibitors used in the test? no What?
2-chloro-6(trichloro methyl) pyridine or Hach Nitrification Inhibitor 2533 may be used only if carbonaceous BODs are being determined (SM p 527, #4g: SSM p 37).

7. Are the 4 nutrient buffers of powder pillows used to make dilution water? ≈2 mth supply made up
If the nutrients are used, how much buffer per liter of dilution water are added? OK
1 mL per liter should be added (SM p527, #5a: SSM p37).

8. How often is the dilution water prepared? daily
Dilution water should be made for each set of BODs run.

9. Is the dilution water aged prior to use? no
Dilution water with nitrification inhibitor can be aged for a week before use (SM p528, #5b).
Dilution water without inhibitor should not be aged.

10. Have any of the samples been frozen? no
If yes, are they seeded?
Samples that have been frozen should be seeded (SSM p38).

11. Is the pH of all samples between 6.5 and 7.5? check
If no, is the sample pH adjusted?
The sample pH should be adjusted to between 6.5 and 7.5 with 1N NaOH or 1N H_2SO_4 if 6.5 > pH >7.5 if caustic alkalinity or acidity is present (SM p529, #5e1: SSM p37).
High pH from lagoons is usually not caustic. Place the sample in the dark to warm up, then check the pH to see if adjustment is necessary.

If the sample pH is adjusted, is the sample seeded?
The sample should be seeded to assure adequate microbial activity if the pH is adjusted (SM p528, #5d).

12. Have any of the samples been chlorinated or ozonated? no
If chlorinated are they checked for chlorine residual and dechlorinated as necesssary?
How are they dechlorinated?
Samples should be dechlorinated with sodium sulfite (SM p529, #5e2: SSM p38), but dechlorination with sodium thiosulfate is common practice. Sodium thiosufate dechlorination is probably acceptable if the chlorine residual is < 1-2 mg/L.
If chlorinated or ozonated, is the sample seeded?
The sample should be seeded if it was disinfected (SM p528, #5d&5e2: SSM p38).

13. Do any samples have a toxic effect on the BOD test? no
Specific modifications are probably necessary (SM p528, #5d: SSM p37).

14. How are DO concentrations measured? wheaton probe
If with a meter, how is the meter calibrated? Winkler
Air calibration is adequate. Use of a barometer to determine saturation is desirable, although not manditory. Checks using the Winkler method of samples found to have a low DO are desirable to assure that the meter is accurate over the range of measurements being made.

How frequently is the meter calibrated? daily
The meter should be calibrated before use.

15. Is a dilution water blank run? yes
A dilution water blank should always be run for quality assurance (SM p527, #5b: SSM p40, #3).

What is the usual initial DO of the blank? 8.0-9.0
The DO should be near saturation; 7.8 mg/L @ 4000 ft, 9.0 mg/L @ sea level (SM p528, #5b). The distilled or deionized water used to make the dilution water may be aged in the dark at ~20 degrees C for a week with a cotton plug in the opening prior to use if low DO or excess blank depletion is a problem. → make sure DW ≈ 20°C

What is the usual 5 day blank depletion? 0.0-0.5
The depletion should be 0.2 mg/L or less. If the depletion is greater, the cause should be found (SM p527-8, #5b: SSM p41, #6).

16. How many dilutions are made for each sample? 3
At least two dilutions are recommended. The dilutions should be far enough apart to provide a good extended range (SM p530, #5f: SSM p41).

17. Are dilutions made by the liter method or in the bottle?
Either method is acceptable (SM p530, #5f).

18. How many bottles are made at each dilution? 3
How many bottles are incubated at each dilution? 3
When determining the DO using a meter only one bottle is necessar[illegible] The DO is measured, then the bottle is sealed and incubated (SM p53[illegible]
When determining the DO using the Winkler method two bottles a[illegible] necessary. The initial DO is found of one bottle and the other bo[illegible]e is sealed and incubated (Ibid.).

19. Is the initial DO of each dilution measured? yes
What is the typical initial DO? ≈ 8.5
The initial DO of each dilution should be measured. It should approximate saturation (see #14).

(20.) What is considered the minimum acceptable DO depletion after 5 days?
What is the minimum DO that should be remaining after 5 days?
The depletion should be at least 2.0 mg/L and at least 1.0 mg/L should be left after 5 days (SM p531, #6: SSM p41). make dilutions so depletion is in this range

(21.) Are any samples seeded? yes
Which?
What is the seed source? 2nd stage of extended aeration
Primary effluent or settled raw wastewater is the preferred seed. Secondary treated sources can be used for inhibited tests (SM p528, #5d: SSM p41).

How much seed is added to each sample? 3 mL / Bottle
Adequate seed should be used to cause a BOD uptake of 0.6 to 1.0 mg/L due to seed in the sample (SM p529, #5d).

→ How is the BOD of the seed determined? should use seed control
Dilutions should be set up to allow the BOD of the seed to be determined just as the BOD of a sample is determined. This is called the seed control (SM p529, #5d: SSM p41).

22. What is the incubator temperature? 20°C
The incubator should be kept at 20 +/- 1 degree C (SM p531, #5i: SSM p40, #3).

How is incubator temperature monitored? 3 thermometers
A thermometer in a water bath should be kept in the incubator on the same shelf as the BODs are incubated.

How frequently is the temperature checked? OK
The temperature should be checked daily during the test. A temperature log on the incubator door is recommended.

How often must the incubator temperature be adjusted? OK
Adjustment should be infrequent. If frequent adjustments (every 2 weeks or more often) are required the incubator should be repaired.

Is the incubator dark during the test period? OK
Assure the switch that turns off the interior light is functioning.

23. Are water seals maintained on the bottles during incubation? yes
Water seals should be maintained to prevent leakage of air during the incubation period (SM p531, #5i: SSM p40, #4).

24. Is the method of calculation correct?
Check to assure that no correction is made for any DO depletion in the blank and that the seed correction is made using seed control data.

Standard Method calculations are (SM p531, #6):

for unseeded samples;

$$BOD\ (mg/L) = \frac{D1 - D2}{P}$$

for seeded samples;

$$BOD\ (mg/L) = \frac{(D1 - D2) - (B1 - B2)f}{P}$$

Where: D1 = DO of the diluted sample before incubation (mg/L)
D2 = DO of diluted sample after incubation period (mg/L)
P = decimal volumetric fraction of sample used
B1 = DO of seed control before incubation (mg/L)
B2 = DO of seed control after incubation (mg/L)

$$f = \frac{\text{amount of seed in bottle D1 (mL)}}{\text{amount of seed in bottle B1 (mL)}}$$

Total Suspended Solids Test Review

Preparation

1. What reference is used for the TSS test? Std. Mthds.

2. What type of filter paper is used?
   Std. Mthds. approved papers are: Whatman 934AH (Reeve Angel), Gelman A/E, and Millipore AP-40 (SM p95,footnote: SSM p23)

3. What is the drying oven temperature? need thermometer
   The temperature should be 103-105 degrees C (SM p96, #3a: SSM p23).

4. Are any volatile suspended solids tests run? seldom
   If yes--What is the muffle furnance temperature?
   The temperature should be 550+/- 50 degrees C (SM p98, #3: SSM p23).

5. What type of filtering apparatus is used?
   Gooch crucibles or a membrane filter apparatus should be used (SM p95, #2b: SSM p23).

6. How are the filters pre-washed prior to use? yes
   The filters should be rinsed 3 times with distilled water (SM p23, #2: SSM p23, #2).

   Are the rough or smooth sides of the filters up? OK
   The rough side should be up (SM p96, #3a: SSM p23, #1)

   How long are the filters dried? ≈ a day
   The filters should be dried for at least one hour in the oven. An additional 20 minutes of drying in the furnance is required if volatile solids are to be tested (Ibid).

   How are the filters stored prior to use? OK
   The filters should be stored in a dessicator (Ibid).

7. How is the effectiveness of the dessicant checked?
   All or a portion of the dessicant should have an indicator to assure effectiveness.

Test Procedure

8. In what is the test volume of sample measured? ≈ 200 mLs
   The sample should be measured with a wide tipped pipette or a graduated cylinder.

9. Is the filter seated with distilled water? OK
   The filter should be seated with distilled water prior to the test avoid leakage along the filter sides (SM p97, #3c).

10. Is the entire measured volume always filtered? OK
The entire volume should always be filtered to allow the measuring vessel to be properly rinsed (SM p97, #3c: SSM p24, #4).

11. What are the average and minimum volumes filtered?

	Volume	
	Minimum	Average
Influent		
Effluent		

12. How long does it take to filter the samples? <5 minutes

	Time
Influent	
Effluent	

13. How long is filtering attempted before deciding that a filter is clogged? OK
Prolonged filtering can cause high results due to dissolved solids being caught in the filter (SM p96, #1b). We usually advise a five minute filtering maximum.

14. What do you do when a filter becomes clogged?
The filter should be discarded and a smaller volume of sample should be used with a new filter.

15. How are the filter funnel and measuring device rinsed onto the filter following sample addition? OK
Rinse 3x's with approximately 10 mLs of distilled water each time (??).

16. How long is the sample dried? ≈ 1 hr
The sample should be dried at least one hour for the TSS test and 20 minutes for the volatile test (SM p97, #3c; p98, #3: SSM p24, #4). Excessive drying times (such as overnight) should be avoided.

17. Is the filter thoroughly cooled in a dessicator prior to weighing? OK
The filter must be cooled to avoid drafts due to thermal differences when weighing (SM p97, #3c: SSM p97 #3c).

18. How frequently is the drying cycle repeated to assure constant filter weight has ben reached (weight loss <0.5 mg or 4%, whichever is less: SM p97, #3c)? seldom
We recommend that this be done at least once every 2 months.

19. Do calculations appear reasonable?
Standard Methods calculation (SM p97, #3c).

$$\text{mg/L TSS} = \frac{(A - B) \times 1000}{\text{sample volume (mL)}}$$

where: A= weight of filter + dried residue (mg)
B= weight of filter (mg)

Appendix - Results of VOA, BNA, Pest/PCB and Metal Priority Pollutant Scans of Water Samples -
Kalama Chemical, 5/88

Sample:	River Intake		001 - Non-contact Cooling Water		002 - Process Wastewater		Method Blank	Field Blank
Lab Log #:	198109	198110	198105	198106	198107	198108		198114
Type:	Grab	Grab	Grab	Grab	Grab	Grab		
Date:	5/3	5/4	5/3	5/4	5/3	5/4		5/3
Time:	1600	0930	1550	0930	1555	0920		
VOA Compounds (ug/L)								
Chloromethane	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Bromomethane	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Vinyl Chloride	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Chloroethane	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U	1.7 U
Methylene Chloride	3.1 B	5.9 B	0.6 JB	0.7 JB	0.5 JB	0.5 JB	1.4 J	1.7 JB
Acetone	5.3	350	3.5 U	3.5 U	3.5 U	1.2 J	3.5 U	3.5 U
Carbon Disulfide	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
1,1-Dichloroethene	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,1-Dichloroethane	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
1,2-Dichloroethene (total)	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Chloroform	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
2-Butanone	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U	3.1 U
1,2-Dichloroethane	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
1,1,1-Trichloroethane	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Carbon Tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Acetate	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
Bromodichloromethane	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,2-Dichloropropane	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Trichloroethene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Benzene	0.5 U	0.5 U	11	5.7	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
1,1,2-Trichloroethane	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
Bromoform	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U	1.3 U
4-Methyl-2-Pentanone	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U	1.8 U
2-Hexanone	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U
1,1,2,2-Tetrachloroethane	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Tetrachloroethene	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
Toluene	0.4 U	0.4 U	170	170	0.9	0.4 U	0.4 U	0.4 U
Chlorobenzene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
trans-1,3-Dichloropropene	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
Ethylbenzene	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
cis-1,3-Dichloropropene	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Styrene	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U	0.6 U
Total Xylenes	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U	0.9 U
2-Chloroethylvinylether	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U	1.4 U
Cyanide (ug/L)	5 U	5 U	45	5 U	300	5 U		

Appendix - Water Samples - Kalama Chemical, 5/88 (Continued)

Sample:	River Intake	001 - Non-contact Cooling Water	002 - Process Wastewater	Method Blank	Field Blank
Lab Log #:	198115	198116	198117		198114
Type:	ECO-Comp	ECO-Comp	ECO-Comp		
Date:	5/3-4	5/3-4	5/3-4		5/3
BNA Compounds (ug/L)					
Phenol	1 U	1 U	1 U	1 U	1 U
Aniline					
Bis(2-Chloroethyl)Ether	1 U	1 U	1 U	1 U	1 U
2-Chlorophenol	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U
Benzyl Alcohol	5 U	5 U	71	5 U	5 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U
2-Methylphenol	1 U	2 M	56	1 U	1 U
Bis(2-chloroisopropyl)ether	1 U	1 U	1 U	1 U	1 U
4-Methylphenol	1 U	1 U	1 U	1 U	1 U
N-Nitroso-Di-n-Propylamine	1 U	1 U	1 U	1 U	1 U
Hexachloroethane	2 U	2 U	2 U	2 U	2 U
Nitrobenzene	1 U	1 U	1 U	1 U	1 U
Isophorone	1 U	1 U	1 U	1 U	1 U
2-Nitrophenol	5 U	5 U	5 U	5 U	5 U
2,4-Dimethylphenol	2 U	2 U	2 U	2 U	2 U
Benzoic Acid	10 U	10 U	10 U	10 U	10 U
Bis(2-Chloroethoxy)Methane	1 U	1 U	1 U	1 U	1 U
2,4-Dichlorophenol	3 U	3 U	3 U	3 U	3 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U
Naphthalene	1 U	1 U	1 U	1 U	1 U
4-Chloroaniline	3 U	3 U	3 U	3 U	3 U
Hexachlorobutadiene	2 U	2 U	2 U	2 U	2 U
4-Chloro-3-Methylphenol	2 U	2 U	2 U	2 U	2 U
2-Methylnaphthalene	1 U	1 U	1 U	1 U	1 U
Hexachlorocyclopentadiene	5 U	5 U	5 U	5 U	5 U
2,4,6-Trichlorophenol	5 U	5 U	5 U	5 U	5 U
2,4,5-Trichlorophenol	5 U	5 U	5 U	5 U	5 U
2-Chloronaphthalene	1 U	1 U	1 U	1 U	1 U
2-Nitroaniline	5 U	5 U	5 U	5 U	5 U
Dimethyl Phthalate	1 U	1 U	1 U	1 U	1 U
Acenaphthylene	1 U	1 U	1 U	1 U	1 U
3-Nitroaniline	5 U	5 U	5 U	5 U	5 U
Acenaphthene	1 U	1 U	1 U	1 U	1 U
2,4-Dinitrophenol	10 U	10 U	10 U	10 U	10 U
4-Nitrophenol	5 U	5 U	5 U	5 U	5 U
Dibenzofuran	1 U	1 U	1 M	1 U	1 U
2,4-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U
2,6-Dinitrotoluene	5 U	5 U	5 U	5 U	5 U
Diethyl Phthalate	1 U	1 U	1 U	1 U	1 U
4-Chlorophenyl-Phenylether	1 U	1 U	1 U	1 U	1 U
Fluorene	1 U	1 U	1 U	1 U	1 U
4-Nitroaniline	5 U	5 U	5 U	5 U	5 U
4,6-Dinitro-2-Methylphenol	10 U	10 U	10 U	10 U	10 U
N-Nitrosodiphenylamine	1 U	1 U	1 U	1 U	1 U
1,2-Diphenylhydrazine					
4-Bromophenyl-Phenylether	1 U	1 U	1 U	1 U	1 U

Appendix - Water Samples - Kalama Chemical, 5/88 (Continued)

Sample:	River Intake	001 - Non-contact Cooling Water	002 - Process Wastewater	Method Blank	Field Blank
Lab Log #:	198115	198116	198117		198114
Type:	ECO-Comp	ECO-Comp	ECO-Comp		
Date:	5/3-4	5/3-4	5/3-4		5/3
Hexachlorobenzene	1 U	1 U	1 U	1 U	1 U
Pentachlorophenol	5 U	5 U	5 U	5 U	5 U
Phenanthrene	1 U	1 U	1 U	1 U	1 U
Anthracene	1 U	1 U	1 U	1 U	1 U
Di-n-Butyl Phthalate	1 U	1 U	1 U	1 U	1 U
Fluoranthene	1 U	1 U	1 U	1 U	1 U
Pyrene	1 U	2	1	1 U	1 U
Benzidine					
Butylbenxylphthalate	1 U	1 U	1 U	1 U	1 U
3,3'-Dichlorobenzidine	5 U	5 U	5 U	5 U	5 U
Benzo(a)Anthracene	1 U	1 U	1 U	1 U	1 U
Chrysene	1 U	1 U	1 U	1 U	1 U
Bis(2-Ethylhexyl)phthalate	1 U	1 U	1 U	1 U	1 U
Di-n-Octyl Phthalate	1 U	1 U	1 U	1 U	1 U
Benzo(b)Fluoranthene	1 U	1 U	1 U	1 U	1 U
Benzo(k)Fluoranthene	1 U	1 U	1 U	1 U	1 U
Benzo(a)Pyrene	1 U	1 U	1 U	1 U	1 U
Indeno(1,2,3-cd)Pyrene	1 U	1 U	1 U	1 U	1 U
Dibenzo(a,h)Anthracene	1 U	1 U	1 U	1 U	1 U
Benzo(g,h,i)Perylene	1 U	1 U	1 U	1 U	1 U
Pest/PCB Compounds (ug/L)					
alpha-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
beta-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
delta-BHC	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
gamma-BHC (Lindane)	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Heptachlor	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Aldrin	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Heptachlor Epoxide	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Endosulfan I	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Dieldrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan II	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDD	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endosulfan Sulfate	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
4,4'-DDT	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Methoxychlor	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Endrin Ketone	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
alpha-Chlordane *	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
gamma-Chlordane *					
Toxaphene	5 U	5 U	5 U	5 U	5 U
Aroclor-1016	1 U	1 U	1 U	1 U	1 U
Aroclor-1221					
Aroclor-1232					
Aroclor-1242	1 U	1 U	1 U	1 U	1 U
Aroclor-1248	1 U	1 U	1 U	1 U	1 U
Aroclor-1254	1 U	1 U	1 U	1 U	1 U
Aroclor-1260	1 U	1 U	1 U	1 U	1 U
Endrin Aldehyde					

Appendix - Water Samples - Kalama Chemical, 5/88 (Continued)

	Sample: River Intake	001 - Non-contact Cooling Water	002 - Process Wastewater	Method Blank	Field Blank
	Lab Log #: 198115	198116	198117		198114
	Type: ECO-Comp	ECO-Comp	ECO-Comp		
	Date: 5/3-4	5/3-4	5/3-4		5/3
Priority pollutant metals (ug/L)					
Antimony					
Arsenic	4	2	3		2 U
Beryllium	1 U	1 U	1 U	1 U	1 U
Cadmium	5	8	5 U	5 U	5 U
Chromium	10	10 U	10 U	10 U	10 U
Copper	19	22	119	4 U	60
Lead	20 U	20 U	20 U	20 U	20 U
Mercury	0.074 U	0.074 U	0.088		0.074 U
Nickel	37	21	62	20 U	20 U
Selenium	1 U	1 U	1 U		1 U
Silver					
Thallium	1 U	1 U	1 U		1 U
Zinc	3	4	15	3 U	3 U

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

* - total chlordane

Appendix - Results of VOA, BNA, Pest/PCB and Metal Priority Pollutant Scans of Sediment Samples - Kalama Chemical, 5/88

Station	Sediment-1 Upstream	Sediment-2 Outfall	Sediment-3 Downstream	Method Blank
Lab Log #	198119	198120	198121	
Contract #	1530A	1530B	1530C	0511MBS
Latitude (degree-min-sec)	46-01-14	46-01-18	46-01-22	
Longitude (degree-min-sec)	122-51-29	122-51-35	122-51-40	
Water depth (ft)	40	32	32	
Total solids (%)	69.7	73.2	66.6	
Grain size (% dry basis)				
Gravel	<2	<2	<2	
Sand	91.0	85.8	85.1	
Silt	7.8	12.4	12.5	
Clay	1.2	1.8	2.4	
TOC (% dry basis)	0.2	0.4	0.4	
VOA Compounds (ug/Kg dry wt)				
Chloromethane	5.3 U	4.4 U	4.6 U	3.8 U
Bromomethane	4.3 U	3.6 U	3.8 U	3.1 U
Vinyl Chloride	2.8 U	2.3 U	2.4 U	2.0 U
Chloroethane	4.6 U	3.8 U	4.0 U	3.3 U
Methylene Chloride	25.0 B	13.0 B	12 B	8.2
Acetone	4.0 J	8.0 U	8.4 U	6.9 U
Carbon Disulfide	1.7 U	1.4 U	1.5 U	1.2 U
1,1-Dichloroethene	1.0 U	0.8 U	0.8 U	0.7 U
1,1-Dichloroethane	0.8 U	0.7 U	0.7 U	0.6 U
1,2-Dichloroethene (total)	1.1 U	0.9 U	1.0 U	0.8 U
Chloroform	1.5 U	1.3 U	1.3 U	1.1 U
2-Butanone	8.7 U	7.2 U	7.5 U	6.2 U
1,2-Dichloroethane	0.7 U	0.6 U	0.6 U	0.5 U
1,1,1-Trichloroethane	4.4	0.6 M	0.5 M	0.6 U
Carbon Tetrachloride	1.3 U	1.0 U	1.1 U	0.9 U
Vinyl Acetate	4.3 U	3.6 U	3.8 U	3.1 U
Bromodichloromethane	0.4 U	0.3 U	0.4 U	0.3 U
1,2-Dichloropropane	1.0 U	0.8 U	0.8 U	0.7 U
Trichloroethene	0.6 M	0.7 U	0.7 U	0.6 U
Benzene	1.4 U	1.2 U	1.2 U	1.0 U
Dibromochloromethane	1.0 U	0.8 U	0.8 U	0.7 U
1,1,2-Trichloroethane	1.0 U	0.8 U	0.8 U	0.7 U
Bromoform	3.5 U	2.9 U	3.0 U	2.5 U
4-Methyl-2-Pentanone	4.9 U	4.1 U	4.2 U	3.5 U
2-Hexanone	4.5 U	3.7 U	3.9 U	3.2 U
1,1,2,2-Tetrachloroethane	3.8 U	3.1 U	3.3 U	2.7 U
Tetrachloroethene	0.7 U	0.6 U	0.6 U	0.5 U
Toluene	1.1 U	0.8 J	0.7 J	0.8 U
Chlorobenzene	1.3 U	1.0 U	1.1 U	0.9 U
trans-1,3-Dichloropropene	2.5 U	2.1 U	2.2 U	1.8 U
Ethylbenzene	1.1 U	0.9 U	1.0 U	0.8 U
cis-1,3-Dichloropropene	2.7 U	2.2 U	2.3 U	1.9 U
Styrene	1.5 U	1.3 U	1.3 U	1.1 U
Total Xylenes	2.5 U	2.1 U	2.2 U	1.8 U
2-Chloroethylvinylether	3.8 U	3.1 U	3.3 U	2.7 U

Appendix - Sediment Samples - Kalama Chemical, 5/88 (Continued)

Station	Sediment-1 Upstream	Sediment-2 Outfall	Sediment-3 Downstream	Method Blank
Lab Log #	198119	198120	198121	
Contract #	1530A	1530B	1530C	0511MBS
BNA Compounds (ug/Kg dry wt)				
Phenol	45 U	63 U	72 U	67 U
Aniline				
Bis(2-Chloroethyl)Ether	45 U	63 U	72 U	67 U
2-Chlorophenol	45 U	63 U	72 U	67 U
1,3-Dichlorobenzene	45 U	63 U	72 U	67 U
1,4-Dichlorobenzene	45 U	63 U	72 U	67 U
Benzyl Alcohol	220 U	320 U	360 U	330 U
1,2-Dichlorobenzene	45 U	63 U	72 U	67 U
2-Methylphenol	45 U	63 U	72 U	67 U
Bis(2-chloroisopropyl)ether	45 U	63 U	72 U	67 U
4-Methylphenol	45 U	63 U	72 U	67 U
N-Nitroso-Di-n-Propylamine	45 U	63 U	72 U	67 U
Hexachloroethane	90 U	130 U	140 U	130 U
Nitrobenzene	45 U	63 U	72 U	67 U
Isophorone	45 U	63 U	72 U	67 U
2-Nitrophenol	220 U	320 U	360 U	330 U
2,4-Dimethylphenol	90 U	130 U	140 U	130 U
Benzoic Acid	450 U	630 U	720 U	670 U
Bis(2-Chloroethoxy)Methane	45 U	63 U	72 U	67 U
2,4-Dichlorophenol	130 U	190 U	220 U	200 U
1,2,4-Trichlorobenzene	45 U	63 U	72 U	67 U
Naphthalene	99	63 U	72 U	67 U
4-Chloroaniline	130 U	190 U	220 U	200 U
Hexachlorobutadiene	90 U	130 U	140 U	130 U
4-Chloro-3-Methylphenol	90 U	130 U	140 U	130 U
2-Methylnaphthalene	45 U	63 U	72 U	67 U
Hexachlorocyclopentadiene	220 U	320 U	360 U	330 U
2,4,6-Trichlorophenol	220 U	320 U	360 U	330 U
2,4,5-Trichlorophenol	220 U	320 U	360 U	330 U
2-Chloronaphthalene	45 U	63 U	72 U	67 U
2-Nitroaniline	220 U	320 U	360 U	330 U
Dimethyl Phthalate	45 U	63 U	72 U	67 U
Acenaphthylene	45 U	63 U	72 U	67 U
3-Nitroaniline	220 U	320 U	360 U	330 U
Acenaphthene	21 M	63 U	72 U	67 U
2,4-Dinitrophenol	450 U	630 U	720 U	670 U
4-Nitrophenol	220 U	320 U	360 U	330 U
Dibenzofuran	45 U	63 U	72 U	67 U
2,4-Dinitrotoluene	220 U	320 U	360 U	330 U
2,6-Dinitrotoluene	220 U	320 U	360 U	330 U
Diethyl Phthalate	45 U	63 U	72 U	67 U
4-Chlorophenyl-Phenylether	45 U	63 U	72 U	67 U
Fluorene	45 U	63 U	72 U	67 U
4-Nitroaniline	220 U	320 U	360 U	330 U
4,6-Dinitro-2-Methylphenol	450 U	630 U	720 U	670 U
N-Nitrosodiphenylamine	45 U	63 U	72 U	67 U
1,2-Diphenylhydrazine				
4-Bromophenyl-Phenylether	45 U	63 U	72 U	67 U

Appendix - Sediment Samples - Kalama Chemical, 5/88 (Continued)

Station Lab Log # Contract #	Sediment-1 Upstream 198119 1530A	Sediment-2 Outfall 198120 1530B	Sediment-3 Downstream 198121 1530C	Method Blank 0511MBS
Hexachlorobenzene	45 U	63 U	72 U	67 U
Pentachlorophenol	220 U	320 U	360 U	330 U
Phenanthrene	198	63 U	35 M	67 U
Anthracene	37 M	63 U	72 U	67 U
Di-n-Butyl Phthalate	45 U	63 U	72 U	67 U
Fluoranthene	160	51 M	62 M	67 U
Pyrene	160	56 M	58 M	67 U
Benzidine				
Butylbenxylphthalate	45 U	63 U	72 U	67 U
3,3'-Dichlorobenzidine	220 U	320 U	360 U	330 U
Benzo(a)Anthracene	63 M	63 U	72 U	67 U
Chrysene	52	63 U	72 U	67 U
Bis(2-Ethylhexyl)phthalate	45 U	63 U	72 U	67 U
Di-n-Octyl Phthalate	45 U	63 U	72 U	67 U
Benzo(b)Fluoranthene	45 U	63 U	72 U	67 U
Benzo(k)Fluoranthene	45 U	63 U	72 U	67 U
Benzo(a)Pyrene	45 U	63 U	72 U	67 U
Indeno(1,2,3-cd)Pyrene	45 U	63 U	72 U	67 U
Dibenzo(a,h)Anthracene	45 U	63 U	72 U	67 U
Benzo(g,h,i)Perylene	45 U	63 U	72 U	67 U
Pest/PCB Compounds (ug/Kg dry wt)				
alpha-BHC	2 U	3 U	4 U	2 U
beta-BHC	2 U	3 U	4 U	2 U
delta-BHC	2 U	3 U	4 U	2 U
gamma-BHC (Lindane)	2 U	3 U	4 U	2 U
Heptachlor	2 U	3 U	4 U	2 U
Aldrin	2 U	3 U	4 U	2 U
Heptachlor Epoxide	2 U	3 U	4 U	2 U
Endosulfan I	2 U	3 U	4 U	2 U
Dieldrin	4 U	6 U	8 U	4 U
4,4'-DDE	4 U	6 U	8 U	4 U
Endrin	4 U	6 U	8 U	4 U
Endosulfan II	4 U	6 U	8 U	4 U
4,4'-DDD	4 U	6 U	8 U	4 U
Endosulfan Sulfate	4 U	6 U	8 U	4 U
4,4'-DDT	4 U	6 U	8 U	4 U
Methoxychlor	4 U	6 U	8 U	4 U
Endrin Ketone	4 U	6 U	8 U	4 U
alpha-Chlordane *	20 U	30 U	40 U	20 U
gamma-Chlordane *				
Toxaphene	200 U	300 U	400 U	200 U
Aroclor-1016	40 U	60 U	80 U	40 U
Aroclor-1221				
Aroclor-1232				
Aroclor-1242	40 U	60 U	80 U	40 U
Aroclor-1248	40 U	60 U	80 U	40 U
Aroclor-1254	40 U	60 U	80 U	40 U
Aroclor-1260	40 U	60 U	80 U	40 U
Endrin Aldehyde				

Appendix - Sediment Samples - Kalama Chemical, 5/88 (Continued)

Station Lab Log # Contract #	Sediment-1 Upstream 198119 1530A	Sediment-2 Outfall 198120 1530B	Sediment-3 Downstream 198121 1530C	Method Blank 0511MBS
Priority pollutant metals (mg/Kg dry wt)				
Antimony				
Arsenic	2.8	3.2	5.4	
Beryllium	0.4	0.4	0.4	
Cadmium	1.1	1.7	0.8	
Chromium	7.1	7.6	8.4	
Copper	32.4	23.4	23.1	
Lead	6.5	7.9	8.6	
Mercury	0.01	0.01	0.03	
Nickel	24.7	26.6	29.3	
Selenium	0.1	0.1	0.1 U	
Silver				
Thallium	0.1 U	0.1 U	0.1 U	
Zinc	69.2	86.1	105	

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

* total chlordane