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M E M O R A N D U M

April 14, 1986

To: Nom Glenn

Through: Bill Yake

From: Art Johnson and Dale Norton

Subject: Preliminary Plan for an Investigation of Metals Contamination in the Upper Columbia River/Franklin D. Roosevelt Lake

INTRODUCTION

A substantial amount of evidence has now accumulated showing the upper Columbia River (Grand Coulee to international border) is contaminated by several metals. Among the most significant findings are:

- o Initial monitoring for metals in upper Columbia River fish during Ecology's 1984 Basic Water Monitoring Program (BWMP) showed Northport samples had higher levels of cadmium, lead, zinc, and copper than elsewhere in the state (Hopkins, et al., 1985). One of the two edible tissue samples analyzed had 8,100 $\mu\text{g}/\text{Kg}$ lead which exceeds the Food and Drug Administration (FDA) guideline of 7,000 $\mu\text{g}/\text{Kg}$. The 1985 Northport samples have not been analyzed.
- o Northport sediment collected during the 1984 BWMP had two to three orders of magnitude higher lead, zinc, and mercury, and one order of magnitude higher cadmium, copper, and arsenic than sediment from the nine other rivers sampled (Hopkins, et al., 1985).
- o Whole fish from the Columbia River at Grand Coulee had the highest concentrations of cadmium and third highest concentrations of lead out of 112 stations sampled nationwide by the United States Fish and Wildlife Service (USFWS) in 1980-81. Zinc and arsenic concentrations in Grand Coulee fish exceeded the national 85th percentile (Lowe, et al., 1985). USFWS has not completed analysis of their most recent data from samples collected in 1983.
- o EPA water quality criteria for cadmium, lead, zinc, and copper are often exceeded in the Columbia River at Northport. Ecology has received USGS water quality alerts for metals at this site and in the Pend Oreille River, an upstream tributary.

The predominant source of metals is thought to be historical discharges by Cominco Limited's metallurgical plant at Trail, British Columbia. This facility is the largest integrated zinc-lead smelting and refining operation

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in the world (Rocchini, et al., 1979). Historical discharges by zinc-lead mills once operated in Washington near Northport (Orlob, et al., 1954) and mining and mineral deposits in drainages tributary to the upper Columbia are also potential sources.

The Toxics Surveys Unit plans to investigate this problem in 1986. The objectives of this work will be:

- o Measure metals concentrations in resident fish from the upper Columbia River/Franklin D. Roosevelt Lake, and evaluate potential hazards to humans and aquatic life.
- o Assess the relative importance of current metals loads to this reach.
- o Evaluate spatial and temporal metals concentrations gradients in bed sediments.
- o Obtain a measure of sediment toxicity through bioassay.

SAMPLING

The study area (see Figure 1) includes the 150-mile reach of the Columbia River/Franklin D. Roosevelt Lake from just below Grand Coulee Dam to the international border. Field work will be completed in three surveys between May and September of 1986.

Water quality surveys will be done May 12-16 and September 8-12. Peak runoff in this drainage occurs from spring snowmelt in April and May. This is the period of probable maximum transport of sediment and associated metals. Low flow occurs in September and is the period when adverse water quality impacts on aquatic life would most likely occur.

Table 1 shows the locations of proposed water sampling stations. Columbia River mainstem stations are Northport, and Grand Coulee Dam. Northport and Grand Coulee Dam are part of the Ecology/USGS routine monitoring network. The four major tributaries to this reach of the Columbia--Kettle, Colville, Spokane, and Sanpoil Rivers--will be sampled at Ecology/USGS routine stations except the Kettle River which will be sampled farther downstream at Orient. Collection of independent metals data at the above stations is required because past Ecology and USGS metals analyses have suffered quality control problems (Friedman, 1980). Six smaller tributaries were also selected for sampling based on the information referenced in Table 1.

Water samples will be grabs analyzed for temperature, pH (field), specific conductivity, hardness, total suspended solids, cadmium, lead, mercury, zinc, copper, arsenic, aluminum, manganese, iron, and cyanide (creeks only). Selected samples will be replicated. Metals samples (except mercury) will be filtered (0.4 micron) and acidified (HNO₃ ampoules) in the field for determination of total and dissolved concentrations. Flow data will be obtained for all stations. Table 2 shows the number of samples anticipated.

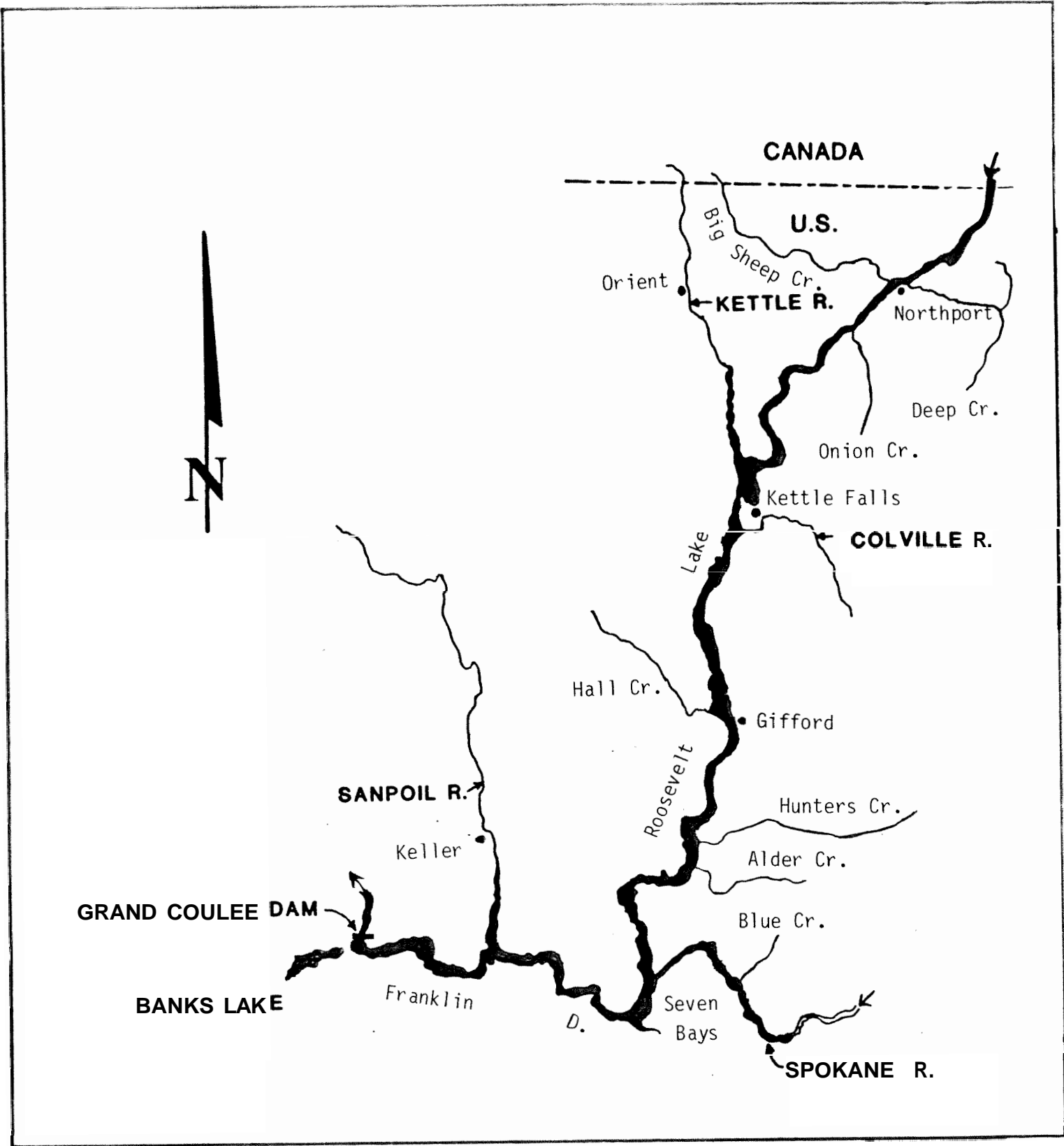


Figure 1. Proposed locations of samples to be collected during the WQIS investigation of metals in the upper Columbia River/Franklin Roosevelt Lake in 1986.

Table 1, Surface water quality stations for the WQIS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Name	Sampling Location	Station Number	River Mile	Drainage Area (mi ²)
Columbia River at Northport	Highway 25 bridge	61A070	735.1	60,200
Deep Creek ^{b,c,g}	Highway 251 bridge	--	737.0L	--
Big Sheep Creek ^d	Highway 25 bridge	--	736.7R	22.5
Onion Creek ^{a,b,g}	" " "	--	730.1L	50.5
Kettle River at Orient	to be determined	--	706.4R	4,140
Colville River near Kettle Falls	Right bank 1 mile south of Kettle Falls	59A070	699.5L	1,020
Hall Creek ^{c,e}	Bridge at Inchelium	--	677.5R	40.7
Hunters Creek ^{a,b}	Highway 25 bridge	--	659.0L	161
Alder Creek ^g	Mouth at Fruitland	--	657.0L	--
Spokane River at Long Lake	Left bank at Long Lake powerhouse	54A070	638.9	6020
Blue Creek ^f	to be determined	--	Spokane trib. mile 11	
Sanpoil River at Keller	Bridge off Highway 21	52A070	615.0	979
Columbia River at Grand Coulee Dam	Highway 155 bridge	53A070	596.3	74,700

a - mining contamination (lead, zinc) reported (Mowen, 1969)

b - bed sediments elevated in lead, zinc (Mowen, 1969)

c - cadmium deposits in drainage (Hunting, 1956)

d - zinc, copper deposits in drainage (Hunting, 1956)

e - lead, zinc deposits in drainage (Hunting, 1956)

f - USGS water quality alerts for cadmium; potential aquatic toxicity for cadmium, aluminum, and other metals (Sumioka, 1986)

g - mining contamination (Ray, 1986)

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Table 2, Surface water samples to be collected during the WQIS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Collection Date	Total Metals	Dissolved Metals	Total Suspended Solids	Specific Conduct. Hardness	Cyanide
May 12-16	15	15	15	15	8
September 8-12	<u>15</u>	<u>15</u>	<u>15</u>	<u>15</u>	<u>8</u>
Total	30	30	30	30	16

Fish bed sediments, and water column samples will be collected August 18-22. At this time, Franklin D. Roosevelt Lake will be at full pool (important for fish collections in the upper reaches at Northport) and maximum stratification. The reservoir is drawn down from January to June in preparation for spring runoff and peak power demand.

Fish will be collected by sinking gill net at Northport and Gifford and Seven Bays (four miles downstream of Spokane River confluence). Gifford and Seven Bays were selected based on recommendations by the USFWS (Nelson, 1986). The primary species of interest will be walleye (*Stizostedion vitreum*), the most important game fish in the study reach (Beckman, 1985), and largescale sucker (*Catostomus macrocheilus*) an abundant bottom-living species. Muscle tissue from walleye (and a few muscle samples from other game fish, as available) will be analyzed to evaluate metals associated risks to human health; whole largescale suckers will be analyzed to assess the potential for adverse effect on wildlife. The effects of age on cadmium, lead, and mercury accumulation in walleye muscle will be evaluated at Northport.

The distribution of fish tissue samples is shown in Table 3.

Table 3. Fish tissue samples to be collected during the WQIS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Location	Walleye Muscle	Sucker whole	Other Species† Muscle
Northport	10"	4	2
Gifford	4	4	2
Seven Bays	<u>4</u>	<u>4</u>	2
Subtotal =	18	12	6
Total =	<u>36</u>		

†Yellow perch and Lake whitefish are two probable species.

*6 for cadmium, lead, mercury only.

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Muscle and whole-fish samples will be from individual fish. Analysis will include cadmium, lead, mercury, zinc, arsenic, and percent solids. Biological data will include total length, weight, and sex. Age will be determined from length-weight relationships published for Franklin D. Roosevelt Lake (Beckman, 1985).

Sediment samples will be collected with a 0.1 m² VanVeen grab at locations shown in Table 4. The distribution of samples will be in the form of a longitudinal transect. One sample each will be replicated at Northport and Gifford. The top 2 cm will be retained for analysis. A vertical profile of metals concentrations will be obtained by gravity corer at Kettle Falls, the upper limit up the reservoir during drawdown, and Seven Bays, in an attempt to determine the history of contamination. Sediment analysis will be for cadmium, lead, mercury, zinc, copper, arsenic, aluminum, manganese, iron, grain size, total non-volatile solids, and percent solids. Core increments will be dated by ¹³⁷Cs activity.

Table 4. Sediment samples to be collected during the WQIS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Location	Surface Sediment	Vertical Profile
Northport [†]	3	
Northport mill sites (2)	2	
Kettle Falls [†]	2	5
Gifford [†]	3	
Seven Bays [†]	2	5
Grand Coulee forebay [†]	1	
Selected tributaries*?	4	
	Subtotal = 17	Subtotal = 10
	Total = 27	

[†]bioassay

*selection to be based on results of May water quality survey

Sediment bioassays using the cladoceran Daphnia pulex and the amphipod Hyaella azteca will be done on sample aliquots from the six sites indicated in Table 4. A reference station (low metals concentrations in sediment) will be selected through analysis of several tributary sediments collected during the May water quality survey. The Daphnia bioassay is a 48-hour elutriate test, in this case intended to reflect the availability and toxicity of sediment associated metals. The Hyaella bioassay is a 10-day test in which the amphipods remain in contact with the sediment. Each sample will be tested in triplicate. Elutriate and bioassay water will be Manchester dechlorinated tap water. Sufficient excess sample will be collected at sites with the highest probability of toxicity to enable follow-up dilution bioassays.

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Water column sampling will consist of one profile each at Kettle Falls and Seven Bays. Sampling will be done with a 10-liter, teflon-lined "go-flo" bottle. Duplicate samples from each cast will be analyzed for temperature, pH (field), dissolved oxygen (field), conductivity, hardness, nutrients, total suspended solids, cadmium, lead, mercury, zinc, copper, arsenic, aluminum, manganese, and iron (total and dissolved metals). Sampling depths will be selected on the basis of temperature profiles obtained with a bathythermograph. The estimated numbers of water samples to be generated are shown in Table 5.

Table 5. Water column samples to be collected during WQIS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Location	Metals		Conductivity, Hardness, Nutrients, Solids
	Total	Dissolved	
Kettle Falls	6	6	6
Seven Bays	<u>3</u>	<u>3</u>	<u>3</u>
Subtotal =	9	9	9

3 depths; Kettle Falls samples replicated

A summary of the proposed sampling program is shown in Table 6.

QUALITY ASSURANCE

Metals analyses for these surveys will be done by Steve Twiss of the Ecology/EPA Manchester laboratory. The accuracy and precision of the analyses will be assessed by analysis of standard reference materials, spikes, and duplicate samples. Table 7 shows the reference materials to be analyzed.

Table 7. Reference materials to be analyzed by the Ecology/EPA Manchester laboratory for Ecology's survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Sample Type	Analytes
NBS-SRM 1642 Mercury in Water	Mercury
" " 1643 Trace Elements in Water	Arsenic, cadmium, copper, iron, lead, manganese, zinc, and others
" " 1645 River Sediment	Aluminum, iron, zinc, cadmium, copper, lead, lead, manganese, mercury, and others
NBS-RM 50 Albacore Tuna	Mercury, zinc, arsenic, lead, and others

Table 6. Summary of sample analyses required for WQIS survey of metals in upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Sample Location	Water Samples				Water Samples				Water Samples				Tissue Samples			Sediment Samples			
	May 12 - 16				September 8-12				August 18 - 22				August 18 - 22			August 18 - 22			
	MtIs (9)	TSS	Spec. Cond. Hard.	Cyan.	MtIs (9)	TSS	Spec. Cond. Hard.	Cyan.	MtIs (9)	TSS, Sp. Cond., Hard., Nutr.	MtIs (5)	MtIs (3)	% Solids	MtIs (9)	Grain Size	TNVS	% Solids	Daphnid bioassay	Amphipod bioassay
Columbia R. @ Northport	4	2	2		4	2	2				10	6	16	5	5	5	5	1	1
Deep Creek	2	1	1	1	2	1	1	1											
Big Sheep Creek	2	1	1	1	2	1	1	1											
Onion Creek	4	2	2	2	4	2	2	2						(1)	(1)	(1)	(1)		
Kettle River	2	1	1		2	1	1												
Columbia R. @ Kettle Falls									12	6				7	7	7	7	1	1
Colville River	2	1	1		2	1	1							(1)	(1)	(1)	(1)	(1)	(1)
Columbia R. @ Gifford											10		10	3	3	3	3	1	1
Hall Creek	2	1	1	1	2	1	1	1											
Hunters Creek	2	1	1	1	2	1	1	1						(1)	(1)	(1)	(1)		
Alder Creek	2	1	1	1	2	1	1	1											
Blue Creek	2	1	1	1	2	1	1	1						(1)	(1)	(1)	(1)		
Spokane River	2	1	1		2	1	1												
Columbia R. @ Seven Bays									6	3	10		10	7	7	7	7	1	1
Sanpoil River	2	1	1		2	1	1												
Columbia R. Grand Coulee forebay														1	1	1	1	1	1
Columbia R. blw. Grand Coulee	<u>2</u>	<u>1</u>	<u>1</u>	<u>—</u>	<u>2</u>	<u>1</u>	<u>1</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>
Total =	30	15	15	8	30	15	15	8	18	9	30	6	36	27	27	27	27	6	6

NOTE: metals QA samples (approximately 10 percent) not shown

Metals (9) = cadmium, lead, mercury, zinc, copper, arsenic, aluminum, manganese, iron

Metals (5) = cadmium, lead, mercury, zinc, arsenic

Metals (3) = cadmium, lead, mercury

†parenthesis indicates tentative location of sample

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Field and methods blanks will be analyzed for each sample collection. The ability of the system selected to filter water without introducing contamination has been documented (Norton and Johnson, 1985).

The Manchester laboratory has had chronic problems analyzing water samples without introducing contamination by lead, zinc, copper, and other metals. Filtering and acidifying in the field, use of sample containers prepared by a rigorous acidleaching procedure (Moody, *et al.*: 1977), and analysis by direct aspiration at Manchester are three steps intended to eliminate these problems. The results obtained by these procedures will be field-tested before use on the Columbia.

Manchester has also recently shown poor accuracy in mercury analysis of fish tissue. This problem is not yet resolved. The services of a contract laboratory may be needed.

COSTS

The special items shown in Table 8 will be needed to satisfactorily complete the survey:

TARGET COMPLETION DATES

<u>Date</u>	<u>Activity</u>	<u>Personnel</u>
<u>1986</u>		
May 12-16	high-flow water quality survey	Johnson/Norton
June 30	data report	Manchester lab
August 18-22	fish, sed., water column sampling	Johnson/Norton/Yake
September 8-12	low-flow water quality survey	Johnson/Norton
October 31	data report	Manchester lab
<u>1987</u>		
March	draft report	Johnson/Norton
May	final report	Johnson/Norton

AJ:DN:cp

Attachment

Table 8. Equipment, supplies, and services required for WQS survey of metals in the upper Columbia River/Franklin D. Roosevelt Lake in 1986.

Item	Number	Vendor	Cost
Sinking gill net (250' x 6', variable mesh)	2	Eastside Net Shop, Bothell	\$ 480
137Cs analysis	10	Dr. A. Nevissi, Univ. of Wash.	\$ 600
Bathythermograph rental	1 week	Dept. of Oceanography, Univ. of Wash.	\$ 14
Bathythermograph slides	6	" " " " " "	\$ 12
Reversing thermometers and rack rental	1 unit	" " " " " "	\$ 40
Corer rental	1 week	" " " " " "	\$ 35
Core liners	6 (4' ea)	" " " " " "	\$ 24
Reference materials:			
SRM 1645 River Sediment	1	Office of Std. Ref. Materials, National Bureau of Standards, Gaithersburg, MD	\$ 118
SRM 1642 Mercury in Water	1	"	\$ 156
SRM 1643b Trace Elements in Water	1	"	\$ 165
RM 50 Albacore Tuna	1	"	\$ 85
Electric winch modification	1	Zeiglers Welding, Olympia	\$ 250 est
Hydrowire	100 meters	Kahlsico Int. Corp., El Cajon, CA	\$ 184
Nucleopore filters (0.4 micron)	50	Nucleopore Corp., Pleasanton, CA	\$ 135
Total =			\$2,398

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