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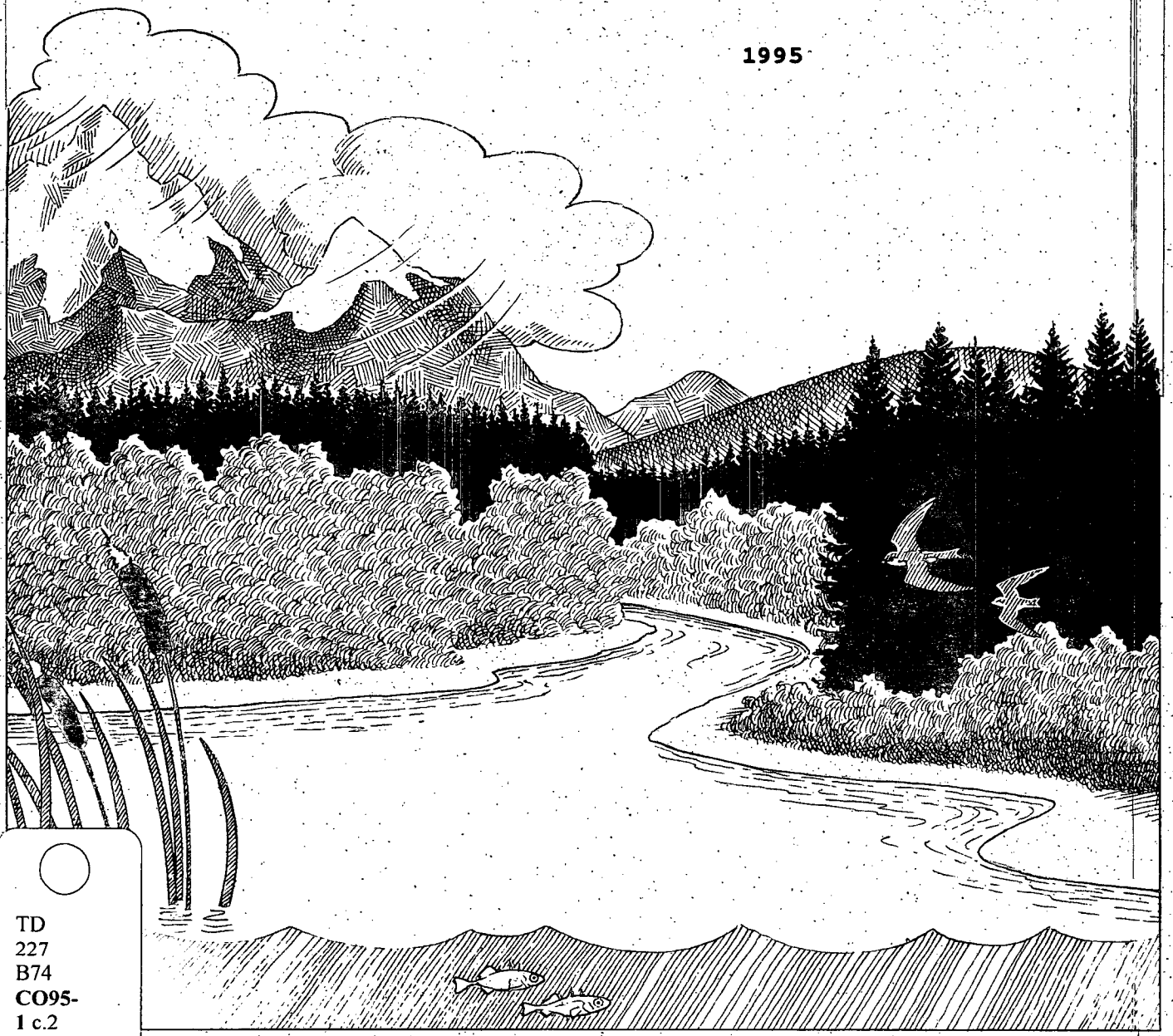
SCIENCE DIVISION

COLUMBIA RIVER INTEGRATED ENVIRONMENTAL MONITORING PROGRAM (CRIEMP) 1991-1993

SAMPLING AUDIT BY ENVIRONMENT CANADA IN 1991 AND 1992

Thomas-Louis Tremblay and Gail Moyle

1995



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Columbia River Integrated Monitoring Program (CRIEMP) 1991-1993 : sampling audit by Environment Canada

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Environmental Conservation Branch
Environment Canada
Pacific and Yukon Region
North Vancouver, B.C.
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ABSTRACT

In 1991 and 1992, Environment Canada audited three components of the sampling program carried out through the Columbia River Integrated Environmental Monitoring Program (CRIEMP) 1991-93, to assess the quality of the collected data. These components were water quality sampling in ambient waters, bed sediment sampling, and emergent insect (caddisfly) sampling. For each component, a team from Environment Canada and another team working for CRIEMP collected their respective samples side by side. The samples of each party were then analyzed at the laboratories normally used by this party. Subsamples were also exchanged in the field between the parties to allow cross-comparisons of sampling and analytical practices.

This report presents the procedures used by both parties and the analytical data obtained for these audits. The data generally show good agreement between CRIEMP and Environment Canada results.

RESUME

En 1991-1992, Environnement Canada a été chargé de contrôler trois composantes de l'échantillonnage effectué pour le compte du programme intégré de surveillance de l'environnement du fleuve Columbia (Columbia River Integrated Environmental Monitoring Program - CRIEMP) (1991-1993), afin d'évaluer la qualité des données recueillies. Ces composantes étaient la surveillance continue de la qualité des eaux ambiantes, l'échantillonnage des sédiments de fond, et l'échantillonnage des insectes adultes émergeant du fleuve. Pour chacune de ces composantes, une équipe d'Environnement Canada et une équipe travaillant pour le CRIEMP ont effectué l'échantillonnage côte à côte. Les échantillons de chaque partie ont ensuite été analysés par les laboratoires normalement utilisés par cette partie. Les deux parties ont aussi échangé des portions d'échantillons sur le terrain pour comparer leurs méthodes d'échantillonnage et d'analyse.

Le présent rapport compare les procédures utilisées et les résultats obtenus par chaque partie pour chacune des composantes. En général, les résultats d'Environnement Canada et du CRIEMP sont semblables.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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INTRODUCTION

The Columbia River Integrated Environmental Monitoring Program, 1991-1993 (CRIEMP 1991-1993) was implemented in the Columbia River from the Hugh Keenleyside Dam to the International Boundary from September 1991 to March 1993. The program was supported by three levels of government (federal, provincial and municipal) and by industry (BC Hydro, Celgar Pulp Company and Cominco) to integrate their individual monitoring requirements into a common program.

Sampling for the different components of this program was conducted by several CRIEMP parties and a consultant; the samples were analyzed at private laboratories. To enhance the credibility of the data from these diverse sources, Environment Canada audited three components of the program to provide independent measures for these components, in terms of sampling and analysis. Environment Canada has previous experience in sampling environmental media for contaminant analysis.

Sampling for water quality was audited in November 1991; sampling for emergent insects, in July 1992; and sampling for bed sediments, in September 1992. For all three audits, EC staff took samples side by side with the CRIEMP routine collectors (for water quality) or with the CRIEMP consultants (for emergent insects and bed sediments).

This report presents the results of these three audits. Each audit is presented in its own chapter.

CHAPTER 1

WATER QUALITY SAMPLING AUDIT

I. INTRODUCTION

The water quality monitoring component of CRIEMP 1991-1993 was conducted from September 1991 to October 1992. CRIEMP staff collected water samples at six stations at a frequency varying from weekly to bimonthly, depending on the station and variable. CRIEMP collected water samples at two of the stations (Birchbank and Waneta) according to the methods used for water quality sampling under the Canada-British Columbia Water Quality Monitoring Agreement ("federal-provincial methods"). At the remaining four stations, CRIEMP sampling was conducted according to methods followed by the British Columbia Ministry of Environment, Lands and Parks (BCELP).

As part of the quality assurance for the water quality monitoring, Environment Canada (EC) conducted a field sampling and analytical audit on November 26, 1991 at three of the six CRIEMP sampling stations. On that date, CRIEMP staff sampled all three stations using BCELP sampling and analytical methods, as well as the federal-provincial methods. EC staff conducted the audit by taking water samples side by side with the routine CRIEMP water collectors.

Results of this audit are presented below. Methods used and analytical results obtained by EC will be compared to those of the routine CRIEMP monitoring.

II. SAMPLING SITES

The three CRIEMP water quality sampling sites audited by Environment Canada on November 26, 1991 are shown on Figure 1-1 and are described in Table 1-1.

Figure 1-1

Map of the Columbia River north of the International Boundary illustrating the sites where water samples were collected during the CRIEMP water quality sampling audit (November 26, 1991)

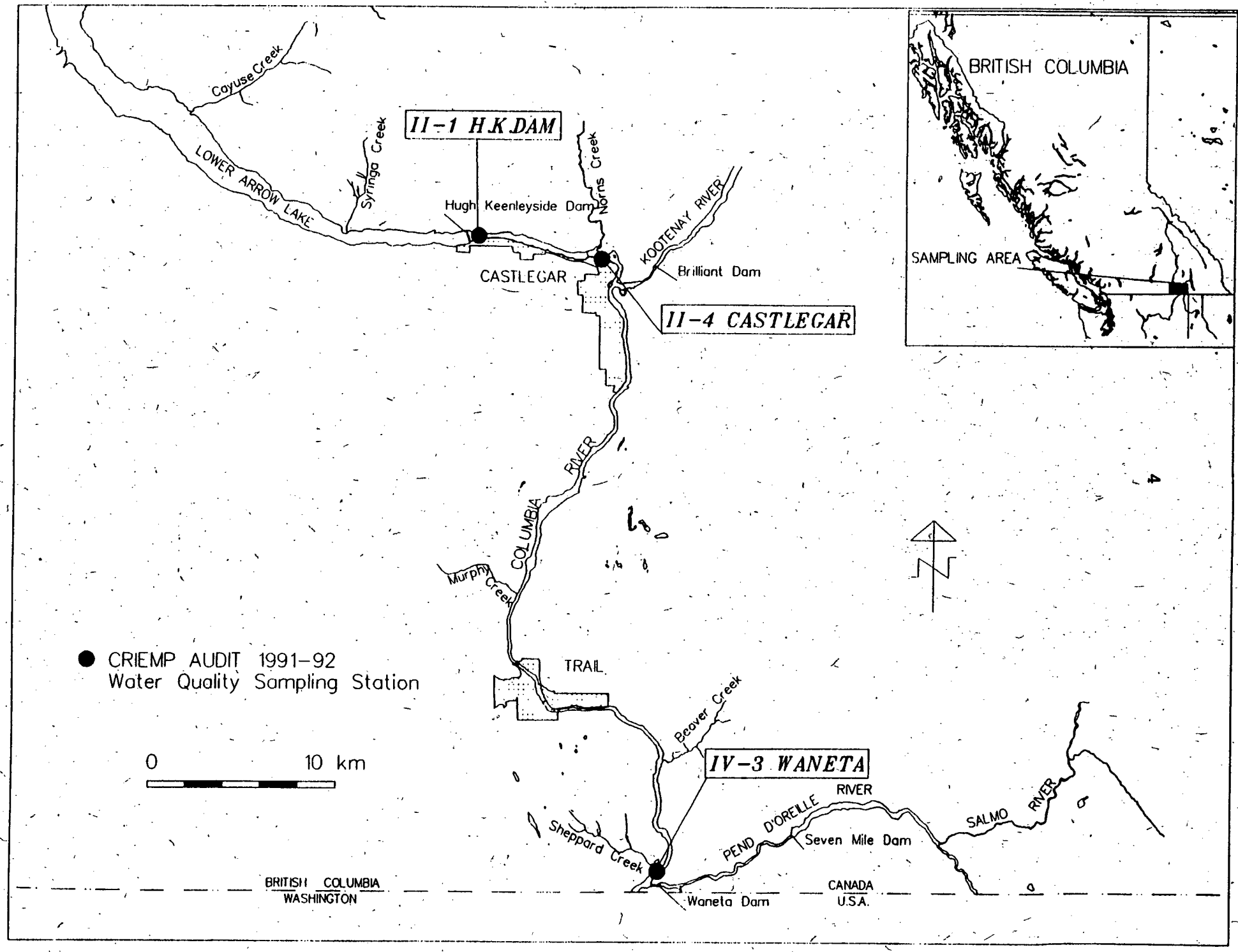
BRITISH COLUMBIA
SAMPLING AREA
Coyuse Creek
LOWER ARROW LAKE
Syringa Creek
II-1 H.K.DAM
Hugh Keenleyside Dam
Norns Creek
KOOTENAY RIVER
Brilliant Dam
CASTLEGAR
II-4 CASTLEGAR
COLUMBIA RIVER
Murphy Creek
CRIEMP AUDIT 1991-92
Water Quality Sampling Station
TRAIL
Beaver Creek
IV-3 WANETA
0
10 km
RIVER
PEND D'OREILLE
Seven Mile Dam
SALMO RIVER
Sheppard Creek
BRITISH COLUMBIA
WASHINGTON
Waneta Dam
CANADA
U.S.A.

TABLE 1-1

LOCATIONS OF CRIEMP WATER QUALITY SAMPLING STATIONS AUDITED ON NOVEMBER 26, 1991

CRIEMP Station #	Station Name	Station Location	Land Access
II-1	H. K. DAM Columbia River below the Hugh Keenleyside Dam	Left bank of the Columbia River, 0.8 km below the dam Lat. 49°20'32" N Long. 117°45'58" W	Via Broadwater Road and a secondary road about 1 km downstream of the dam
II-4	CASTLEGAR Columbia River upstream of Kootenay River	Right bank, near downtown Castlegar Lat. 49°19'37" N Long. 117°39'13" W	At the eastern end of Third Street in Castlegar, via a secondary street to the North
IV-3	WANETA Columbia River at Waneta	Left bank, 0.4 km upstream of the Pend d'Oreille River confluence, at the federal/ provincial water quality station Lat. 49°00'34" N Long. 117°36'47" W	West side of Highway 22A, by the Cominco monitoring station

III. METHODS

A) Field sampling

At each station, sampling was conducted from a river boat. Samples were collected from the upstream side of the boat and, as much as possible, upwind of the exhaust.

Water samples were taken as simultaneously as possible by EC and CRIEMP collectors working side by side. Figure 1-2 presents a schematic of the collection/analytical methods used for the audit. At each station, EC staff collected three replicate samples for all variables, except total chlorinated phenols, for which one sample per station was collected.

CRIEMP collectors measured water pH in the field with a hand-held pH meter. EC staff did not do so.

For this sampling, the CRIEMP collectors took samples at all three stations for general variables and nutrients using BCELP methods. Single samples were collected below the Hugh Keenleyside Dam ("H.K. Dam") and at Castlegar, and triplicate samples were collected at Waneta. At Waneta only, CRIEMP collectors also took triplicate samples for heavy metals analysis using the BCELP methods. Samples for metals were routinely collected at the other two stations once every two months. Due to a communication problem, the audit was not conducted on a day when samples for metals were taken at these stations.

For this sampling, the CRIEMP collectors also took samples for all variables (except chlorinated phenols) at all three stations using the federal-provincial methods. At each station, triplicate samples were taken for general variables and metals, and nine replicate samples were taken for nutrients.

Table 1-2 describes the pre-trip preparation of the sampling bottles. It also compares the procedures used by EC and CRIEMP for sample collection and preservation.

Field blanks were taken by EC and CRIEMP. They were made by filling sample bottles with distilled water in the laboratory before the trip. These bottles were taken to the sampling stations and handled exactly as sample bottles, short of filling them with river water. EC analyzed from one to three field blanks for all variables (except colour) at each station. CRIEMP analyzed single blanks for most variables at the H.K. Dam and at Waneta.

EC field staff also made laboratory blanks before the sampling trip for all variables except colour. These blanks were prepared as the field blanks, but remained in the laboratory.

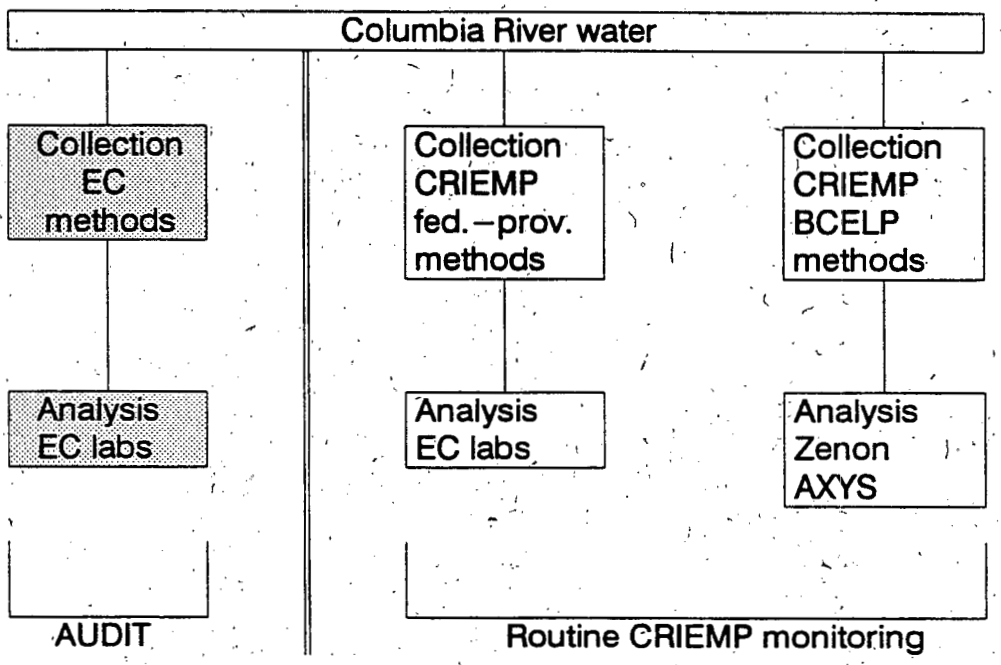

FIGURE 1–2

SUMMARY OF WATER SAMPLE COLLECTION AND ANALYSIS FOR THE CRIEMP WATER QUALITY SAMPLING AUDIT (NOVEMBER 26, 1991)

TABLE 1-2 SAMPLING METHODS USED BY ENVIRONMENT CANADA AND CRIEMP FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT

Variables	Environment Canada methods	CRIEMP using BCELP methods	CRIEMP using federal-provincial methods
General variables (physical variables and major ions)	Samples were collected in 500 mL polyethylene bottles which had been washed with soap and rinsed with deionised water. The bottles were placed into a multiple sampler (1) (previously rinsed once in the river), rinsed three times in the river, and filled. The caps were rinsed three times with river water. The bottles were recapped and kept cold and dark. The samples were analysed within 72 hours.	Samples were collected in new unwashed 2 L polyethylene bottles that had been rinsed with deionised water. Sampling staff wore plastic gloves. The bottle cap was removed and left in a plastic bag. The bottle was submerged by hand until filled, then recapped. The sample was kept cold and dark, and was analysed within 72 hours. The pH was measured on site with a hand-held pH meter.	Samples were collected in 500 mL polyethylene bottles which had been washed with soap and rinsed with deionised water. The bottles were put into a multiple sampler (1) (previously rinsed once in the river), filled (without rinsing), and recapped. The samples were kept cold and dark, and were analysed within 72 hours.
Nitrogen species	Samples were collected in 100 mL and 200 mL polyethylene bottles which had been washed with soap and then rinsed with deionised water. The bottles were placed into a multiple sampler (1) (previously rinsed once in the river), rinsed three times in the river, and filled. The caps were rinsed three times with river water. The 100 mL bottles ("unfiltered" samples) were kept cold and dark. The "field-filtered" samples (200 mL bottles) were filtered in the mobile laboratory within one hour of collection. These samples were filtered under vacuum through 0.45 um pore size cellulose acetate filters (pre-soaked in 0.1% V/V hydrochloric acid), using sulphuric acid-washed glass filtering funnel and flask. A new filter was used for each sample. Each filtrate was poured into a 100 mL bottle which had been rinsed three times with the filtrate. These "field-filtered" samples were also kept cold and dark. All samples were analysed within 72 hours.	These variables were analysed from the same sample as the General Variables (see above).	Samples were collected in 100 mL polyethylene bottles which had been washed with soap, then rinsed with deionised water. The bottles were placed into a multiple sampler (previously rinsed once in the river) and the caps were taken off. The bottles were filled, the recapped. The samples were kept cold and dark, and were analysed within 72 hours.
Phosphorus species	Water samples were collected in 50 and 100 mL borosilicate glass bottles which had been washed with phosphate-free soap and rinsed with deionised water. Teflon-lined caps were used for these bottles. The bottles were placed into a multiple sampler (1) previously rinsed once in the river), rinsed three times in the river and filled. The caps were rinsed three times with river water. The 50 mL bottles ("unfiltered" samples were kept cold and dark. The "field-filtered" samples (100 mL) were filtered in the mobile laboratory within one hour of collection. The samples were filtered under pressure through filtering kits which consisted of hydrochloric acid-washed polycarbonate filter holders containing 0.45 um pore size cellulose acetate filters (pre-soaked in deionised water), coupled to acid-washed polypropylene syringes. Each kit was used for only one sample. The sample was filtered into a 50 mL bottle which had been rinsed three times with the filtrate. These "field-filtered" samples were also kept cold and dark. All samples were analysed within 72 hours.	These variables were analysed from the same sample as the General Variables (see above).	Samples were collected in 50 mL borosilicate glass bottles which had been washed with phosphate-free soap and rinsed with deionised water. Teflon-lined caps were used for these bottles. The bottles were placed into a multiple sampler (1) (previously rinsed once in the river), the caps were taken off, and the bottles were filled and recapped. The samples were kept cold and dark, and were analysed within 72 hours.

(1) Multiple sampler: an acrylic, PVC and stainless steel frame designed to hold several sampling bottles

TABLE 1-2 (CONT'D)

Variables	Environment Canada methods	CRIEMP using BCELP methods	CRIEMP using federal-provincial methods
Total metals	Samples were collected in 500 mL polyethylene bottles which had been washed with soap, rinsed with deionised water, soaked in nitric acid and rinsed with deionised water. These bottles were placed into a multiple sampler (1) (previously rinsed once in the river), rinsed three times in the river, and filled. The caps were rinsed three times with river water. Each sample was preserved with 2 mL of 50% nitric acid. The samples were analysed within a month.	Samples were collected in 250 mL high density polyethylene bottles which had been washed by the supplier (Environmental Sampling Supply) with soap, nitric acid and deionised water. The preservative glass vials (5 mL) had been acid-washed by Zenon; each vial contained 2 mL of analytical grade nitric acid. Sampling staff wore plastic gloves. The bottle cap was removed and left in a plastic bag. The bottle was submerged by hand until filled. The preservative was added and the bottle was recapped. The sample was analysed within a month.	Samples were collected in 500 mL polyethylene bottles which had been washed with soap, rinsed with deionised water, soaked in nitric acid and rinsed with deionised water. These bottles were put into a multiple sampler (1) (previously rinsed once in the river) and filled. The preservatives (2 mL per sample of 50% nitric acid in acid-washed vials) were added and the bottles were recapped. The samples were analysed within a month.
Arsenic/Selenium (total)	Samples were collected in 125 mL polyethylene bottles which had been washed with soap and rinsed with deionised water. These bottles were put into a multiple sampler (previously rinsed once in the river), rinsed three times in the river, and filled. The caps were rinsed three times with river water and put back on the bottles. The samples were kept cold and dark, and were analysed within a month.	These variables were analysed from the same sample as the Total Metals (see above).	Samples were collected in 125 mL polyethylene bottles which had been washed with soap and rinsed with deionised water. These bottles were put into a multiple sampler (previously rinsed once in the river). The caps were taken off and the bottles were filled, then recapped. The samples were kept cold and dark, and were analysed within a month.
Total Mercury	Samples were collected in 100 mL Teflon bottles which had been washed with soap, rinsed with deionised water, soaked in nitric acid and rinsed with deionised water. These bottles were put into a multiple sampler (1) (previously rinsed once in the river), rinsed three times, and filled. The caps were rinsed three times with river water. Each sample was preserved with 2 mL of Mercury Preservative (50% V/V sulphuric acid-2.5% W/V potassium dichromate), and the bottles were recapped. The samples were analysed within a month.	Samples were collected in 1 L glass bottles which had been washed by the manufacturer (Eagle Picher) with detergent, nitric acid, deionised water and hexane. The preservatives (6 mL of 10% W/V potassium dichromate and 6 mL of concentrated sulphuric acid) were contained in nitric acid-washed 8 mL glass vials. Sampling staff wore plastic gloves when sampling. The bottle cap was removed and left in a plastic bag. The bottle was submerged by hand until filled. The sample was preserved with the solutions described above and the bottle was recapped. The sample was analysed within a month.	Samples were collected in 100 mL Teflon bottles which had been washed with soap, rinsed with deionised water, soaked in nitric acid and rinsed with deionised water. These bottles were put into a multiple sampler (1) (previously rinsed once in the river). The caps were taken off and the bottles were filled. Each sample was preserved with 2 mL of Mercury Preservative (50% V/V sulphuric acid - 2.5% W/V potassium dichromate) and the bottles were recapped. The samples were analysed within a month.
Chlorinated phenols (total)	Samples were collected in 1 L amber glass bottles which had been washed by the manufacturer (Eagle Picher) with detergent, nitric acid and hexane. The bottle was put into a Frame sampler (2) (previously rinsed once in the river), rinsed three times in the river, and filled. The caps were rinsed three times with river water. Each sample was preserved with 5 mL of sulphuric acid (50% V/V - previously extracted with dichloromethane) and recapped. The samples were analysed within three weeks.	Samples were collected in 4 L amber glass bottles which had been washed with a detergent, rinsed with deionised water and baked at 350 degC for 6 hours. Sampling staff wore plastic gloves when sampling. The bottle cap was removed and left in a plastic bag. The bottle was submerged by hand until filled, then recapped. The sample was kept in a cooler along with ice packs, sent to AXYS and analysed as quickly as possible.	not done

(1) Multiple sampler: an acrylic, PVC and stainless steel frame designed to hold several sampling bottles

(2) Frame sampler: a steel frame designed to hold a single bottle

B) Analytical methods

Samples taken by EC collectors, as well as the samples taken by CRIEMP collectors using federal-provincial methods, were analyzed at the EC laboratories. General variables and nutrients were analyzed at the Pacific and Yukon Region Conservation and Protection Laboratory in West Vancouver, B.C., according to methods described in Environment Canada (1979-1981) and some unpublished updated methods. Heavy metals and total chlorinated phenols were analyzed at the National Laboratory for Environmental Testing (NLET) in Burlington, Ontario, using some unpublished methods listed in the ENVIRODAT Provisional Dictionary of Codes (1993).

CRIEMP samples collected using the BCELP methods were analyzed at Zenon and AXYS laboratories, located respectively in Burnaby and Saanich, B.C. General variables, nutrients and heavy metals were analyzed by Zenon according to methods described in Zenon (1976) and unpublished updated methods. Total chlorinated phenols were analyzed at AXYS according to methods summarised in Baturin (1993).

Table 1-3 presents the analytical methods and the detection limits used for general variables, nutrients and metals by the EC and Zenon laboratories.

TABLE 1–3 ANALYTICAL METHODS AND DETECTION LIMITS USED FOR THE ENVIRONMENT CANADA AND CRIEMP WATER SAMPLES FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT

Variable	Environment Canada				CRIEMP–ZENON			
	NAQUADAT Code	Method	Detection limit	Unit	Zenon Number	Method	Detection limit	Unit
General Variables								
Alkalinity (total)	10101	El.–pH4.5	0.5	mg CaCO3 /L	1020101	El.–pH4.5	0.5	mg CaCO3 /L
Chloride–dissolved	17206	Autoanal.	0.2	mg/L	1041702	Autoanal.	0.5	mg/L
Colour (apparent)	02011	Visual	––	––	0010101	Visual	1	Col. unit
Colour (true)	not done	––	––	––	0022101	Visual	5	Col. unit
Colour (TAC)	not done	––	––	––	0241701	Spectro.	1	TAC unit
Conductivity	02041	Meter	2	µS/cm	0110101	Meter	1	µS/cm
Calcium–total	––	ICP	0.1	mg/L	––	ICP	0.02	mg/L
Magnesium–total	––	ICP	0.1	mg/L	––	ICP	0.02	mg/L
Sodium–total	––	ICP	0.1	mg/L	––	ICP	0.5	mg/L
Silicon–total	––	ICP	0.05	mg/L	1201702	Silica	0.2	mg SiO2 /L
Potassium–total	19105	ICP	0.01	mg/L	2641703	Autoanal.	0.1	mg/L
Hardness–cal'd	10602	ICP	0.4	mg CaCO3 /L	––	ICP	0.1	mg CaCO3 /L
pH	10301	Meter	––	––	0040101	Meter	––	––
Sulphate	––	Autoanal.	0.5	mg/L	––	Autoanal.	1.0	mg/L
Nutrients								
Ammonia	07555	Autoanal.	0.002	mg N /L	1081704	Autoanal.	0.005	mg N /L
Nitrate/Nitrite	07110	Autoanal.	0.002	mg N /L	1091703	Autoanal.	0.02	mg N /L
Total dissolved N	07655	Autoanal.	0.02	mg N /L	not done	––	––	––
Total N (measured)	07655	Autoanal.	0.02	mg N /L	not done	––	––	––
Total N (computed)	not done	––	––	––	1130105 plus 1091703	Autoanal. Autoanal.	0.04 0.02	mg N /L mg N /L
Ortho–Phosphorus	15256	Autoanal.	0.002	mg P /L	1181703	Autoanal.	0.003	mg P /L
Total Phosphorus	15406	Autoanal.	0.002	mg P /L	1190103	Autoanal.	0.003	mg P /L
Total dissolved P	15102	Autoanal.	0.002	mg P /L	1191703	Autoanal.	0.003	mg P /L
Total Heavy Metals								
Aluminum	13009	ICP	0.002	mg/L	––	ICP	0.02	mg/L
Barium	56009	ICP	0.0002	mg/L	––	ICP	0.001	mg/L
Beryllium	04010	ICP	0.05	µg/L	––	not done		
Cadmium	48009	ICP	0.0001	mg/L	––	GFAA	0.0005	mg/L
Cobalt	27009	ICP	0.0001	mg/L	––	ICP	0.003	mg/L
Chromium	24009	ICP	0.0002	mg/L	––	ICP	0.002	mg/L
Copper	29009	ICP	0.0002	mg/L	––	ICP	0.001	mg/L
Iron	26009	ICP	0.002	mg/L	––	ICP	0.003	mg/L
Lithium	03009	ICP	0.0001	mg/L	––	not done		mg/L
Manganese	25010	ICP	0.0001	mg/L	––	ICP	(0.001–0.002)	mg/L
Molybdenum	42009	ICP	0.0001	mg/L	––	ICP	0.004	mg/L
Nickel	28009	ICP	0.0002	mg/L	––	ICP	0.008	mg/L
Lead	82009	ICP	0.0002	mg/L	––	GFAAS	0.001	mg/L
Strontium	38009	ICP	0.0001	mg/L	––	not done		mg/L
Vanadium	23009	ICP	0.0001	mg/L	––	ICP	0.003	mg/L
Zinc	30009	ICP	0.0002	mg/L	––	ICP	0.002	mg/L
Arsenic	33008	ICP	0.0001	mg/L	––	Hydr. ICP	0.001	mg/L
Selenium	34008	ICP	0.0001	mg/L	––	Hydr. ICP	0.03	mg/L
Mercury	80011	C.V. ICP	0.01	µg/L	––	C.V. AAS	0.05	µg/L
Thallium	––	ICP	0.002	mg/L	––	ICP	0.003	mg/L

C.V.: Cold Vapour

C.V.: Cold Vapour

IV. RESULTS AND DISCUSSION

A) Blanks

Table 1-4 presents the analytical results from the laboratory and field blanks. The laboratory blanks were prepared and analyzed by Environment Canada (EC) only. Both EC and CRIEMP prepared and analyzed field blanks.

The results of the EC laboratory blanks suggest some slight contamination for total nitrogen and some metals (aluminum, cobalt, iron, molybdenum and nickel). Either the deionised water or the sampling bottles (or both) could be the source of this problem. Except for nickel and iron, the concentrations detected in the bottles were well below levels measured in the environmental samples. For nickel and iron, the measured levels of contamination would affect the environmental results.

Data for the EC field blanks suggest some slight contamination for sulphate, ammonia, nitrate/nitrite, total nitrogen, ortho-phosphorus, total dissolved phosphorus, aluminum, barium, cadmium, cobalt, iron, manganese, nickel and arsenic. However, most values measured in EC field blanks for nitrogen and heavy metals were lower than the Zenon detection limits for these variables.

The CRIEMP field blanks for General Variables showed some contamination for conductivity, alkalinity and sulphate. This may be a reflection of the bottle preparation. The bottles used by CRIEMP for General Variables were not washed with soap prior to sampling, but were simply rinsed with deionised water. The CRIEMP field blanks for copper and mercury also showed some contamination.

In general, the levels in the field blanks for CRIEMP and EC were lower than in the environmental samples. Notable exceptions were some EC measurements for ortho-phosphorus, total dissolved phosphorus, iron, nickel and arsenic, and some CRIEMP measurements for copper and mercury.

B) Field samples

Table 1-5 presents the data for all variables, and Table 1-6 presents qualitative comparisons between the sampling/analytical methods. These comparisons were not done by statistical methods, due to the small data sets for most variables.

Of the three audited stations, Waneta was sampled most completely. At Waneta, all three sampling methods (CRIEMP sampling

TABLE 1–4 RESULTS OF LABORATORY BLANKS FOR ENVIRONMENT CANADA (EC) AND FIELD BLANKS FOR EC AND CRIEMP FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT

A) GENERAL VARIABLES

Variable	EC laboratory blank	Field blanks		
		Location	EC	CRIEMP BCELP
pH (laboratory)	5.70	H. K. Dam	5.78	
		Castlegar	5.86	
		Waneta	5.87 5.78	7.2
CONDUCTIVITY uS/cm	<2	H. K. Dam	<2	2
		Castlegar	<2	
		Waneta	<2 <2	2
COLOUR (TAC) Rel. units		H. K. Dam		<1
		Castlegar		
		Waneta		2
ALKALINITY mg CaCO3 /L	<0.5	H. K. Dam	<0.5	1.9
		Castlegar	<0.5	
		Waneta	<0.5 <0.5	1.9
CALCIUM–d mg/L	<0.1	H. K. Dam	<0.1	
		Castlegar	<0.1	
		Waneta	<0.1 <0.1	<0.02
MAGNESIUM–d mg/L	<0.1	H. K. Dam	<0.1	
		Castlegar	<0.1	
		Waneta	<0.1 <0.1	<0.02
HARDNESS–cal. mg CaCO3 /L	<0.4	H. K. Dam	<0.4	
		Castlegar	<0.4	
		Waneta	<0.4 <0.4	<0.1
CHLORIDE mg/L	<0.2	H. K. Dam	<0.2	<0.5
		Castlegar	<0.2	
		Waneta	<0.2 <0.2	<0.5
SODIUM–d mg/L	<0.1	H. K. Dam	<0.1	<0.5
		Castlegar	<0.1	
		Waneta	<0.1 <0.1	<0.5
POTASSIUM–d mg/L	<0.01	H. K. Dam	<0.01	<0.1
		Castlegar	<0.01	
		Waneta	<0.01 <0.01	<0.1
SULPHATE mg/L	<0.5	H. K. Dam	<0.5	1
		Castlegar	0.8	
		Waneta	<0.5 <0.5	<1
SILICON mg/L	<0.05	H. K. Dam	<0.05	<0.2 *
		Castlegar	<0.05	
		Waneta	<0.05 <0.05	<0.2 *

* Zenon measured reactive silica – the CRIEMP–BCELP values were readjusted to SILICON by multiplying the reactive silica data by (28/60)

TABLE 1–4 (CONT'D)

8) NUTRIENTS

Variable	EC laboratory blank	Field blanks		
		Location	EC	CRIEMP BCELP
AMMONIA mg N /L	<0.002	H.K. Dam	<0.002	
		filtered	0.004	
		samples	<0.002	
		H.K. Dam	<0.002	<0.005
		unfiltered	0.002	
		samples	0.004	
		Castlegar	<0.002	
		filtered	<0.002	
		samples	<0.002	
		Castlegar	<0.002	
		unfiltered	<0.002	
		samples	<0.002	
		Waneta	<0.002	
		filtered	<0.002	
		samples	<0.002	
		Waneta	<0.002	<0.005
		unfiltered	<0.002	
		samples	<0.002	
NO2/NO3 mg N /L	<0.002	H.K. Dam	<0.002	
		filtered	0.005	
		samples	<0.002	
		H.K. Dam	0.007	<0.02
		unfiltered	<0.002	
		samples	<0.002	
		Castlegar	0.002	
		filtered	<0.002	
		samples	<0.002	
		Castlegar	<0.002	
		unfiltered	0.002	
		samples	<0.002	
		Waneta	<0.002	
		filtered	<0.002	
		samples	<0.002	
		Waneta	<0.002	<0.02
		unfiltered	<0.002	
		samples	0.003	
TN mg N /L	0.04	H.K. Dam	<0.02	
		filtered	0.04	
		samples	<0.02	
		H.K. Dam	0.04	<0.06
		unfiltered	<0.02	
		samples	<0.02	
		Castlegar	<0.02	
		filtered	<0.02	
		samples	<0.02	
		Castlegar	<0.02	
		unfiltered	<0.02	
		samples	<0.02	
		Waneta	0.02	
		filtered	<0.02	
		samples	<0.02	
		Waneta	<0.02	<0.06
		unfiltered	<0.02	
		samples	<0.02	

Variable	EC laboratory blank	Field blanks		
		Location	EC	CRIEMP BCELP
Ortho–P mg P /L	<0.002	H. K. Dam	<0.002	<0.003
		Station #	<0.002	
		II–1	<0.002	
		Castlegar	0.006	
		Station #	<0.002	
		II–4	<0.002	
		Waneta	<0.002	<0.003
		Station #	0.005	
		IV–3	<0.002	
Total P mg P /L	<0.002	H. K. Dam	<0.002	<0.003
		Station #	<0.002	
		II–1	<0.002	
		Castlegar	<0.002	
		Station #	<0.002	
		II–4	<0.002	
		Waneta	<0.002	<0.003
		Station #	<0.002	
		IV–3	<0.002	
TDP mg P /L	<0.002	H. K. Dam	<0.002	
		Station #	0.005	
		II–1	<0.002	
		Castlegar	<0.002	
		Station #	<0.002	
		II–4	<0.002	
		Waneta	<0.002	<0.003
		Station #	<0.002	
		IV–3	<0.002	

TABLE 1–4 (CONT'D)

C) METALS

Variable	EC laboratory blank	Field blanks		
		Location	EC	CRIEMP BCELP
ALUMINUM–t mg/L	0.004	H. K. Dam	0.010 0.011	
		Castlegar	0.029 0.004	
		Waneta	<0.002 <0.002	<0.02
BARIUM–t mg/L	<0.0002	H. K. Dam	<0.0002 <0.0002	
		Castlegar	0.0002 <0.0002	
		Waneta	<0.0002 <0.0002	<0.001
CADMIUM–t mg/L	<0.0001	H. K. Dam	0.0001 0.0001	
		Castlegar	<0.0001 0.0001	
		Waneta	<0.0001 <0.0001	<0.0005
COBALT–t mg/L	0.0001	H. K. Dam	0.0001 0.0001	
		Castlegar	0.0001 0.0001	
		Waneta	0.0001 0.0001	<0.003
CHROMIUM–t mg/L	<0.0002	H. K. Dam	<0.0002 <0.0002	
		Castlegar	<0.0002 <0.0002	
		Waneta	<0.0002 <0.0002	0.003
COPPER–t mg/L	<0.0002	H. K. Dam	<0.0002 <0.0002	
		Castlegar	<0.0002 <0.0002	
		Waneta	<0.0002 <0.0002	0.001
IRON–t mg/L	0.0133	H. K. Dam	0.0029 0.0042	
		Castlegar	0.0059 0.0013	
		Waneta	0.0180 0.0005	<0.003
MANGANESE–t mg/L	<0.0001	H. K. Dam	0.0001 <0.0001	
		Castlegar	<0.0001 <0.0001	
		Waneta	0.0001 <0.0001	<0.001

Variable	EC laboratory blank	Field blanks		
		Location	EC	CRIEMP BCELP
MOLYBDENUM–total (mg/L)	0.0001	H. K. Dam	<0.0001 <0.0001	
		Castlegar	<0.0001 <0.0001	
		Waneta	<0.0001 <0.0001	<0.004
NICKEL–t mg/L	0.0004	H. K. Dam	0.0003 0.0004	
		Castlegar	0.0003 0.0004	
		Waneta	0.0003 0.0003	<0.008
LEAD–t mg/L	<0.0002	H. K. Dam	<0.0002 <0.0002	
		Castlegar	<0.0002 <0.0002	
		Waneta	<0.0002 <0.0002	<0.001
VANADIUM–t mg/L	<0.0001	H. K. Dam	<0.0001 <0.0001	
		Castlegar	<0.0001 <0.0001	
		Waneta	<0.0001 <0.0001	<0.003
ZINC–t mg/L	<0.0002	H. K. Dam	<0.0002 <0.0002	
		Castlegar	<0.0002 <0.0002	
		Waneta	<0.0002 <0.0002	<0.002
ARSENIC–t mg/L	<0.0001	H. K. Dam	0.0002 <0.0001	
		Castlegar	<0.0001 <0.0001	
		Waneta	<0.0001 <0.0001	<0.001
MERCURY–t ug/L	<0.01	H. K. Dam	<0.01 <0.01	
		Castlegar	<0.01 <0.01	
		Waneta	<0.01 <0.01	0.1
THALLIUM–t mg/L	<0.002	H. K. Dam	<0.002 <0.002	
		Castlegar	<0.002 <0.002	
		Waneta	<0.002 <0.002	<0.003

TABLE 1–5 COMPARISON OF THE DATA OBTAINED BY EC AND CRIEMP FROM THE COLUMBIA RIVER FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT

A) GENERAL VARIABLES

Variable	Location	EC	CRIEMP BCELP	CRIEMP Federal–provincial		
pH		(laboratory)	(field)	(laboratory)		
	H. K. Dam	7.87	7.2	7.89	--	--
	Station #	7.87	--	7.92	--	--
	II–1	7.84	--	7.90	--	--
	Castlegar	7.79	7.3	7.82	--	--
	Station #	7.82	--	7.92	--	--
	II–4	7.82	--	7.88	--	--
	Waneta	7.91	7.2	7.98	--	--
	Station #	7.95	7.3	7.97	--	--
	IV–3	7.92	7.3	7.94	--	--
CONDUCTIVITY uS/cm	H. K. Dam	121	121	121	--	--
	Station #	121	--	121	--	--
	II–1	121	--	122	--	--
	Castlegar	122	123	122	--	--
	Station #	123	--	124	--	--
	II–4	123	--	123	--	--
	Waneta	135	133	135	--	--
	Station #	135	133	134	--	--
	IV–3	135	133	134	--	--
TURBIDITY FTU	H. K. Dam	--	0.3	0.3	--	--
	Station #	--	--	0.3	--	--
	II–1	--	--	1.6	--	--
	Castlegar	--	0.3	0.3	--	--
	Station #	--	--	0.4	--	--
	II–4	--	--	0.3	--	--
	Waneta	--	0.4	0.3	--	--
	Station #	--	0.6	0.2	--	--
	IV–3	--	0.7	0.3	--	--
COLOUR–APP.	H. K. Dam	--	1	<5	--	--
	Station #	--	--	<5	--	--
	II–1	--	--	<5	--	--
	Castlegar	--	3	<5	--	--
	Station #	--	--	<5	--	--
	II–4	--	--	<5	--	--
	Waneta	--	3	<5	--	--
	Station #	--	2	<5	--	--
	IV–3	--	4	<5	--	--
ALKALINITY mg CaCO3/L	H. K. Dam	49.8	52	49.6	--	--
	Station #	49.9	--	49.7	--	--
	II–1	49.8	--	50.0	--	--
	Castlegar	50.3	52	50.2	--	--
	Station #	49.8	--	50.8	--	--
	II–4	49.8	--	50.1	--	--
	Waneta	54.4	56.6	54.3	--	--
	Station #	54.2	56.6	54.4	--	--
	IV–3	54.4	56.6	54.0	--	--
CALCIUM–d mg/L	H. K. Dam	16.6	--	17.2	--	--
	Station #	16.5	--	17.6	--	--
	II–1	16.8	--	16.7	--	--
	Castlegar	17.3	--	17.4	--	--
	Station #	17.2	--	17.4	--	--
	II–4	17.3	--	17.7	--	--
	Waneta	18.4	18.0	19.4	--	--
	Station #	18.2	18.2	19.2	--	--
	IV–3	18.5	18.2	19.0	--	--
MAGNESIUM–d mg/L	H. K. Dam	3.5	--	3.5	--	--
	Station #	3.5	--	3.5	--	--
	II–1	3.5	--	3.6	--	--
	Castlegar	3.6	--	3.5	--	--
	Station #	3.6	--	3.5	--	--
	II–4	3.6	--	3.5	--	--
	Waneta	3.9	4.17	4.0	--	--
	Station #	3.9	4.19	3.9	--	--
	IV–3	4.0	4.15	3.9	--	--

Variable	Location	EC	CRIEMP BCELP	CRIEMP Federal–provincial		
HARDNESS mg CaCO3/L (computed)	H. K. Dam	55.8	--	57.2	--	--
	Station #	55.7	--	56.4	--	--
	II–1	56.4	--	49.3	--	--
	Castlegar	58.1	--	57.9	--	--
	Station #	57.6	--	57.8	--	--
	II–4	57.9	--	58.8	--	--
	Waneta	62.0	61.5	64.7	--	--
	Station #	61.7	61.6	64.2	--	--
	IV–3	62.5	62.5	63.6	--	--
CHLORIDE mg/L	H. K. Dam	0.3	<0.5	0.3	--	--
	Station #	0.3	--	0.3	--	--
	II–1	0.3	--	0.3	--	--
	Castlegar	0.5	0.7	0.5	--	--
	Station #	0.5	--	0.6	--	--
	II–4	0.6	--	0.6	--	--
	Waneta	0.7	0.8	0.7	--	--
	Station #	0.7	0.9	0.7	--	--
	IV–3	0.7	1.0	0.8	--	--
SODIUM–d mg/L	H. K. Dam	0.7	0.8	0.7	--	--
	Station #	0.7	--	0.7	--	--
	II–1	0.7	--	0.8	--	--
	Castlegar	1.0	1.1	1.0	--	--
	Station #	1.0	--	1.0	--	--
	II–4	1.0	--	1.1	--	--
	Waneta	1.1	1.3	1.2	--	--
	Station #	1.1	1.3	1.2	--	--
	IV–3	1.1	1.4	1.2	--	--
POTASSIUM–d mg/L	H. K. Dam	0.64	0.6	0.73	--	--
	Station #	0.63	--	0.71	--	--
	II–1	0.66	--	0.63	--	--
	Castlegar	0.65	0.6	0.74	--	--
	Station #	0.65	--	0.72	--	--
	II–4	0.65	--	0.73	--	--
	Waneta	0.64	0.6	0.68	--	--
	Station #	0.61	0.6	0.65	--	--
	IV–3	0.61	0.7	0.68	--	--
SULPHATE mg/L	H. K. Dam	7.8	8.7	8.2	--	--
	Station #	7.7	--	8.5	--	--
	II–1	8.2	--	8.9	--	--
	Castlegar	7.0	8.9	7.7	--	--
	Station #	8.2	--	8.6	--	--
	II–4	8.8	--	8.6	--	--
	Waneta	8.8	9.9	9.2	--	--
	Station #	8.3	9.9	7.1	--	--
	IV–3	8.2	10.1	7.4	--	--
SILICON mg/L	H. K. Dam	1.76	1.7 *	1.75	--	--
	Station #	1.76	--	1.80	--	--
	II–1	1.80	--	1.33	--	--
	Castlegar	1.90	1.7 *	1.78	--	--
	Station #	1.87	--	1.77	--	--
	II–4	1.89	--	1.83	--	--
	Waneta	2.00	1.9 *	2.09	--	--
	Station #	1.98	2.0 *	2.05	--	--
	IV–3	2.04	1.9 *	2.01	--	--

* Zenon measured reactive silica – the CRIEMP–BCELP values were readjusted to SILICON by multiplying the reactive silica data by (28/60)

TABLE 1–5 (CONT'D)

B) NUTRIENTS

Variable	Location	EC	CREMP BCELP	CREMP Federal–provincial		
AMMONIA mg N/L	H. K. Dam	<0.002	--	--	--	--
	filtered	<0.002	--	--	--	--
	samples	<0.002	--	--	--	--
	H. K. Dam	<0.002	<0.005	--	--	--
	unfiltered	<0.002	--	--	--	--
	samples	<0.002	--	--	--	--
	Castlegar	0.002	--	--	--	--
	filtered	0.003	--	--	--	--
	samples	0.003	--	--	--	--
	Castlegar	0.005	<0.005	--	--	--
	unfiltered	0.002	--	--	--	--
	samples	<0.002	--	--	--	--
	Waneta	0.015	--	--	--	--
	filtered	0.017	--	--	--	--
	samples	0.017	--	--	--	--
	Waneta	0.015	0.009	--	--	--
	unfiltered	0.016	0.009	--	--	--
	samples	0.015	0.007	--	--	--
NO2/NO3 mg N/L	H. K. Dam	0.149	--	--	--	--
	filtered	0.152	--	--	--	--
	samples	0.153	--	--	--	--
	H. K. Dam	0.164	0.14	0.161	0.157	0.159
	unfiltered	0.163	--	0.158	0.159	0.160
#	samples	0.155	--	0.158	0.163	0.159
	Castlegar	0.150	--	--	--	--
	filtered	0.152	--	--	--	--
	samples	0.153	--	--	--	--
	Castlegar	0.160	0.14	0.157	0.159	0.164
	unfiltered	0.161	--	0.160	0.156	0.157
#	samples	0.162	--	0.157	0.157	0.156
	Waneta	0.135	--	--	--	--
	filtered	0.136	--	--	--	--
	samples	0.136	--	--	--	--
	Waneta	0.138	0.13	0.143	0.143	0.147
	unfiltered	0.138	0.13	0.147	0.141	0.141
#	samples	0.136	0.13	0.144	0.151	0.145
	H. K. Dam	0.15	--	--	--	--
	filtered	0.16	--	--	--	--
	samples	0.16	--	--	--	--
	H. K. Dam	0.19	0.18	0.18	0.19	0.22
	unfiltered	0.19	--	0.19	0.19	0.22
#	samples	0.19	--	0.18	0.20	0.19
	Castlegar	0.17	--	--	--	--
	filtered	0.17	--	--	--	--
	samples	0.17	--	--	--	--
	Castlegar	0.19	--	0.18	0.18	0.18
	unfiltered	0.21	--	0.18	0.27	0.18
#	samples	0.18	--	0.18	0.19	0.18
	Waneta	0.17	--	--	--	--
	filtered	0.18	--	--	--	--
	samples	0.18	--	--	--	--
	Waneta	0.18	<0.17	0.18	0.19	0.17
	unfiltered	0.19	<0.17	0.19	0.19	0.18
#	samples	0.18	<0.17	0.18	0.17	0.19

Variable	Location	EC	CREMP BCELP	CREMP Federal–provincial		
Ortho–P mg P/L	H. K. Dam	<0.002	<0.003	--	--	--
	Station #	<0.002	--	--	--	--
	II–1	<0.002	--	--	--	--
	Castlegar	<0.002	<0.003	--	--	--
	Station #	<0.002	--	--	--	--
	II–4	<0.002	--	--	--	--
	Waneta	0.002	<0.003	--	--	--
	Station #	0.002	<0.003	--	--	--
	IV–3	0.002	<0.003	--	--	--
Total P mg P/L	H. K. Dam	0.004	0.003	0.004	0.003	0.004
	Station #	0.003	--	0.008	0.004	0.004
#	II–1	<0.002	--	0.002	0.003	0.003
	Castlegar	0.003	0.003	0.005	0.003	0.003
	Station #	0.003	--	0.003	<0.002	0.003
#	II–4	0.004	--	0.003	0.004	0.004
	Waneta	0.007	0.005	0.008	0.008	0.008
	Station #	0.008	0.006	0.008	0.007	0.008
#	IV–3	0.008	0.005	0.007	0.005	0.006
TDP mg P/L	H. K. Dam	0.002	<0.003	--	--	--
	Station #	<0.002	--	--	--	--
	II–1	0.003	--	--	--	--
	Castlegar	<0.002	<0.003	--	--	--
	Station #	<0.002	--	--	--	--
	II–4	<0.002	--	--	--	--
	Waneta	0.004	<0.003	--	--	--
	Station #	0.003	<0.003	--	--	--
	IV–3	0.004	<0.003	--	--	--

Three federal–provincial water quality sample kits were collected at each station. Each kit contained three nitrogen sample bottles and three phosphorus sample bottles. For each variable and each station, data from one sample kit are on the same line.

TABLE 1–5 (CONT'D)

C) METALS

Variable	Location	EC	CRIEMP BCELP	CRIEMP Fed.–prov.
ALUMINUM–t				
mg/L	H. K. Dam	0.036	--	0.027
	Station #	0.022	--	0.055
	II–1	0.029	--	0.027
	Castlegar	0.026	--	0.023
	Station #	0.025	--	0.021
	II–4	0.023	--	0.026
	Waneta	0.031	0.05	0.023
	Station #	0.033	0.05	0.089
	IV–3	0.018	0.05	0.023
BARIUM–t				
mg/L	H. K. Dam	0.0153	--	0.0158
	Station #	0.0159	--	0.0160
	II–1	0.0158	--	0.0161
	Castlegar	0.0157	--	0.0157
	Station #	0.0161	--	0.0158
	II–4	0.0159	--	0.0161
	Waneta	0.0199	0.019	0.0199
	Station #	0.0196	0.019	0.0196
	IV–3	0.0196	0.018	0.0200
CADMIUM–t				
mg/L	H. K. Dam	0.0001	--	0.0001
	Station #	0.0001	--	0.0001
	II–1	0.0001	--	<0.0001
	Castlegar	0.0001	--	0.0001
	Station #	0.0001	--	0.0001
	II–4	0.0001	--	0.0001
	Waneta	0.0002	<0.0005	0.0002
	Station #	0.0002	<0.0005	0.0002
	IV–3	0.0002	<0.0005	0.0002
COBALT–t				
mg/L	H. K. Dam	0.0002	--	0.0001
	Station #	<0.0001	--	0.0002
	II–1	0.0001	--	0.0001
	Castlegar	0.0002	--	0.0001
	Station #	0.0001	--	0.0001
	II–4	0.0001	--	0.0001
	Waneta	0.0002	<0.003	0.0002
	Station #	0.0002	<0.003	0.0001
	IV–3	0.0002	<0.003	0.0002
CHROMIUM–t				
mg/L	H. K. Dam	<0.0002	--	<0.0002
	Station #	<0.0002	--	0.0020
	II–1	<0.0002	--	<0.0002
	Castlegar	<0.0002	--	<0.0002
	Station #	<0.0002	--	<0.0002
	II–4	<0.0002	--	<0.0002
	Waneta	<0.0002	0.003	<0.0002
	Station #	<0.0002	0.002	<0.0002
	IV–3	<0.0002	0.003	<0.0002
COPPER–t				
mg/L	H. K. Dam	0.0004	--	0.0006
	Station #	0.0007	--	0.0004
	II–1	0.0003	--	0.0005
	Castlegar	0.0004	--	0.0004
	Station #	0.0004	--	0.0006
	II–4	0.0003	--	0.0004
	Waneta	0.0032	0.002	0.0018
	Station #	0.0017	0.001	0.0020
	IV–3	0.0016	0.001	0.0019
IRON–t				
mg/L	H. K. Dam	0.0210	--	0.0213
	Station #	0.0194	--	0.0314
	II–1	0.0215	--	0.0191
	Castlegar	0.0208	--	0.0198
	Station #	0.0212	--	0.0212
	II–4	0.0210	--	0.0210
	Waneta	0.0426	0.052	0.0275
	Station #	0.0306	0.050	0.0349
	IV–3	0.0291	0.056	0.0387
MANGANESE–t				
mg/L	H. K. Dam	0.0011	--	0.0012
	Station #	0.0011	--	0.0011
	II–1	0.0011	--	0.0011
	Castlegar	0.0021	--	0.0020
	Station #	0.0021	--	0.0021
	II–4	0.0020	--	0.0021
	Waneta	0.0022	0.003	0.0020
	Station #	0.0021	0.003	0.0020
	IV–3	0.0021	0.003	0.0023

Variable	Location	EC	CRIEMP BCELP	CRIEMP Fed.–prov.
MOLYBDENUM–t				
mg/L	H. K. Dam	0.0004	--	0.0005
	Station #	0.0005	--	0.0005
	II–1	0.0004	--	0.0004
	Castlegar	0.0005	--	0.0005
	Station #	0.0005	--	0.0004
	II–4	0.0004	--	0.0005
	Waneta	0.0005	<0.004	0.0005
	Station #	0.0005	<0.004	0.0005
	IV–3	0.0005	<0.004	0.0005
NICKEL–t				
mg/L	H. K. Dam	0.0007	--	0.0007
	Station #	0.0007	--	0.0007
	II–1	0.0005	--	0.0004
	Castlegar	0.0007	--	0.0006
	Station #	0.0006	--	0.0007
	II–4	0.0006	--	0.0006
	Waneta	0.0008	<0.008	0.0006
	Station #	0.0008	<0.008	0.0007
	IV–3	0.0008	<0.008	0.0007
LEAD–t				
mg/L	H. K. Dam	<0.0002	--	<0.0002
	Station #	<0.0002	--	<0.0002
	II–1	<0.0002	--	<0.0002
	Castlegar	<0.0002	--	<0.0002
	Station #	<0.0002	--	<0.0002
	II–4	<0.0002	--	<0.0002
	Waneta	0.0015	0.001	0.0010
	Station #	0.0014	0.001	0.0017
	IV–3	0.0009	0.001	0.0015
VANADIUM–t				
mg/L	H. K. Dam	0.0002	--	0.0002
	Station #	0.0001	--	0.0002
	II–1	0.0001	--	0.0001
	Castlegar	0.0002	--	0.0001
	Station #	0.0002	--	0.0001
	II–4	0.0001	--	0.0001
	Waneta	0.0002	<0.003	0.0001
	Station #	0.0001	<0.003	0.0003
	IV–3	0.0002	<0.003	0.0002
ZINC–t				
mg/L	H. K. Dam	0.0011	--	0.0052
	Station #	0.0014	--	<0.0002
	II–1	<0.0002	--	0.0004
	Castlegar	<0.0002	--	0.0002
	Station #	<0.0002	--	<0.0002
	II–4	<0.0002	--	0.0003
	Waneta	0.0046	0.008	0.0032
	Station #	0.0038	0.008	0.0030
	IV–3	0.0027	0.008	0.0034
ARSENIC–t				
mg/L	H. K. Dam	0.0001	--	<0.0001
	Station #	0.0002	--	0.0001
	II–1	0.0001	--	0.0002
	Castlegar	0.0002	--	0.0001
	Station #	0.0001	--	0.0001
	II–4	0.0001	--	0.0001
	Waneta	0.0003	<0.001	0.0002
	Station #	0.0002	<0.001	0.0002
	IV–3	0.0003	<0.001	0.0002
MERCURY–t				
µg/L	H. K. Dam	<0.01	--	<0.01
	Station #	--	--	0.01
	II–1	<0.01	--	0.01
	Castlegar	<0.01	--	0.01
	Station #	<0.01	--	<0.01
	II–4	<0.01	--	<0.01
	Waneta	0.01	0.1	0.01
	Station #	0.01	0.1	0.02
	IV–3	0.02	--	0.01
THALLIUM–t				
mg/L	H. K. Dam	<0.002	--	--
	Station #	<0.002	--	--
	II–1	<0.002	--	--
	Castlegar	0.002	--	--
	Station #	0.002	--	--
	II–4	<0.002	--	--
	Waneta	<0.002	0.004	--
	Station #	<0.002	0.004	--
	IV–3	0.002	0.010	--

TABLE 1–6 SUMMARY OF RESULTS FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT – QUALITATIVE COMPARISON BETWEEN EC AND CRIEMP DATA

Variables for which CRIEMP BCELP data are available for all three stations

Variable	EC	CRIEMP BCELP	EC	CRIEMP Federal–provincial
Colour (app.)	no data		no data	
pH	>		=	
Silicon	=		=	
Conductivity	=		=	
Potassium	=		<	
Sodium	<		</=	
Chloride	<		=	
Alkalinity	<		=	
Sulphate	=		=	
Ammonia (unf.)	>		no data	
Nitrate+Nitrite	>		=	
Total Nitrogen	>		=	
Ortho–Phosphorus	?		no data	
Total Phosphorus	=		=	
Total diss. P	>/=		no data	

Variables for which CRIEMP BCELP data are available for Waneta station only

Variable	EC	CRIEMP BCELP	EC	CRIEMP Federal–provincial
Calcium	=		</=	
Magnesium	<		>/=	
Hardness	=		?	
Aluminum	<		?	
Barium	=		=	
Copper	=		=	
Iron	<		=	
Lead	=		=	
Manganese	<		=	
Mercury	<		=	
Thallium	<		no data	
Zinc	<		=	

Variables for which all EC and CRIEMP–BCELP values are under the Zenon laboratory detection limits

Variable	EC	CRIEMP BCELP	EC	CRIEMP Federal–provincial
Arsenic	EC < Zenon detection limit		=	
Cadmium	EC < Zenon detection limit		=	
Chromium	EC < Zenon detection limit		=	
Cobalt	EC < Zenon detection limit		=	
Molybdenum	EC < Zenon detection limit		=	
Nickel	EC < Zenon detection limit		=	
Vanadium	EC < Zenon detection limit		=	

Variables for which no CRIEMP BCELP data are available

Variable	EC	CRIEMP BCELP	EC	CRIEMP Federal–provincial
Beryllium		no data	< detection limit	
Lithium		no data	=	
Selenium		no data	=	
Strontium		no data	=	

using BCELP methods; CRIEMP sampling using federal-provincial methods; EC using EC methods) were used to collect samples for analysis of all variables.

At the other audited stations (H.K. Dam and Castlegar), the routine CRIEMP sampling (with BCELP methods) was conducted only for general variables and nutrients, not for metals. However, the CRIEMP collectors sampled for these variables using the federal-provincial sampling technique. This technique is not regularly used by the CRIEMP collectors at these stations.

1) General Variables

The values for most general variables were either identical or very close among the three sampling/analytical methods. A few exceptions are detailed below.

CRIEMP collectors measured pH in the field, but pH values for EC samples were measured at the EC laboratory. Therefore, the data are not directly comparable.

The CRIEMP-BCELP method gave some slightly elevated levels for alkalinity, chloride and magnesium. These values may be related to the bottle preparation procedure used by Zenon; some elevated field blanks values were also noted for alkalinity (see above).

The CRIEMP federal-provincial method gave slightly elevated levels for calcium. There is no apparent reason for this result.

The EC and CRIEMP federal-provincial methods generally gave equal values, except for some potassium, sodium, calcium, hardness and aluminum values.

2) Nutrients

The values reported by Zenon (CRIEMP-BCELP), when above the detection limits, are slightly lower than those for the other two methods. The closeness of the Zenon detection limits to the reported values makes further comparison difficult. The EC and CRIEMP federal-provincial methods generally gave equal values.

3) Heavy Metals

The CRIEMP-BCELP method showed higher values than the others for aluminum, iron, manganese, zinc, mercury and thallium. It showed equal levels for barium, copper and lead. For cadmium,

cobalt, chromium, molybdenum, nickel, vanadium and arsenic, the higher Zenon detection limits prevent comparisons with EC values. The EC and CRIEMP federal-provincial methods generally gave equal values. The data indicate potential limitations in comparing levels between sites because of Zenon's higher detection limits.

4) Chlorophenols

The EC detection limits are much higher than the CRIEMP-BCELP (AXYS) detection limits (table 1-7), thus limiting comparison of the data. All the EC values are under EC detection limits. Only three CRIEMP-BCELP values are at or over the AXYS detection limits. These values are much lower than the corresponding EC detection limits. In this case, EC's higher detection limits restrict the value of EC's data for environmental samples.

TABLE 1–7

CONCENTRATIONS OF CHLOROPHENOLS IN WATER SAMPLES COLLECTED BY ENVIRONMENT CANADA (EC) AND CRIEMP FROM THE COLUMBIA RIVER FOR THE NOVEMBER 26, 1991 WATER QUALITY SAMPLING AUDIT

All data in ng/L "––" denotes "not analysed" ( ) denotes a remark at end of table

Compound name	H. K. Dam		Castlegar		Waneta	
	EC	CRIEMP BCELP	EC	CRIEMP BCELP	EC	CRIEMP BCELP
2–chlorophenol	<65	––	<65	––	<65	––
3–chlorophenol	<50	––	<50	––	<50	––
4–chlorophenol	<40	<2.4	<40	<1.2	<40	<2.4
2–chloro–5–methylphenol	<105	––	<105	––	<105	––
2,6–dichlorophenol	<55	<0.6	<55	<0.3	<55	<0.6
4–chloro–3–methylphenol	<65	––	<65	––	<65	––
2,4–dichlorophenol	<50	<0.5	<50	<0.3	<50	<0.5
3,5–dichlorophenol	<35	<0.5	<35	<0.2	<35	<0.5
2,3–dichlorophenol	<65	<0.5	<65	<0.3	<65	<0.6
3,4–dichlorophenol	<40	<0.4	<40	<0.2	<40	<0.4
2,4,6–trichlorophenol	<50	<0.6	<50	9.8 (1)	<50	5.1 (2)
2,3,6–trichlorophenol	<65	<0.8	<65	<0.4	<65	<0.6
2,3,5–trichlorophenol	<55	<0.5	<55	<0.3	<55	<0.4
2,4,5–trichlorophenol	<45	<0.4	<45	<0.2	<45	<0.3
2,3,4–trichlorophenol	<60	<0.6	<60	<0.3	<60	<0.5
3,4,5–trichlorophenol	<70	<0.5	<70	<0.3	<70	<0.4
2,3,5,6–tetrachlorophenol	<80	<0.7	<80	<0.4	<80	<0.4
2,3,4,6–tetrachlorophenol	<60	<0.9	<60	0.9 (3)	<60	<0.6
2,3,4,5–tetrachlorophenol	<90	<0.4	<90	<0.3	<90	<0.3
Pentachlorophenol	<85	<0.4	<85	<0.5	<85	<0.4

(1) Detection limit: 0.3 ng/L
(2) Detection limit: 0.4 ng/L
(3) Detection limit: 0.9 ng/L

V. CONCLUSIONS AND RECOMMENDATIONS

This field audit was conducted on a date when the CRIEMP samplers did not routinely collect a complete series of water samples. The usefulness of the audit was somewhat diminished by this fact, which was caused by a misunderstanding between CRIEMP and EC staff. Therefore, good communication is recommended.

The EC laboratory blanks suggest slight contamination for some variables. This fact illustrates the need for quality control on the bottle washing operations and the water deionising system. Therefore, CRIEMP should obtain such QA/QC data from the analytical laboratories on a regular basis.

The EC and CRIEMP field blanks were mostly clean. However, slight contamination was detected, mainly in some EC field blanks. EC took more field blanks, and its detection limits were lower; both factors increased the likelihood of "detects". Therefore, at each sampling run, CRIEMP sampling staff should collect one field blank at each sampling site for each variable or group of variables. The purpose of these multiple field blanks is to detect gross contamination in the field and quickly assess its extent; sampling staff can then be prompted to avoid it.

CRIEMP took single 2-litre samples at all stations for several variables, except at Waneta (and only on the date of the audit). Triplicate samples should be taken occasionally (e.g., four to six times a year) at each station to estimate the variability of the data and to detect sample contamination.

CRIEMP was collecting 2-litre samples in polyethylene bottles to measure the General Variables and the Nutrients; subsamples were taken at the laboratory. Although the data in this audit do not indicate any problem, the CRIEMP approach presents a risk: if the single sample is contaminated in the field, during transport or at the laboratory, more variables will be affected than if separate bottles are used. Therefore, CRIEMP should consider the use of separate sampling bottles.

For several heavy metals, the CRIEMP analytical detection limits were higher than the levels measured by EC at all three audited stations. These metals were cadmium, cobalt, copper, molybdenum, nickel, lead, vanadium, zinc, arsenic, mercury and thallium. Therefore, on the date of the audit, CRIEMP may have missed differences between the sampling stations located upstream and downstream of Cominco, even if metals samples had been taken at the upstream stations. For future monitoring, the CRIEMP detection limits for metals should be lowered to those used by EC, or lower.

VI. LITERATURE CITED

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CHAPTER 2

BED SEDIMENT SAMPLING AUDIT

I. INTRODUCTION

The bed sediment sampling component of CRIEMP was conducted by Norecol Environmental Consultants in September 1992. The groups of variables measured in the bed sediment samples were heavy metals, chlorinated organics, total nitrogen and carbon, and particle size distribution. As part of the quality assurance component of CRIEMP, EC conducted a field sampling and analytical audit of the sampling done by Norecol at two stations in the Columbia River. This audit consisted of two parts as described below.

The first part of the audit was conducted to compare the cleanliness of sampling by Norecol and by EC. It was done at a station located upstream of both Celgar pulp mill and Cominco smelter. Both teams were to sample side by side with their own equipment and have their samples analyzed at their respective laboratories. Moreover, each team was to provide subsamples for analysis at the other team's laboratories, to compare analytical values measured on similar samples.

The second part of the audit was conducted to compare the analytical results from the different laboratories on subsamples of common origin. It was done at a station located downstream of both industries. Norecol collected one large sample and made subsamples for their own laboratories and for the EC laboratories.

II. SAMPLING SITES

The stations sampled by Environment Canada and Norecol for this audit are shown in Figure 2-1 and described in Table 2-1.

The site in Lower Arrow Lake is a control station. It is located upstream of the industries located in Castlegar and Trail. The first part of the audit was conducted at this site.

The site in the Columbia River is located downstream of the industries in Castlegar and Trail. The second part of the audit was conducted at this site.

Figure 2-1

Map of the Columbia River north of the International Boundary illustrating the sites where bed sediment samples were collected during the CRIEMP sediment sampling audit (September 1-2, 1992)

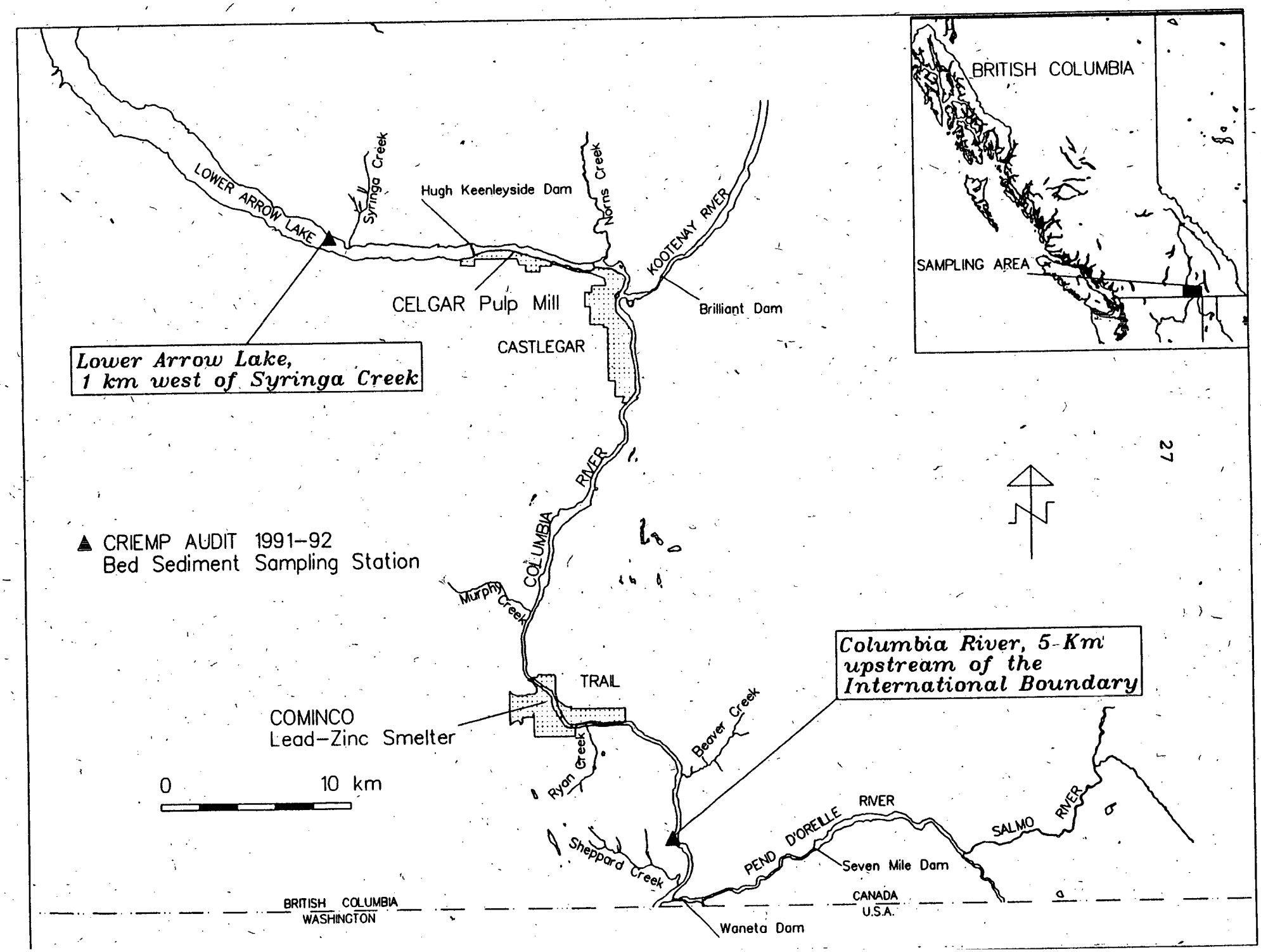
BRITISH COLUMBIA
SAMPLING AREA
LOWER ARROW LAKE
Syringa Creek
Hugh Keenleyside Dam
Norns Creek
KOOTENAY RIVER
CELGAR Pulp Mill
Brilliant Dam
CASTLEGAR
Lower Arrow Lake,
1 km west of Syringa Creek
27
▲ CRIEMP AUDIT 1991–92
Bed Sediment Sampling Station
COLUMBIA RIVER
Murphy Creek
TRAIL
COMINCO
Lead–Zinc Smelter
Ryan Creek
Beaver Creek
Columbia River, 5-Km
upstream of the
International Boundary
0
10 km
Sheppard Creek
PEND D'ORELLE RIVER
SALMO RIVER
Seven Mile Dam
BRITISH COLUMBIA
WASHINGTON
CANADA
U.S.A.
Waneta Dam

TABLE 2–1 SITE LOCATIONS, SAMPLING DEPTHS AND METHODS USED FOR THE CRIEMP SEDIMENT SAMPLING AUDIT (SEPTEMBER 1–2, 1992)

Sampling Date (1992)	CRIEMP sampling site name and station # (Environment Canada #)	Site Location	Sampling Depth (m)	Sampling method
September 1	Lower Arrow Lake one kilometre west of Syringa Creek (I–1) (1)	Lower Arrow Lake, one km west (upstream) of Syringa Creek, 20 to 50 m off both south and north lakeshores Latitude: 49°21'11" N Longitude: 117°53'49" W	25–30	Ekman dredge
September 2	Columbia River 5.0 km upstream of the International Boundary (IV–3A) (2)	Columbia River across from Cominco gravel pit, 2–30 m off right bank in small bay Latitude: 49°01'50" N Longitude: 117°36'18" W	0.6–1.5	Scoop and Ekman dredge

III. METHODS

A) Sampling equipment

All equipment used to collect and handle the bed sediments were made of stainless steel. At each station, just before sampling, EC cleaned each piece with phosphate-free soap, rinsed it with deionised water, dried it in air, rinsed it with acetone and hexane, and kept it wrapped in baked aluminum foil until usage. Norecol used the same procedure, except that river water was used instead of deionised water for rinsing.

Because of the early loss of the Norecol Ekman dredge during sampling, Norecol used the Environment Canada Ekman dredge at all stations, including both audit stations. Unfortunately, this modification partly defeated the first objective of the sampling audit, which was to compare the overall cleanliness of separate sampling operations by both teams.

B) Sampling procedure

The bed sediment samples were collected either with an Ekman dredge or with a scoop, depending on the water depth. In either case, great care was taken to avoid contamination from boat gas fumes. Personnel wore clean polyethylene gloves.

1) Ekman dredge

Before each sampling, the open dredge was rinsed a few times in the river. The dredge was lowered, and the depth was measured approximately by the length of rope needed for the dredge to reach the bottom. Efforts were made so that the dredge hit the bottom vertically. After retrieving the dredge, the overlaying water was drained as much as possible, and the dredge was opened inside a tray. The top layer (2-5 cm) of the bed sediment sample was put into a bucket, and the rest was discarded. This procedure was repeated until there was enough top-layer sediment for samples. The contents of the bucket were well mixed, and dispensed into the sediment sample containers.

2) Scoop

When the water depth allowed wading, the top layer of the bed sediment was collected directly with a scoop and then put into a bucket. Care was taken to avoid sampling in footsteps. This procedure was repeated until there was enough top-layer sediment. The contents of the bucket were well mixed, and dispensed into the bed sediment sample containers.

C) Sample containers

1) Environment Canada

Sediment samples for analyses of organics and for carbon (organic and inorganic) and nitrogen ("CCN") were put into Teflon jars which had been washed with phosphate-free soap, rinsed with deionised water, dried and rinsed with acetone and hexane. Samples were kept on dry ice.

Sediment samples for analyses of heavy metals were put into polyethylene bottles which had been washed with phosphate-free soap, immersed overnight in 10% nitric acid, rinsed with deionised water and dried in air. Samples were kept on dry ice.

Sediment samples for particle size analysis were treated the same way as the metals samples, but were placed on regular ice, not on dry ice.

2) Norecol

Sediment samples for analyses of organics and heavy metals were placed into glass jars (precleaned, respectively, by the AXYS and Zenon Laboratories) and kept frozen on dry ice. Organic and inorganic carbon and nitrogen ("CCN") were analyzed from the heavy metals jars.

Sediment samples for particle size analysis were put into Whirl-Pak polyethylene bags and placed on regular ice.

D) Analytical methods

The Norecol samples (and the subsamples from EC) for total heavy metals, total carbon and total nitrogen were analyzed at Zenon Environmental Laboratories Inc. (Norecol Environmental Consultants Ltd, 1993; Zenon Environmental Laboratories Ltd, 1993). Total metals were determined by Inductively Coupled Argon Plasma (ICAP). Arsenic and selenium were determined by ICAP-hydride generation. Mercury was analyzed by digestion of organomercury and UV analysis. Total carbon was determined by combustion (LECO method), and total inorganic carbon was determined on an ashen sample. The difference between these two values was total organic carbon. Total nitrogen (free ammonia and organic nitrogen) was measured by the Kjeldahl method.

The Norecol samples (and the subsamples provided by EC) for dioxins, furans, chlorinated phenols and particle size distribution

were analyzed at AXYS Analytical Services Ltd in Sidney, B.C. (Norecol Environmental Consultants Ltd, 1993). The samples for chlorinated organics were analyzed by High Resolution Gas Chromatography/Mass Spectrometry. The samples for particle size distribution were analyzed by the pipette method for the smaller particles (less than 0.062 mm) and the sieve method for the larger particles.

The EC samples (and the subsamples provided by Norecol) for total metals, dioxins, furans, chlorinated phenols, total nitrogen and total carbon were analyzed at the National Laboratory for Environmental Testing (NLET) in Burlington, Ontario using unpublished methods listed in the ENVIRODAT Provisional Dictionary of Codes (1993). Samples for total metals were digested in perchloric-nitric acid and then analyzed by atomic absorption with direct aspiration. The samples for chlorinated organics were analyzed by Low resolution Gas Chromatography/Mass Spectrometry. The samples for total nitrogen were analyzed by the CHN analyzer method. These samples were also analyzed with the CHN analyzer for total carbon and total organic carbon; the difference between these two values was total inorganic carbon.

EC also made subsamples for dioxins and furans at both audited stations for analysis at a third laboratory, Zenon Environmental Laboratories. Zenon analyzed these samples by High Resolution Chromatography coupled to a High Resolution Mass Spectrometry utilizing ion monitoring.

The EC samples for Particle Size Distribution were analyzed at the Environmental Surveys Branch Sediment Laboratory of Environment Canada (New Westminster, B.C.) by the U.S. Standard Sieve method (Water Resources Branch, 1988). Particles smaller than 0.0625 mm were not separated.

IV. RESULTS AND DISCUSSION

A) Heavy metals

Table 2-2 presents the heavy metal data for this audit. Each sample was split in the field, and subsamples were submitted to the NLET and Zenon analytical laboratories. Table 2-2 presents the analytical data and their means. For both upstream and downstream sites, NLET reported higher values than Zenon for several metals (Co, Cr, Fe, Mn, Zn), but the reverse situation was observed for other metals (Cd, Pb). For the upstream station only, a "paired comparison test of the means by a two-way ANOVA without replication with randomized complete blocks" (Sokal and Rohlf, 1969) was used to test if the data obtained at NLET were significantly different ($P \leq 0.05$) from the data obtained at Zenon. The conclusions of this analysis are presented in Table 2-3. The NLET mean values for this station were significantly higher than the Zenon mean values for chromium, iron and nickel.

Chromium values measured by NLET are higher than those of Zenon, especially at the upstream site (by a factor of 2 to 4). Zenon's "QA/QC report for the CRIEMP sediment monitoring program" (Zenon Environmental Laboratories Ltd, 1993) shows a weak recovery (17%) for chromium from a certified sediment sample, but a 119% recovery for chromium in a spiked sample. Zenon attributes such an erratic performance to a possible incomplete acid digestion of the sediment samples.

For the upstream site, both NLET and Zenon data sets showed higher levels for most metals in the EC subsamples, compared to the Norecol subsamples (Table 2-2). As each sampling team collected its own samples, these differences may reflect real differences between the samples.

At the downstream site, where Norecol collected the sample used for quality assurance, the values for the subsamples put into EC bottles and Norecol bottles, then all analyzed at NLET, were comparable. This shows that the bottles used by EC and Norecol were of similar cleanliness.

In conclusion, NLET has reported higher values than Zenon for several metals. The performance of each analytical laboratory for the analysis of standard reference materials should be examined to determine the accuracy of the results.

B) Particle size

Table 2-4 presents the results for particle size. For the particle diameters between 2 mm and 0.0625 mm, the percentages are fairly comparable. Environment Canada did not separate particles finer than 0.0625 mm diameter.

TABLE 2-2 HEAVY METALS LEVELS IN COLUMBIA RIVER BED SEDIMENTS COLLECTED ON SEPTEMBER 1 AND 2, 1992 DURING THE CRIEMP SEDIMENT SAMPLING AUDIT AND ANALYZED AT THE EC AND ZENON LABORATORIES

Analytical data: expressed in micrograms/gram of DRY sediment

A) Upstream (control) site Arrow Lake near Syringa Creek

	EC (NLET) laboratory						Zenon laboratory					
	EC subsamples			Norecol subsamples			EC subsamples			Norecol subsamples		
Metal	1-A-ECS	1-B-ECS	Mean	1-A-NS	1-B-NS	Mean	92020283	92020284	Mean	92020282	92020281	Mean
Cadmium	<1	<1	<1	<1	<1	<1	1.3	1.0	1.2	1.2	0.93	1.07
Cobalt	23.6	22.4	23.0	19.8	19.7	19.8	18.3	18.4	18.4	17.4	16.1	16.8
Chromium	124	117	121	103	98.6	100.8	30.8	49.6	40.2	30.3	23.0	26.7
Copper	62.0	61.7	61.9	52.8	50.7	51.8	52.4	52.3	52.4	48.9	48.5	48.7
Iron	52700	52500	52600	48900	47700	48300	46600	45900	46300	43100	39600	41400
Manganese	1090	1080	1085	1010	967	989	902	885	894	744	675	710
Nickel	61.9	62.4	62.2	58.0	55.9	57.0	53.0	53.3	53.2	50.1	46.0	48.1
Lead	70.4	77.3	73.9	69.8	66.5	68.2	80	81	81	66	70	68
Zinc	191	195	193	171	168	170	161	161	161	145	155	150
Arsenic	9.0	9.5	9.3	9.1	8.5	8.8	11	11	11	8.8	8.7	8.8
Selenium	0.7	0.8	0.8	0.6	0.6	0.6	<1	<1	<1	<1	<1	<1
Mercury	0.06	0.06	0.06	0.05	0.05	0.05	0.06	0.08	0.07	0.05	0.06	0.06

B) Downstream site Columbia River 5 km upstream of the Border

	EC (NLET) laboratory						Zenon laboratory			
	EC bottles			Norecol bottles			Norecol bottles			
Metal	2-B-ECB	2-C-ECB	Mean	2-A-NB	2-B-NB	2-C-NB	92020288	92020287	92020280	Mean
Cadmium	8.98	7.62	8.30	10.6	8.49	8.80	9.30	10.7	9.8	9.0	9.8
Cobalt	11.9	9.15	10.5	11.7	11.4	11.5	11.5	9.2	9.0	8.7	9.0
Chromium	76.0	72.1	74.1	85.1	73.5	66.8	75.1	56.3	53.1	45.8	51.7
Copper	507	426	467	503	491	506	500	486	471	442	466
Iron	42500	35400	39000	42100	40800	41800	41600	32900	32600	31200	32200
Manganese	633	554	594	650	634	628	637	404	397	386	396
Nickel	19.0	16.0	17.5	20.7	18.3	19.3	19.4	19.4	18.9	18.1	18.8
Lead	479	436	458	533	466	491	497	566	532	508	535
Zinc	2380	2020	2200	2400	2420	2420	2410	2080	1990	1900	1990
Arsenic	18.6	16.9	17.8	17.6	18.1	17.0	17.6	18	18	18	18
Selenium	1.9	1.7	1.8	1.9	1.8	1.8	1.8	1	1	<1	1
Mercury	1.40	1.60	1.50	0.98	2.77	1.02	1.59	1.65	1.39	1.39	1.48

TABLE 2–3 STATISTICAL ANALYSIS OF DATA FOR HEAVY METALS IN BED SEDIMENT SAMPLES COLLECTED IN THE COLUMBIA RIVER FOR THE CRIEMP SEDIMENT SAMPLING AUDIT (SEPTEMBER 1–2, 1992)

Comparison between Means values of EC and Zenon subsamples collected at the upstream station (Arrow Lake near Syringa Creek) and analyzed at the NLET and Zenon laboratories

TEST = Paired Comparison of Means by a Two–Way ANOVA without replication and with randomized complete blocks
"?" denotes that all values from one laboratory are under its detection limit, so no conclusion is made

	NLET		Zenon laboratory			
HEAVY METAL	Mean of EC subsamples	Mean of Norecol subsamples	Mean of EC subsamples	Mean of Norecol subsamples	significance of the test at P</=0.05	relationship between NLET and Zenon data
Cadmium	< 1	< 1	1.15	1.07	?	?
Cobalt	23.0	19.8	18.4	16.8	no	not sign. different
Chromium	120.5	100.8	40.2	26.7	yes	NLET > Zenon
Copper	61.9	51.8	52.4	48.7	no	not sign. different
Iron	52600	48300	46300	41400	yes	NLET > Zenon
Manganese	1085	989	894	710	no	not sign. different
Nickel	62.2	57.0	53.2	48.1	yes	NLET > Zenon
Lead	73.9	68.2	80.5	68.0	no	not sign. different
Zinc	193	170	161	150	no	not sign. different
Arsenic	9.3	8.8	11.0	8.8	no	not sign. different
Selenium	0.8	0.6	< 1	< 1	?	?
Mercury	0.06	0.05	0.08	0.06	no	not sign. different

TABLE 2–4 PARTICLE SIZE ANALYSIS OF THE COLUMBIA RIVER BED SEDIMENT SAMPLES COLLECTED DURING THE CRIEMP SEDIMENT SAMPLING AUDIT ON SEPTEMBER 1 AND 2, 1992 AND ANALYZED BY THE EC AND AXYS LABORATORIES

Analytical data: Percentage (in weight) finer than indicated mesh opening

A) Upstream (control) site Arrow Lake near Syringa Creek

Mesh opening (mm)	EC laboratory		AXYS laboratory	
	EC subsample	Norecol subsample	EC subsample	Norecol subsample
16	--	--	--	--
8	--	--	--	--
4	--	--	--	--
2	100.0	100.0	100.0	100.0
1	99.7	99.9	99.7	100.0
0.5	98.7	98.8	99.1	99.7
0.25	93.2	95.7	97.3	98.3
0.125	84.4	90.0	--	--
0.105	--	--	89.1	88.9
0.063	--	--	78.2	76.4
0.0625	69.7	74.4	--	--
0.044	--	--	74.8	71.9
0.031	--	--	69.2	67.5
0.022	--	--	64.1	62.5
0.016	--	--	59.2	56.9
0.0078	--	--	53.0	51.4
0.0039	--	--	47.0	44.8
0.002	--	--	44.2	38.4

B) Downstream site Columbia River 5 km upstream of the Border

Mesh opening (mm)	EC laboratory						AXYS laboratory
	EC bottles			Norecol bottles			Norecol bottle
	2-A-ECB	2-B-ECB	2-C-ECB	2-A-NB	2-B-NB	2-C-NB	2437-28A
16	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--
4	--	--	--	--	--	--	--
2	--	--	--	--	--	--	100.0
1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
0.5	99.8	99.9	99.9	99.9	99.8	99.7	99.8
0.25	97.5	97.6	97.1	97.4	97.4	96.7	96.2
0.125	77.6	78.2	75.4	76.0	76.1	74.4	--
0.105	--	--	--	--	--	--	62.6
0.063	--	--	--	--	--	--	32.5
0.0625	42.0	42.9	40.1	40.6	41.7	40.5	--
0.044	--	--	--	--	--	--	27.5
0.031	--	--	--	--	--	--	20.5
0.022	--	--	--	--	--	--	16.3
0.016	--	--	--	--	--	--	12.4
0.0078	--	--	--	--	--	--	9.5
0.0039	--	--	--	--	--	--	7.4
0.002	--	--	--	--	--	--	6.1

C) Total carbon and nitrogen

Table 2-5 presents the data for these variables.

Carbon: The organic and inorganic carbon results are highly variable, especially for the EC (NLET) laboratory results. Zenon reported higher values for organic carbon than for inorganic carbon, but NLET reported the reverse. Both laboratories have verified their data for possible errors and have confirmed them. Differences in methodology may explain some of the differences: Zenon measures inorganic carbon directly and calculates organic carbon, while NLET does the reverse. No further conclusion can be drawn.

Nitrogen (total): The reported data for both laboratories were variable but more consistent than for carbon. Both laboratories have verified and confirmed their respective data sets.

D) Chlorophenols

The data are shown in Table 2-6. The detection limits for the EC (NLET) laboratory were high, so nothing was detected. AXYS had much lower detection limits and detected (but could not quantify) 4-chlorophenol in the Arrow Lake sediment sample collected by Environment Canada; nothing was detected in the Norecol sample. Arrow Lake was an upstream (control) station. No chlorophenols were detected by AXYS at the downstream site.

E) Dioxins and Furans

Table 2-7 presents the data. Values from the Zenon laboratory are generally lower than those from the NLET and AXYS laboratories. The subsamples analyzed at Zenon were sent to this laboratory several months after the other subsamples had been analyzed at NLET and AXYS. This delay may have caused changes in these subsamples.

At the upstream site, the EC and Norecol subsamples show comparable levels for the congeners of dioxins and furans. AXYS and NLET laboratories showed comparable levels and detection limits for these congeners. Some variability between replicate subsamples is apparent.

At the downstream site, comparable values were obtained for subsamples placed in EC and Norecol bottles and analyzed at NLET. Given the variability among subsamples, comparable results were reported by NLET and AXYS laboratories.

TABLE 2–5 CARBON AND NITROGEN LEVELS IN THE COLUMBIA RIVER BED SEDIMENT SAMPLES COLLECTED ON SEPTEMBER 1 AND 2, 1992 DURING THE CRIEMP SEDIMENT SAMPLING AUDIT AND ANALYZED AT THE EC AND ZENON LABORATORIES

Analytical data for Carbon and Nitrogen: expressed in micrograms/gram of DRY sediment

EC laboratory: thermal combustion (CHN analyzer) Zenon laboratory: Kjeldahl Nitrogen

A) Upstream (control) site Arrow Lake near Syringa Creek

	EC laboratory				Zenon laboratory			
	EC subsamples		Norecol subsamples		EC subsamples		Norecol subsamples	
Variable	1–A–ECS	1–B–ECS	1–A–NS	1–B–NS	92020283	92020284	92020281	92020282
Carbon–organic	8100	18700	10000	7700	23800	23500	22300	15800
Carbon–inorganic	28800	14400	19400	23300	1900	1500	1200	1500
Nitrogen (total)	1500	1700	1500	800	1230	1360	1320	1260

B) Downstream site Columbia River 5 km upstream of the border

	EC laboratory						Zenon laboratory		
	EC bottles			Norecol bottles			Norecol bottles		
Variable	2–A–ECB	2–B–ECB	2–C–ECB	2–A–NB	2–B–NB	2–C–NB	92020280	92020287	92020288
Carbon–organic	1800	800	2100	15700	7000	2000	13900	13700	12500
Carbon–inorganic	17400	17500	10600	1900	7800	14700	1300	1600	1200
Nitrogen (total)	600	100	600	3100	400	200	542	1350	439

TABLE 2–6 CHLOROPHENOLS IN BED SEDIMENT SAMPLES FROM THE COLUMBIA RIVER COLLECTED DURING THE CRIEMP SEDIMENT SAMPLING AUDIT ON SEPTEMBER 1 AND 2, 1992 AND ANALYZED AT THE EC AND AXYS LABORATORIES

Analytical data: in nanograms/gram of DRY sediment
"<value": under detection limit
"NDR": peak detected but did not meet quantification criteria

A) Upstream (control) site Arrow Lake near Syringa Creek

	EC laboratory				AXYS laboratory	
	EC subsamples		Norecol subsamples		EC subsample	Norecol subsample
Chlorophenol	1–A–ECS	1–B–ECS	1–A–NS	1–B–NS	2437–20	2437–29
2–chlorophenol	<300	<300	<300	<300	--	--
3–chlorophenol	<150	<150	<150	<150	--	--
4–chlorophenol	<150	<150	<150	<150	NDR (2.7)	< 0.4
2–chloro–5–methylphenol	<400	<400	<400	<400	--	--
2,6–dichlorophenol	<100	<100	<100	<100	< 0.3	< 0.4
4–chloro–3–methylphenol	<400	<400	<400	<400	--	--
2,4–dichlorophenol	<200	<200	<200	<200	< 0.4	< 0.3
3,5–dichlorophenol	<200	<200	<200	<200	< 0.3	< 0.3
2,3–dichlorophenol	<200	<200	<200	<200	< 0.3	< 0.3
3,4–dichlorophenol	<200	<200	<200	<200	< 0.3	< 0.2
2,4,6–trichlorophenol	<100	<100	<100	<100	< 0.2	< 0.2
2,3,6–trichlorophenol	<200	<200	<200	<200	< 0.2	< 0.4
2,3,5–trichlorophenol	<200	<200	<200	<200	< 0.2	< 0.3
2,4,5–trichlorophenol	<200	<200	<200	<200	< 0.2	< 0.3
2,3,4–trichlorophenol	<200	<200	<200	<200	< 0.2	< 0.4
3,4,5–trichlorophenol	<200	<200	<200	<200	< 0.2	< 0.4
2,3,5,6–tetrachlorophenol	<100	<100	<100	<100	< 0.4	< 0.8
2,3,4,6–tetrachlorophenol	<100	<100	<100	<100	< 0.5	< 1.1
2,3,4,5–tetrachlorophenol	<100	<100	<100	<100	< 0.3	< 0.5
Pentachlorophenol	< 50	< 50	< 50	< 50	< 0.6	< 1.1

B) Downstream site Columbia River 5 km upstream of the Border

	EC laboratory						AXYS laboratory
	EC bottles			Norecol bottles			Norecol bottle
Chlorophenol	2–A–ECB	2–B–ECB	2–C–ECB	2–A–NB	2–B–NB	2–C–NB	2437–28
2–chlorophenol	<300	<300	<300	<300	<300	<300	--
3–chlorophenol	<150	<150	<150	<150	<150	<150	--
4–chlorophenol	<150	<150	<150	<150	<150	<150	< 0.8
2–chloro–5–methylphenol	<400	<400	<400	<400	<400	<400	--
2,6–dichlorophenol	<100	<100	<100	<100	<100	<100	< 0.4
4–chloro–3–methylphenol	<400	<400	<400	<400	<400	<400	--
2,4–dichlorophenol	<200	<200	<200	<200	<200	<200	< 0.5
3,5–dichlorophenol	<200	<200	<200	<200	<200	<200	< 0.4
2,3–dichlorophenol	<200	<200	<200	<200	<200	<200	< 1.1
3,4–dichlorophenol	<200	<200	<200	<200	<200	<200	< 0.3
2,4,6–trichlorophenol	<100	<100	<100	<100	<100	<100	< 0.4
2,3,6–trichlorophenol	<200	<200	<200	<200	<200	<200	< 0.5
2,3,5–trichlorophenol	<200	<200	<200	<200	<200	<200	< 0.5
2,4,5–trichlorophenol	<200	<200	<200	<200	<200	<200	< 0.4
2,3,4–trichlorophenol	<200	<200	<200	<200	<200	<200	< 0.4
3,4,5–trichlorophenol	<200	<200	<200	<200	<200	<200	< 0.4
2,3,5,6–tetrachlorophenol	<100	<100	<100	<100	<100	<100	< 0.2
2,3,4,6–tetrachlorophenol	<100	<100	<100	<100	<100	<100	< 0.3
2,3,4,5–tetrachlorophenol	<100	<100	<100	<100	<100	<100	< 0.3
Pentachlorophenol	< 50	< 50	< 50	< 50	< 50	< 50	< 0.6

TABLE 2–7 DIOXINS AND FURANS IN BED SEDIMENT SAMPLES FROM THE COLUMBIA RIVER COLLECTED ON SEPTEMBER 1 AND 2, 1992 DURING THE CRIEMP SEDIMENT SAMPLING AUDIT AND ANALYZED AT THE EC, AXYS AND ZENON LABORATORIES

Analytical data: in picograms/gram of DRY sediment

A) Upstream (control) site: Arrow Lake near Syringa Creek

	EC laboratory (NLET)				AXYS laboratory			Zenon laboratory	
	EC subsamples		Norecol subsamples		EC sample (LAB. DUPLICATES)		Norecol sample	EC subsamples	
Compound	1–A–ECS	1–B–ECS	1–A–NS	1–B–NS	2437–20A	2437–20B	2437–29	1–A–IOS	1–B–IOS
2,3,7,8–TCDD	< 0.1	< 0.2	< 0.3	< 0.1	< 0.2	< 0.1	< 0.2	< 2.4	< 3.4
Total TCDD	< 0.1	< 0.2	< 0.3	< 0.1	< 0.2	< 0.1	< 0.2	< 2.4	< 3.4
1,2,3,7,8–PeCDD	< 1	< 1	< 1.3	< 0.9	< 0.2	< 0.2	< 0.2	< 4.3	< 9.5
Total PeCDD	< 1	< 1	< 1.3	< 0.9	< 0.2	< 0.2	< 0.2	< 4.3	< 9.5
1,2,3,4,7,8–HxCDD	< 1.1	< 2.8	< 1.7	< 2.7	0.2	0.2	(0.3)	< 1.3	< 9.7
Total HxCDD	6.5	< 2.8	3	< 2.7	7.2	7.4	5.3	< 9.4	< 7.2
1,2,3,4,6,7,8–HpCDD	19.1	16.3	15.8	14.9	16	14	19	<12	<13
Total HpCDD	38.4	33.9	31.7	27.4	29	29	28	<12	<13
OCDD	74.1	72.3	65.6	59.5	59	53	54	19	<12
2,3,7,8–TCDF	< 0.1	< 0.1	1.7	< 0.1	0.9	0.8	0.9	< 2.8	< 3.4
Total TCDF	< 0.1	2	2.1	1.4	6.1	4.8	5.7	< 2.8	< 3.4
1,2,3,7,8–PeCDF	< 0.7	< 0.7	< 0.9	< 0.6	(0.2)	(0.2)	< 0.2	< 3.4	< 5.7
Total PeCDF	< 0.7	< 0.7	< 0.9	< 0.6	4.4	3.5	4.0	< 4.6	< 5.5
1,2,3,4,7,8–HxCDF	1.9	< 1.5	< 1.7	< 1.6	1.5	1.4	1.2	< 7.3	< 4.0
Total HxCDF	4.6	3.8	< 1.7	< 1.6	12	8.9	10	< 6.9	< 3.8
1,2,3,4,6,7,8–HpCDF	< 1.6	4.7	3.4	3.7	4.8	4.0	3.5	< 7.4	< 5.2
Total HPCDF	< 1.6	4.7	8.1	3.7	14	8.9	8.1	< 8.7	< 6.1
OCDF	< 2.4	8	3.8	6.1	6.6	5.0	4.9	<12	<14

B) Downstream site: Columbia River 5 km upstream of the Border

	EC laboratory (NLET)						AXYS laboratory	Zenon laboratory		
	EC bottles			Norecol bottles			Norecol bottle	EC bottles		
Compound	2–A–ECB	2–B–ECB	2–C–ECB	2–A–NB	2–B–NB	2–C–NB	2437–28	2–A–IOS	2–B–IOS	2–C–IOS
2,3,7,8–TCDD	2.9	0.9	< 0.2	3.4	3.4	< 0.2	0.7	< 2.1	< 2.6	< 1.2
Total TCDD	2.9	0.9	< 0.2	3.4	3.4	< 0.2	0.7	< 2.1	< 2.6	< 1.2
1,2,3,7,8–PeCDD	< 0.9	< 0.9	< 1	< 1.2	< 2.5	< 0.7	< 0.2	< 3.3	< 3.3	< 2.1
Total PeCDD	< 0.9	< 0.9	< 1	< 1.2	< 2.5	< 0.7	< 0.2	< 3.3	< 3.3	< 2.1
1,2,3,4,7,8–HxCDD	< 0.6	< 2.6	< 1.1	< 1.8	< 1.7	< 1.5	0.2	< 6.3	< 8.9	< 4.3
Total HxCDD	< 0.6	< 2.6	< 1.1	< 1.8	4	< 1.5	7.6	< 4.7	< 6.5	< 3.2
1,2,3,4,6,7,8–HpCDD	14.5	< 1.2	< 1.2	13.7	11.5	7.8	5.6	< 6.0	< 7.9	< 6.0
Total HpCDD	21.1	8	< 1.2	21.9	11.5	16.2	13	< 6.0	< 7.9	< 6.0
OCDD	54.8	42.7	83.4	64	51.6	50.8	34	11	9.6	17
2,3,7,8–TCDF	66.0	70.2	66.1	66.7	69.3	73.7	61	20	21	26
Total TCDF	106.4	114.9	113.6	105.0	116.5	115.8	99	29	32	38
1,2,3,7,8–PeCDF	3.9	< 1.1	4.1	4.5	7.3	< 1.2	0.7	< 1.8	< 1.9	< 2.4
Total PeCDF	5.3	< 1.1	4.1	6.1	8.7	< 1.2	4.5	< 1.8	< 1.9	< 1.4
1,2,3,4,7,8–HxCDF	5.2	< 1.7	5.2	< 0.7	< 1.4	< 1.5	(0.3)	< 3.1	< 3.2	< 2.2
Total HxCDF	5.2	< 1.7	5.2	1.8	< 1.4	< 1.5	2.6	< 2.9	< 3.0	< 2.1
1,2,3,4,6,7,8–HpCDF	7.5	< 1.6	9.9	5	< 1.7	< 0.9	2.0	< 4.1	< 3.7	< 3.1
Total HPCDF	7.5	< 1.6	9.9	7.5	< 1.7	< 0.9	4.4	< 4.8	< 4.3	< 3.4
OCDF	23.4	< 2.5	26.3	18	12.1	< 2.9	3.0	< 7.4	< 8.6	< 5.3

V. CONCLUSIONS AND RECOMMENDATIONS

The early loss by Norecol staff of their only Ekman dredge prevented comparison of overall sampling cleanliness of the two teams. In this audit, the comparisons between EC and Norecol data are restricted to the preparation of the sample containers and to the analytical methodologies. This loss proves the necessity of bringing backup equipment to the field.

The metals values from the EC (NLET) laboratory are often higher than the corresponding levels from Zenon. The performance of each laboratory for reference standard analysis should be examined. This audit demonstrates the value of using a second laboratory to check the quality of the analyses.

The carbon and nitrogen results were highly variable; this made comparisons between samples or laboratories difficult. At least three splits (subsamples) should be made and analyzed for these variables.

The dioxins and furans data were fairly similar between AXYS and EC (NLET) laboratories. The Zenon laboratory reported lower values, but the samples were submitted to Zenon several months after collection. This problem shows the necessity of analyzing the samples as soon as possible after their collection, to minimise sample degradation and obtain reliable data.

It is recommended to collect field replicates at each sampling station to estimate the variability within the site. One should also make splits (subsamples) from some samples, to estimate the analytical variability. The sampling and analytical costs will be higher, but the credibility of the data will be greatly increased.

VI. LITERATURE CITED

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CHAPTER 3

CADDISFLY SAMPLING AUDIT

I. INTRODUCTION

The bioaccumulation sampling component of CRIEMP 1991-93 was conducted in the summer and fall of 1992. A few selected species were tested for a variety of contaminants. Emergent, adult forms of the insect order Trichoptera (caddisflies) were chosen as one of the sentinel species due to their seasonal availability, ease of capture, and their significant contribution to the food chain of freshwater ecosystems (McCafferty, 1983).

Trichoptera larvae live and feed on the bottom of the river and accumulate contaminants from bottom sediments during this stage, before emerging as winged adults to reproduce. The adults are short-lived and neither feed nor defecate during this final stage. Therefore, they retain the contaminants accumulated during their larval stage. Under favourable conditions, swarms of adults emerge at night from the river.

As part of the quality assurance component of CRIEMP 1991-1993, Environment Canada (EC) conducted an audit of the sampling and analytical procedures used in the caddisfly bioaccumulation section of the program. This audit was conducted at two locations on July 15 and 16, 1992. UV light traps placed along the river bank were used to attract the emergent caddisflies. Norecol and Environment Canada teams conducted their sampling side by side and had their own samples analyzed at their respective laboratories. Moreover, the two teams exchanged subsamples for analysis at their respective laboratories.

II. SAMPLING SITES

The two sites used for the emergent insect sampling audit are described in Table 3-1 and are shown on Figure 3-1. The upstream (control) site at Glade on the lower Kootenay River is located upstream of the contaminant sources in the lower Columbia River at Castlegar and Trail. The downstream site at Waneta on the Columbia River is located downstream of these same sources. Both sampling sites were located far away from other light sources to reduce interference or competition for the light traps.

Figure 3-1

Map of the lower Kootenay River and of the Columbia River north of the International Boundary illustrating the sites where caddisfly samples were collected during the CRIEMP emergent insect sampling audit (July 15-16, 1992)

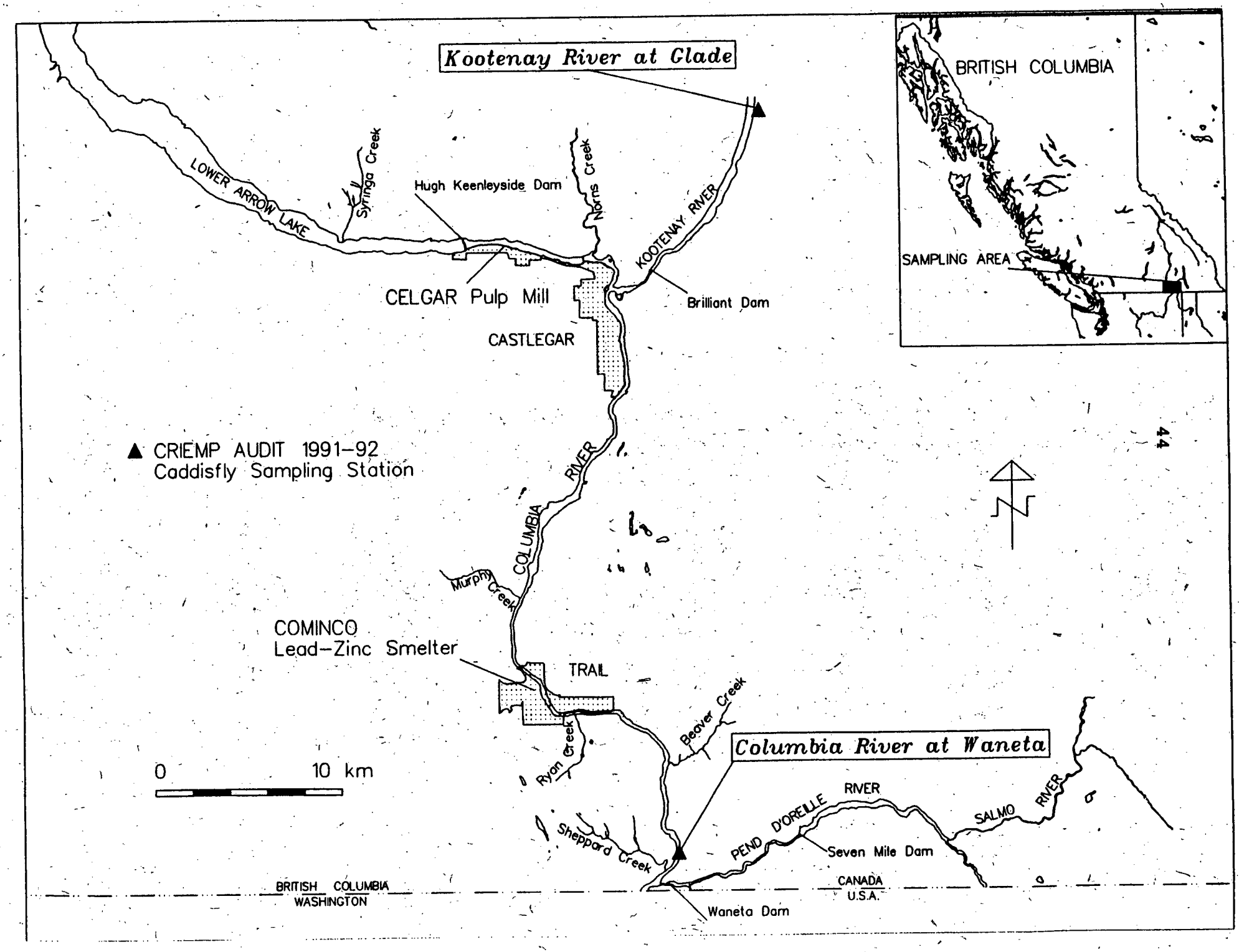
Kootenay River at Glade
LOWER ARROW LAKE
Syringa Creek
Hugh Keenleyside Dam
Norns Creek
KOOTENAY RIVER
CELGAR Pulp Mill
Brilliant Dam
CASTLEGAR
▲ CRIEMP AUDIT 1991–92
Caddisfly Sampling Station
COLUMBIA RIVER
Murphy Creek
COMINCO
Lead–Zinc Smelter
TRAIL
Beaver Creek
Ryan Creek
Columbia River at Waneta
0
10 km
PEND D'OREILLE RIVER
SALMO RIVER
Seven Mile Dam
Sheppard Creek
BRITISH COLUMBIA
WASHINGTON
CANADA
U.S.A.
Waneta Dam
BRITISH COLUMBIA
SAMPLING AREA
44

TABLE 3–1

LOCATIONS OF SITES SAMPLED IN JULY 1992 FOR THE CRIEMP EMERGENT INSECTS (CADDISFLIES) SAMPLING AUDIT

Date of sampling	Site name	Site location	Land access
July 16, 1992	UPSTREAM SITE Kootenay River at Glade	Left bank of the Kootenay River, upstream of Glade ferry and sawmill Lat. 49°24'40" N Long. 117°32'22" W	Ferry to Glade, left turn, small roads along river
July 15, 1992	DOWNSTREAM SITE Columbia River at Waneta	Left bank of the Columbia River, one kilometre upstream of the Pend d'Oreille River Lat. 49°01'17" N Long. 117°36'05" W	West side of Highway 22A, small road to river bank

III. METHODS

A) Description of the emergent insect light traps

The emergent insect light traps used for this audit by both EC and Norecol Environmental Consultants were modified versions of the traps described in Kovats and Ciborowski (1989). The traps were modified by EC for this study. They consist of a stainless-steel bucket supporting a stainless-steel structure with a UV light tube in the centre. Radiating from this tube are three stainless steel vanes (Figure 3-2). The insects were collected in modified Teflon jars to prevent contamination from metals and organics. The ultra-violet (UV) 15-watt DC collecting lights were obtained from Bioquip Products, and were powered by rechargeable 12-volt batteries.

B) Sampling procedure used by Environment Canada

One sampling site was audited per day. For each audit, six traps were used by Environment Canada.

All pieces of equipment coming in contact with insects were washed with a non-phosphate detergent and rinsed with deionised water, acetone and hexane before use. The traps and the UV lights were solvent-rinsed again at the sampling site just before the collection began. Personnel wore polyethylene gloves to handle all pieces of equipment. The ends of the UV lights and the electrical wires joining these ends were covered with Teflon tape to prevent contamination of any insect landing on the lights during sampling.

A Teflon jar was placed in the centre of each bucket and raised on an aluminum foil pad to touch the underside of the funnel. This was done to minimize loss of insects falling on the dry ice beside the Teflon jars. Small pieces of dry ice were placed around the Teflon jar to keep it in a central position and to anaesthetize the insects. The traps were placed on the river bank, about 1 metre from the water.

Sampling began soon after sunset (about 9 p.m. in July). The caddisflies emerging from the river were attracted by the UV lights and hit the vanes of the trap. They were anaesthetized by the carbon dioxide vapours and fell through the funnel into the Teflon jars. The cold temperature kept them anaesthetized. When full, the jars were replaced and their contents processed immediately (see below). The sampling continued until approximately 11 p.m. The UV lights were then shut off and the traps opened. The Teflon jars were taken out and the insects were processed on site.

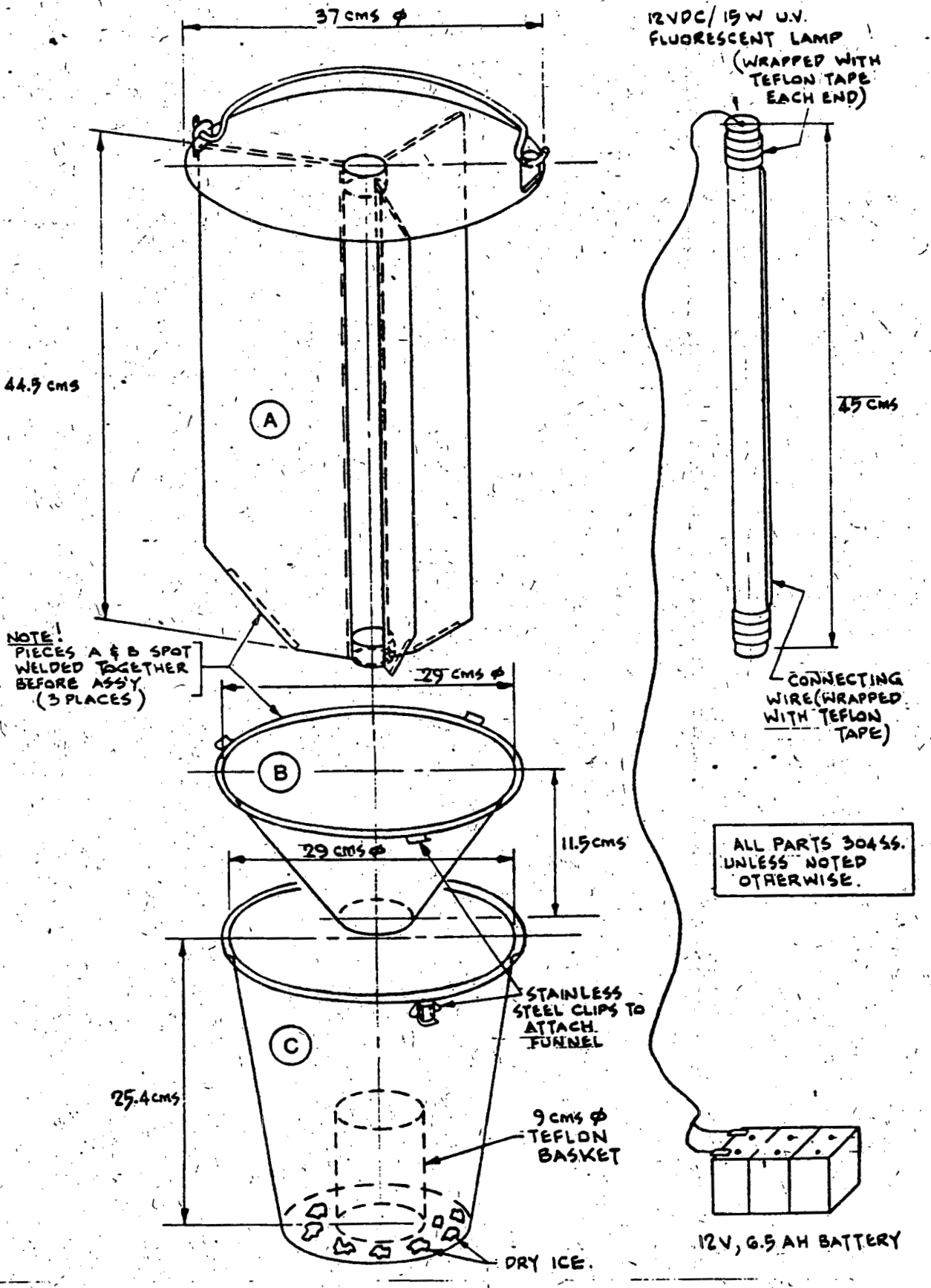

Figure 3.2 Diagram of light trap components. All trap parts are made of stainless steel material except the glass lamp and teflon basket. A, light assembly consisting of circular stainless steel top plate and handle, vanes and 12VDC/15 W UV fluorescent lamp; B, funnel; C, bucket containing Teflon basket and dry ice (actual size of ice chunks to reach basket top).

C) Sampling procedure used by Norecol

Norecol and Environment Canada used similar procedures, with the following exceptions:

-Norecol used four traps at the two audited sites, while Environment Canada used six traps;

-Norecol used cloth towels to wipe water off the traps after rinsing, while Environment Canada let the traps dry in air;

-Norecol placed the traps and the UV lights in cardboard cartons for transport to the sampling sites, while Environment Canada used polypropylene bags washed in nitric acid and rinsed with acetone and hexane;

-at the sites, Norecol rinsed the traps with hexane only, while Environment Canada used both acetone and hexane.

D) Processing of captured insects by Environment Canada

The processing was done at the sampling site, inside a mobile field laboratory, to minimize the possibility of contamination. Staff wore labcoats and polyethylene gloves. Stainless steel trays and utensils were used. Before use, these were washed with a non-phosphate detergent and rinsed with deionised water, acetone and hexane, then covered in aluminum foil washed in the same manner.

The insects from each Teflon jar were poured into a large tray. The caddisflies were separated from the other insects with spoons and forceps, and then weighed. This handling had to be done quickly, because some insects recovered when removed from dry ice. Therefore, the Teflon jars were left inside the traps until their processing began.

The caddisflies from all jars were combined and mixed well. Subsamples were taken for species identification, metals analysis and organics analysis, as follows:

-the subsamples for species identification were put in large-mouth plastic jars and preserved with 10% formalin;

-the metals subsamples were put into polyethylene bags (pre-washed with 25% nitric acid and rinsed with deionised water) and frozen;

-the organics subsamples were put into small stainless-steel trays; the tray tops were covered with aluminum foil and the samples were frozen.

Subsamples were also exchanged with Norecol staff for cross-analysis.

E) Processing of captured insects by Norecol

Norecol proceeded like Environment Canada, except for the following differences:

-insects were sorted and made into the subsamples in a motel room a few hours after collection;

-samples for organics analysis were stored in glass bottles;

-samples for metals analysis were stored in polyethylene jars;

-subsamples for species identification were preserved in 70% ethanol.

F) Laboratory analytical methods

The samples collected by Norecol and the subsamples provided by Environment Canada to Norecol were analyzed for total metals at Zenon Environmental Laboratories Inc. by Inductively Coupled Argon Plasma (ICAP) (Zenon, 1993), and for chlorinated organics at AXYS Analytical Services Ltd by High Resolution Gas Chromatography-Mass Spectrometry.

The samples collected by Environment Canada and the subsamples provided by Norecol to EC were analyzed for total metals and chlorinated organics at the National Laboratory for Environmental Testing (NLET) of Environment Canada in Burlington, Ontario. The samples for total metals were digested in sulphuric-nitric acid and analyzed by Atomic Absorption Spectrometry. The samples for chlorinated organics were analyzed by Gas Chromatography-Mass Spectrometry. The unpublished analytical methods are listed in the Provisional Dictionary of Codes (ENVIRODAT, 1993).

Environment Canada also sent some subsamples of both EC and Norecol samples to the laboratory operated by the Institute of Ocean Sciences (IOS) of the Department of Fisheries and Oceans in Sidney, BC. These subsamples were analyzed by High Resolution Gas Chromatography-Mass Spectrometry (unpublished methods).

Norecol conducted species identification of its own samples and of some Environment Canada subsamples. Environment Canada sent its own samples and some Norecol subsamples to Applied Technical Services of Saanichton, B.C., where Trichoptera were identified to the species level; subsamples were sent to the Royal Ontario Museum for species verification (Appendix I).

IV. RESULTS AND DISCUSSION

A) Species identification

Table 3-2 presents the percentages for the most abundant species of caddisflies found in the EC and Norecol subsamples at both sites. Appendix 1 contains the detailed identification report for the EC samples. At Glade, the proportions are similar among subsamples, except in the EC subsample analyzed by Norecol, where *Hydropsyche occidentalis* and *Cheumatopsyche campyla* have the same abundance. The other Glade subsamples showed three to four times more *Cheumatopsyche campyla* than *Hydropsyche occidentalis*. Since the Norecol report did not provide the total numbers of insects in the samples, this difference cannot be explained. If these numbers were small, the difference may not be significant. At Waneta, similar results were obtained for all four subsamples.

B) Total Metals

The data in Table 3-3 show that at Glade, both laboratories reported some higher values for the EC subsamples. At Waneta, NLET (EC) data are similar for the EC and Norecol subsamples, but Zenon data showed some higher values for the Norecol subsample. Overall, there is reasonable similarity between the data sets. When the analytical laboratories are compared, NLET reported higher levels for cadmium, chromium, copper, iron and zinc, particularly for the Glade subsamples, but not for the other elements. Overall, the data from the two laboratories were fairly similar.

C) Dioxins and Furans

The data are shown in Table 3-4. The subsamples from EC were analyzed at the NLET, AXYS and IOS laboratories. There are some differences among laboratories, but no consistent bias is indicated throughout. The EC sample analyzed at NLET shows values fairly similar to those in the other data sets. Overall, the five data sets show reasonable agreement among the different sampling teams and laboratories.

D) Chlorophenols

The data appear in Table 3-5. The EC (NLET) laboratory detected nothing, due to its high detection limits. The AXYS laboratory had lower detection limits. At Glade, AXYS detected a low level of 2,4-dichlorophenol in the EC subsample and similar levels of pentachlorophenol in both EC and Norecol subsamples. At Waneta, AXYS measured a low level of 2,3,4,6-tetrachlorophenol in the EC subsample and similar levels of pentachlorophenol in both EC and Norecol subsamples.

TABLE 3–2 PERCENTAGES OF THE MOST ABUNDANT CADDISFLY SPECIES IN SAMPLES COLLECTED DURING THE CRIEMP EMERGENT INSECT SAMPLING AUDIT (JULY 15–16, 1992) BY EC AND NORECOL ENVIRONMENTAL CONSULTANTS

A) Upstream site (Kootenay River at Glade)
July 16, 1992

	Norecol consultant laboratory		EC consultant laboratory	
Caddisfly species	Norecol subsample	EC subsample	Norecol subsample	EC subsample
Hydropsyche oslari	0.9	1.8	0	1.18
Hydropsyche occidentalis	17.3	40.9	15.83	20.83
Cheumatopsyche campyla	60.0	39.1	68.38	56.87
Psychomyia flavida	19.1	14.5	15.16	19.80

B) Downstream site (Columbia River at Waneta)
July 15, 1992

	Norecol consultant laboratory		EC consultant laboratory	
Caddisfly species	Norecol subsample	EC subsample	Norecol subsample	EC subsample
Hydropsyche oslari	0.9	5.4	0	0
Hydropsyche occidentalis	63.6	64.9	71.67	58.71
Cheumatopsyche campyla	30.9	25.2	26.90	35.79
Psychomyia flavida	0	0	0.24	0.24

TABLE 3–3 COMPARISON OF HEAVY METALS LEVELS IN CADDISFLY SAMPLES COLLECTED BY EC AND NORECOL ENVIRONMENTAL CONSULTANTS DURING THE CRIEMP EMERGENT INSECT SAMPLING AUDIT (JULY 15–16, 1992)

Analytical data for Heavy Metals in micrograms/gram (on a WET weight basis)

(<value) : less than detection limit of Zenon laboratory (re–adjusted on a WET weight basis)

A) Upstream (control) site

Kootenay River at Glade (left bank) – July 16, 1992

	EC laboratory		Zenon laboratory	
Metal	EC subsample	Norecol subsample	EC subsample	Norecol subsample
Cadmium	0.130	0.120	0.08	0.08
Cobalt	<10	<10	(<0.08)	(<0.08)
Chromium	0.68	0.42	(<0.06)	(<0.06)
Copper	9.49	8.42	7.01	5.81
Iron	42.2	36.5	32.1	24.1
Manganese	5.27	4.74	6.08	3.62
Nickel	0.420	0.219	(<0.22)	(<0.22)
Lead	1.26	1.06	1.37	1.10
Zinc	49.0	40.1	37.0	28.8
Arsenic	0.818	0.640	0.877	0.658
Selenium	0.672	0.718	0.740	0.712
Mercury	<0.01	<0.01	(<0.01)	(<0.01)

B) Downstream site

Columbia River at Waneta (left bank) – July 15, 1992

	EC laboratory		Zenon laboratory	
Metal	EC subsample	Norecol subsample	EC subsample	Norecol subsample
Cadmium	0.212	0.229	0.195	0.217
Cobalt	<10	<10	(<0.09)	(<0.09)
Chromium	0.46	0.50	(<0.06)	(<0.06)
Copper	11.8	11.8	10.1	12.1
Iron	38.0	38.6	30.9	36.5
Manganese	4.27	3.98	3.51	4.34
Nickel	0.181	0.203	(<0.24)	(<0.24)
Lead	7.11	7.30	6.0	7.43
Zinc	62.2	67.8	54.3	64.4
Arsenic	0.620	0.609	0.51	0.653
Selenium	0.461	0.474	0.39	0.446
Mercury	0.014	0.015	(<0.015)	(<0.015)

TABLE 3–4 COMPARISON OF THE LEVELS OF DIOXINS AND FURANS IN CADDISFLY SAMPLES COLLECTED BY EC AND NORECOL ENVIRONMENTAL CONSULTANTS DURING THE CRIEMP EMERGENT INSECT SAMPLING AUDIT (JULY 15–16, 1992)

Analytical data for Dioxins and Furans (in picograms/gram WET weight)

"<value": sample detection limit
"(Value)": Peak detected but did NOT meet quantification criteria ("NDR" for AXYS)
or Not detected due to incorrect ratio ("NDR" for IOS)

NOTE: no Norecol samples for Dioxins and Furans were analysed at the EC (NLET) laboratory for either sampling site

A) Upstream (control) site Kootenay River at Glade (left bank) – July 16, 1992

	EC laboratory	AXYS laboratory		IOS laboratory		
Compound	EC subsample	EC subsample	Norecol subsample	EC subsample 1	EC subsample 2	Norecol subsample
2,3,7,8–TCDD	<0.02	<0.2	<0.1	<0.05	0.06	0.07
Total TCDD	0.42	<0.2	0.4	0.84	0.54	0.72
1,2,3,7,8–PeCDD	0.31	<0.6	<0.2	0.15	(0.17)	(0.14)
Total PeCDD	1.38	<0.6	<0.2	0.94	0.81	0.61
1,2,3,4,7,8–HxCDD	<0.03	<0.6	0.1	(0.13)	0.21	0.13
Total HxCDD	3.7	2.3	3.4	4.16	4.10	3.76
1,2,3,4,6,7,8–HpCDD	4.88	3.8	3.2	3.52	3.39	2.18
Total HpCDD	11.1	8.4	8.4	8.13	7.92	5.62
OCDD	32.4	12	16	15.71	14.82	7.84
2,3,7,8–TCDF	0.47	0.5	(0.4)	0.59	0.51	0.68
Total TCDF	2.8	1.3	1.6	2.48	2.44	2.29
1,2,3,7,8–PeCDF	<0.07	<0.4	<0.2	(0.08)	(0.09)	0.07
Total PeCDF	0.71	0.5	1.3	1.46	1.18	0.97
1,2,3,4,7,8–HxCDF	<0.05	<0.6	<0.3	(0.12)	0.16	0.12
Total HxCDF	<0.05	1.3	3.0	1.49	1.49	1.29
1,2,3,4,6,7,8–HpCDF	0.58	(2.3)	2.0	0.47	0.45	0.25
Total HPCDF	1.33	<0.7	3.4	1.09	0.95	0.58
OCDF	<0.02	<1.6	<1.0	0.58	0.59	0.33

B) Downstream site Columbia River at Waneta (left bank) – July 15, 1992

	EC laboratory	AXYS laboratory		IOS laboratory	
Compound	EC subsample	EC subsample	Norecol subsample	EC subsample	Norecol subsample
2,3,7,8–TCDD	0.57	<0.2	<0.2	0.34	0.13
Total TCDD	3.38	1.0	1.5	2.89	2.05
1,2,3,7,8–PeCDD	0.50	<0.3	<0.3	0.43	(0.41)
Total PeCDD	0.93	1.7	2.8	4.75	3.71
1,2,3,4,7,8–HxCDD	<0.01	<0.4	<0.2	0.46	0.36
Total HxCDD	5.28	3.4	5.8	10.28	9.56
1,2,3,4,6,7,8–HpCDD	3.83	(1.6)	3.9	3.57	2.79
Total HpCDD	8.83	4.7	9.5	9.40	7.79
OCDD	11	7.5	21	14.90	10.50
2,3,7,8–TCDF	3.89	1.9	2.1	3.68	3.21
Total TCDF	14.3	6.3	5.8	9.78	9.17
1,2,3,7,8–PeCDF	0.24	<0.2	<0.2	<0.04	(0.16)
Total PeCDF	1.85	2.1	2.0	3.10	2.68
1,2,3,4,7,8–HxCDF	0.21	<0.5	<0.2	0.27	0.22
Total HxCDF	1.22	0.7	1.1	1.93	1.52
1,2,3,4,6,7,8–HpCDF	0.37	(1.4)	(1.0)	0.28	0.26
Total HPCDF	0.37	<0.8	<0.3	0.58	0.60
OCDF	<0.02	<2.2	<0.3	0.45	0.31

TABLE 3–5 COMPARISON OF THE LEVELS OF CHLOROPHENOLS IN CADDISFLY SAMPLES COLLECTED BY EC AND NORECOL ENVIRONMENTAL CONSULTANTS DURING THE CRIEMP EMERGENT INSECT SAMPLING AUDIT (JULY 15–16, 1992)

Analytical data for Chlorophenols in nanograms/gram (WET weight basis)
Values received from EC (NLET) laboratory were expressed on a DRY weight basis
and were recalculated to a WET weight basis
Values received from AXYS laboratory were expressed on a WET weight basis

"<value": under sample detection limit
"(Value)": Peak detected but did NOT meet quantification criteria ("NDR" for AXYS)

A) Upstream (control) site Kootenay River at Glade (left bank) – July 16, 1992

	EC laboratory		AXYS laboratory	
Chlorophenol	EC subsample	Norecol subsample	EC subsample	Norecol subsample
2–chlorophenol	< 76	< 74	--	--
3–chlorophenol	< 38	< 37	--	--
4–chlorophenol	< 38	< 37	<0.5	<0.9
2–chloro–5–methylphenol	<101	< 98	--	--
2,6–dichlorophenol	< 25	< 25	<0.5	<0.2
4–chloro–3–methylphenol	<101	< 98	--	--
2,4–dichlorophenol	< 50	< 49	0.5	<0.7
3,5–dichlorophenol	< 50	< 49	<0.1	<0.1
2,3–dichlorophenol	< 50	< 49	<0.1	<0.1
3,4–dichlorophenol	< 50	< 49	<0.08	<0.1
2,4,6–trichlorophenol	< 25	< 25	<0.2	<0.2
2,3,6–trichlorophenol	< 50	< 49	<0.2	<0.2
2,3,5–trichlorophenol	< 50	< 49	<0.3	<0.3
2,4,5–trichlorophenol	< 50	< 49	<0.1	<0.1
2,3,4–trichlorophenol	< 50	< 49	<0.2	<0.2
3,4,5–trichlorophenol	< 50	< 49	<0.1	<0.1
2,3,5,6–tetrachlorophenol	< 25	< 25	<0.4	<0.3
2,3,4,6–tetrachlorophenol	< 25	< 25	<0.5	<0.5
2,3,4,5–tetrachlorophenol	< 25	< 25	<0.2	<0.2
Pentachlorophenol	< 13	< 12	2.6	2.4

B) Downstream site Columbia river at Waneta (left bank) – July 15, 1992

	EC laboratory		AXYS laboratory	
Chlorophenol	EC subsample	Norecol subsample	EC subsample	Norecol subsample
2–chlorophenol	< 78	< 79	--	--
3–chlorophenol	< 39	< 39	--	--
4–chlorophenol	< 39	< 39	(0.6)	<0.6
2–chloro–5–methylphenol	<104	<105	--	--
2,6–dichlorophenol	< 26	< 26	<0.2	<0.5
4–chloro–3–methylphenol	<104	<105	--	--
2,4–dichlorophenol	< 52	< 53	<0.2	<0.6
3,5–dichlorophenol	< 52	< 53	<0.2	<0.2
2,3–dichlorophenol	< 52	< 53	<0.2	<0.2
3,4–dichlorophenol	< 52	< 53	<0.1	<0.1
2,4,6–trichlorophenol	< 26	< 26	<0.2	<0.2
2,3,6–trichlorophenol	< 52	< 53	<0.2	<0.3
2,3,5–trichlorophenol	< 52	< 53	<0.3	<0.3
2,4,5–trichlorophenol	< 52	< 53	<0.1	<0.2
2,3,4–trichlorophenol	< 52	< 53	<0.2	<0.2
3,4,5–trichlorophenol	< 52	< 53	<0.1	<0.2
2,3,5,6–tetrachlorophenol	< 26	< 26	<0.3	<0.4
2,3,4,6–tetrachlorophenol	< 26	< 26	0.5	<0.5
2,3,4,5–tetrachlorophenol	< 26	< 26	<0.2	<0.3
Pentachlorophenol	< 13	< 13	6.5	7.4

V. CONCLUSIONS AND RECOMMENDATIONS

For the most part, the data sets for heavy metals and for dioxins and furans show fair agreement between values obtained by Environment Canada and Norecol. The data sets for chlorophenols cannot be compared. In its insect identification data set, Norecol should have provided the size of its samples (i.e. the raw numbers of insects counted); this information would allow an assessment of the apparent differences in species composition between subsamples.

Norecol used procedures which were partly different from those used by Environment Canada: cloth towels versus air to dry the cleaned traps, transport in cardboard cartons, and sorting of the collected insects in a motel room versus a field laboratory. Since the data from Norecol were fairly similar to those from EC, these procedural differences did not seem to affect the results.

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APPENDIX 1

IDENTIFICATION OF ADULT INSECTS

IDENTIFICATION OF ADULT TRICHOPTERA AND OTHER INSECTS COLLECTED IN EMERGENCE TRAPS IN THE COLUMBIA RIVER AND TRIBUTARIES

by

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for

Environment Canada, Conservation and Protection
Environmental Studies Division
North Vancouver, B.C.

October 1992

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGMENTS

My thanks go to Ms. Pat MacCulloch of the Royal Ontario Museum, Toronto, for her prompt and helpful response identification of specimens to species. Thanks also go to Ms. Gail Moyle of Environment Canada for her interest in the progress of the project throughout.

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October 1992

INTRODUCTION

In the summer of 1992, Environment Canada collected insect specimens from 11 emergence trap samples placed in the Columbia, Kootenay and Slocan Rivers in southern British Columbia, as part of the Columbia Monitoring Project. Applied Technical Services was contracted to provide detailed information on the adult Trichoptera from these samples, and also to identify as far as possible any other common insect species.

The following brief report describes the materials and methods used in the analyses, tables of the results and Appendices.

MATERIALS AND METHODS

Sorting and Identification

Samples were sieved through fine Nitex (133 μm) and rinsed in tap water to remove preservative. Extreme care was taken not to damage the insects, which are very delicate in the adult stages. When large numbers of insects were present, the total sample was weighed on an OHaus electronic balance and a subsample by weight was taken for identification. After the subsample had been analysed, the entire sample was examined for rare species.

Identifications of Trichoptera to family level were performed using Merritt and Cummins (1984). Knowledge from other studies performed by Applied Technical Services (Stallard 1991a,b,c; 1992a,b) on benthos and fish diet in similar areas to the present study were used for further identification to genus. The specimens were separated by species and sex and up to 100 of each type from each sample were sent to the laboratory of Dr. Glen Wiggins, a world-renowned Trichoptera expert (e.g., Wiggins 1977) for specific identification. Actual analyses at the Royal Ontario Museum (ROM) in Toronto were performed by Ms. Pat MacCulloch.

Identifications of other adult insects were performed using Edmunds et al. (1976), and Merritt and Cummins (1984). Chironomidae, most other Diptera, Aphididae, and other Homoptera were not further identified.

The specimens were preserved in 70% isopropyl alcohol.

Data and Reporting

After receipt of the samples and analyses from the ROM, the data were extrapolated to total numbers found in each sample, and tabulated. Appendices 1 and 2 contain raw data (computerised copies of lab sheets) and correspondence with the ROM, respectively.

RESULTS

Table 1 lists the numbers of each species or group of insects identified in the 11 samples. Totals are not given for non-Trichoptera. Table 2 gives the percent composition of Trichoptera in the samples.

Table 1. Numbers of organisms counted in total sample

Sample No.		1	2	3	4	5	6	7	8	9	10	11	TOTAL
Location		Slocan A	Slocan B	Waneta A	Syringa	Celgar	Kootenay A	Waneta B	Waneta	Kootenay B	Kootenay	Kootenay	
Date		7/9/92	7/10/92	7/11/92	7/12/92	7/13/92	7/14/92	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	
Subsample*		1	1	4	1	4	1	4	1	5	1	75	
Species	**Stage**												
TRICHOPTERA													
Hydropsychidae													
Arctopsyche grandis	M	1											1
Arctopsyche grandis	F	1						16					17
Cheumatopsyche campyla	M			41		13	16	92	21	509		924	1616
Cheumatopsyche campyla	F		1	1305		243	602	520	92	452		5147	8362
Hydropsyche oslari	M		1							20			21
Hydropsyche oslari	F		13		1								14
Hydropsyche ambila	F		3										3
Hydropsyche occidentalis	M			19		51	6	152	55	183		347	813
Hydropsyche occidentalis	F	12		587	4	913	100	852	246	169		1058	3941
Hydropsyche spp.	M	1						12			12		25
Hydropsyche spp.	F							58	3		6		65
Hydroptilidae													
Hydroptila wyomia	M						1						1
Hydroptila hamata	M									1			1
Hydroptila angusta	M									2			2
Hydroptila xera	M									1			1
Hydroptila sp.	M			1				1					2
Hydroptila sp.	F			5		18	4	5	2	6		52	92
Ithytrichia sp.	F											2	2
Protoptila sp.	F											2	2
Lepidostomatidae													
Lepidostoma pluviale	M		1										1
Lepidostoma spp.										1			1
Lepidostoma spp.		1								2	1		4
Glossosomatidae													
Glossosoma montana	M		2			9							11
Glossosoma montana	F					7							7
Leptoceridae													
Ceraclea (annulicornis)	M						1						1
Ceraclea (annulicornis)	F				1	5				4			10
Oecetis avara	M									1			1
Oecetis spp.	F						1						1

continued ...

Table 1. (continued) Numbers of organisms counted in total sample

Sample No.		1	2	3	4	5	6	7	8	9	10	11	TOTAL
Location		Slocan A	Slocan B	Waneta A	Syringa	Celgar	Kootenay A	Waneta B	Waneta	Kootenay B	Kootenay	Kootenay	
Date		7/9/92	7/10/92	7/11/92	7/12/92	7/13/92	7/14/92	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	
Subsample*		1	1	4	1	4	1	4	1	5	1	75	
Species	Stage												
Leptoceridae (cont'd)													
Mystacides (alafimbriata)	M						1			1			2
Mystacides (alafimbriata)	F									2			2
Mystacides (sepulchralis)	F					1							1
Polycentropodidae													
Polycentropus (cinereus)	F					1							1
Psychomyidae													
Psychomyia flavida	M	1				4	40	1		76		94	216
Psychomyia flavida	F			8		43	193	3	1	260	5	1252	1765
Limnephilidae													
Ecclisomyia (conspersa)	F				1								1
TOTAL TRICHOPTERA		17	21	1966	7	1308	965	1710	420	1690	24	8878	17006
LEPIDOPTERA													
Petrophila spp.	M			1							8	4	13
Petrophila spp.	F	2					2				13	49	66
EPHEMEROPTERA												75	75
Ephemerella inermis	M										9		9
Ephemerella inermis	F					2		1			13		16
Baetis tricaudatus	M										3		3
Baetis tricaudatus	F										2		2
DIPTERA				26		3		26	8			75	138
Tipulidae													
Antocha spp.											3		3
Antocha spp.											1		1
Chironomidae		3	2	127	1	86	99	101	51		2	374	846
HEMIPTERA													
Aphididae								1	1				2
Homoptera								1	1				2
COLEOPTERA													
Staphylinidae								1					1

Table 2. Percent species composition of Trichoptera in each sample.

Sample No.		1	2	3	4	5	6	7	8	9	10	11	TOTAL
Location		Slocan A	Slocan B	Waneta A	Syringa	Celgar	Kootenay A	Waneta B	Waneta	Kootenay B	Kootenay	Kootenay	
Date		32332	32333	7/11/92	7/12/92	7/13/92	7/14/92	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	
Subsample*		1	1	4	1	4	1	4	1	5	1	75	
Species	**Stage**												
TRICHOPTERA													
Hydropsychidae													
Arctopsyche grandis	M	5.88											0.01
Arctopsyche grandis	F	5.88						0.94					0.10
Cheumatopsyche campyla	M			2.09		0.99	1.66	5.38	5.00	30.12		10.41	9.50
Cheumatopsyche campyla	F		4.76	66.38		18.58	62.38	30.41	21.90	26.75		57.97	49.17
Hydropsyche oslari	M		4.76							1.18			0.12
Hydropsyche oslari	F		61.90		14.29								0.06
Hydropsyche ambilis	F		14.29										0.02
Hydropsyche occidentalis	M			0.97		3.90	0.62	8.89	13.10	10.83		3.91	4.78
Hydropsyche occidentalis	F	70.59		29.86	57.14	69.90	10.36	49.82	58.57	10.00		11.92	23.17
Hydropsyche spp.	M	5.88						0.70			50.00		0.15
Hydropsyche spp.	F							3.27	0.71		25.00		0.38
Hydroptilidae													
Hydroptila wyomia	M						0.10						0.01
Hydroptila hamata	M									0.06			0.01
Hydroptila angusta	M									0.12			0.01
Hydroptila xera	M									0.06			0.01
Hydroptila sp.	M			0.05				0.06					0.01
Hydroptila sp.	F			0.25		1.38	0.41	0.29	0.48	0.36		0.59	0.54
Ithytrichia sp.	F											0.02	0.01
Protoptila sp.	F											0.02	0.01
Lepidostomatidae													
Lepidostoma pluviale	M		4.76										0.01
Lepidostoma spp.										0.06			0.01
Lepidostoma spp.		5.88								0.12	4.17		0.02
Glossosomatidae													
Glossosoma montana	M		9.52			0.69							0.06
Glossosoma montana	F					0.54							0.04
Leptoceridae													
Ceraclea (annulicornis)	M						0.10						0.01
Ceraclea (annulicornis)	F				14.29	0.38				0.24			0.06
Oecetis avara	M									0.06			0.01
Oecetis avara	F												
Oecetis spp.	F						0.10						0.01

continued ...

Table 2 (continued). Percent species composition of Trichoptera in each sample.

Sample No.		1	2	3	4	5	6	7	8	9	10	11	TOTAL
Location		Slocan A	Slocan B	Waneta A	Syringa	Celgar	Kootenay A	Waneta B	Waneta	Kootenay B	Kootenay	Kootenay	
Date		32332	32333	7/11/92	7/12/92	7/13/92	7/14/92	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	
Subsample*		1	1	4	1	4	1	4	1	5	1	75	
Species	Stage												
Leptoceridae (cont'd)													
Mystacides (alafimbriata)	M						0.10			0.06			0.01
Mystacides (alafimbriata)	F									0.12			0.01
Mystacides (sepulchralis)	F					0.08							0.01
Polycentropodidae													
Polycentropus (cinereus)	F					0.08							0.01
Psychomyidae													
Psychomyia flavida	M	5.88				0.31	4.15	0.06		4.50		1.06	1.27
Psychomyia flavida	F			0.41		3.29	20.00	0.18	0.24	15.38	20.83	14.10	10.38
Limnephilidae													
Ecclisomyia (conspersa)	F				14.29								0.01
TOTAL PERCENT		100	100	100	100	100	100	100	100	100	100	100	100

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APPENDIX 1

RAW DATA

Sample 1. Slocan A. 9 Jul 92.

Ident	Sex	Number	SS	Total Number
Petrophila	f	2	1	2
Chironomid		3	1	3
Hydropsychidae	f	12	1	12
Hydropsychidae	m	1	1	1
Psychomyia	m	1	1	1
Hydropsychidae #3	f	2	1	2
Lepidostomatidae	f	1	1	1

Sample 2. Slocan B. 10 Jul 92.

Ident	Sex	Number	SS	Total Number
Chironomid		2	1	2
Hydropsychidae	f	17	1	17
Hydropsychidae	m	1	1	1
Hydropsychidae *2	f	1	1	1
Lepidostomatidae	m	1	1	1

Sample 3. Waneta A. 11 Jul 92.

Ident	Sex	Number	SS	Total Number
Petrophila	m	1	1	1
Psychomyia	f	8	1	8
Hydroptilidae	f	5	1	5
Hydroptilidae	m	1	1	1
Hydropsychidae	f	473	4	1892
Hydropsychidae	m	15	4	60
Chironomidae		127	1	127
Diptera		26	1	26
Glossosoma	m	2	1	2

Sample 4. Arrow Lake, Syringa Ck. 12 July 1992.

Ident	Sex	Number	SS	Total Number
Hydropsychidae	f	5	1	5
Leptoceridae	f	1	1	1
Limnephilidae	f	1	1	1
Chironomidae		1	1	1

Sample 5. Celgar. 13 July 1992.

Ident	Sex	Number	SS	Total Number
Hydropsychidae	f	289	4	1156
Hydropsychidae	m	16	4	64
Psychomyia	f	43	1	43
Psychomyia	m	4	1	4
Hydroptilidae	f	18	1	18
Glossosoma	f	7	1	7
Glossosoma	m	9	1	9
Ephemerella	f	2	1	2
Chironomid		86	1	86
Diptera		3	1	3
Leptoceridae	f	5	1	5
Leptoceridae #2	f	1	1	1
Polycentropodidae	f	1	1	1

Sample #6. Kootenay A. 14 July 1992.

Ident	Sex	Number	SS	Total Number
Hydropsychidae	f	702	1	702
Hydropsychidae	m	22	1	22
Psychomyia	f	193	1	193
Psychomyia	m	40	1	40
Hydroptilidae	f	4	1	4
Petrophila	f	2	1	2
Diptera		99	1	99
Leptoceridae	f	1	1	1
Leptoceridae #2	f	1	1	1
Leptoceridae #3	f	1	1	1

Sample 7. Waneta B. 15 July 1992.

Ident	Sex	Number	SS	Total Number
Aphid		1	1	1
Ephemerella	f	1	1	1
Hydropsychidae	f	361	1	361
Hydropsychidae	m	65	1	65
Diptera		26	1	26
Chironomid		101	1	101
Psychomyia	f	3	1	3
Psychomyia	m	1	1	1
Staphylinidae		1	1	1
Homoptera		1	1	1
Hydroptilidae	f	5	1	5
Hydroptilidae	m	1	1	1

Sample 8. Waneta. 15 July 1992. Norecol.

Ident	Sex	Number	SS	Total Number
Diptera		8	1	8
Hydropsychidae	f	341	1	341
Hydropsychidae	m	77	1	77
Psychomyia	f	1	1	1
Hydroptilidae	f	2	1	2
Homoptera		1	1	1
Aphid		1	1	1
Chironomid		51	1	51

Sample 9. Kootenay B. 16 July 1992.

Ident	Sex	Number	SS	Total Number
Hydropsychidae	f	122	5.090	621
Hydropsychidae	m	140	5.090	713
Psychomyia	f	51	5.090	260
Psychomyia	m	15	5.090	76
Hydroptilidae	f	7	1	7
Hydroptilidae	m	4	1	4
Ceraclea	f	3	1	3
Diptera		P	1	0
Homoptera		P	1	0
Petrophila	f	9	1	9
Petrophila	m	3	1	3
Lepidostomatidae	f	3	1	3
Leptoceridae #1	f	2	1	2
Leptoceridae #2	f	3	1	3
Leptoceridae #3	f	1	1	1
Ephemeroptera		P	1	0

Sample 9. Kootenay. 16 July 1992. OTHER.

Ident	Sex	Number	SS	Total Number
Petrophila	f	13	1	13
Petrophila	m	8	1	8
Hydropsychidae	f	6	1	6
Hydropsychidae	m	12	1	12
Psychomyia	f	5	1	5
Lepidostomatidae	m	1	1	1
Antocha	f	1	1	1
Antocha	m	3	1	3
Ephemerella inermis	f	13	1	13
Ephemerella inermis	m	9	1	9
Baetis tricaudatus	f	2	1	2
Baetis tricaudatus	m	3	1	3
Chironomid		2	1	2

Sample 11. Kootenay. 16 July 1992. Norecol.

Ident	Sex	Number*	SS**	Total Number
Hydropsychidae	f	83	74.76	6205
Hydropsychidae	m	17	74.76	1271
Psychomyia	f	16.74	74.76	1252
Psychomyia	m	1.26	74.76	94
Hydroptilidae	f	7	1	7
Hydroptilidae	m	4	1	4
Diptera		P	1	0
Chironomid		P	1	0
Ephemeroptera		9	1	9
Petrophila	m	3	1	3
Lepidostomatidae	f	3	1	3
Leptoceridae #1	f	2	1	2
Leptoceridae #2	f	3	1	3
Leptoceridae #3	f	1	1	1
Ephemeroptera		P	1	0

* Uneven numbers caused by extrapolating sex breakdown of 100 animals
** Subsample based on examination of 1.092g out of 81.64 g.

APPENDIX 2

CORRESPONDENCE WITH ROM

APPLIED TECHNICAL SERVICES

P.O. Box 514
Saanichton
British Columbia, V0S 1M0
Tel: (604) 479-1889
FAX: (604) 479-2962

Dr. Glenn Wiggins
Department of Entomology
Royal Ontario Museum
100 Queenspark
Toronto Ontario M5S 2C6

August 12, 1992

Dear Dr. Wiggins:

Enclosed please find the samples of adult Trichoptera from the Columbia system collected by Environment Canada this July. I have separated them into genera, and have included fairly large numbers of the important ones; so, although this may look like a lot of identifications for you, there is a lot of duplication of species. Although I noticed that there is a large size range of the Hydropsyche, I have assumed that they are all one species—if not, I'm in trouble!! I have assigned the genera to these adults based on the genera of larvae I have identified from the same region. I have enclosed a few specimens of these also, but it is not essential that you look at them. I have also enclosed a Lepidopteran (Petrophila?). If it is too much trouble to identify this, please ignore it.

My entire budget for this project is only $660.00 ($60 per sample)—if it looks as if your costs are likely to approach this number, please let me know and I can try and get an amendment from my Scientific Authority.

A list of the samples I have enclosed are as follows:

1.	Slocan River A	9 July 1992	Hydropsyche #3?	2
2.	Slocan River B	10 July 1992	Hydropsyche	17
			Hydropsyche #2?	1
			Brachycentrus	1
3.	Waneta A	11 July 1992	Glossosoma	2
4.	Arrow Lake,	12 July 1992	Hydropsyche	5
	Syringa Creek		Ceraclea	1
			Limnephilidae	1
5.	Celgar	13 July 1992	Ceraclea?	5
			Leptoceridae #2	1
			Polycentropodidae	1
			Glossosoma	16
			Hydroptila	18
6.	Kootenay River A	14 July	Hydropsyche ♀	100
			Hydropsyche ♂	100
			Psychomyia ♀	100

			Psychomyia ♂	40
			Leptoceridae #1 (Ceraclea?)	1
			Leptoceridae #2	1
			Leptoceridae #3	1
			Hydroptila	4
9.	Waneta B	15 July	Hydropsyche ♀	100
			Hydropsyche ♂	100
			Psychomyia ♀	51
			Psychomyia ♂	15
			Hydroptila	7
			Leptoceridae #1	2
			Leptoceridae #2	3
			Leptoceridae #3	1
			Brachycentrus?	3
11.	Kootenay River	16 July	Hydropsyche	100
			Psychomyia	100
			Hydroptila	56
			Petrophila	53

As I already mentioned, there is a lot of duplication, and, as far as I know, it's the common species that Environment Canada is interested in. They sent me only a subsample of the collected insects; the remainder are being analysed for pollutants. My function was to separate the species and have them identified. I, however, am always interested to know all the species I see!

If you can recommend any publications which would assist me in my identifications of British Columbia Trichoptera, I would be grateful. I have only recently become involved in analyses of freshwater benthic invertebrates, although I have been involved in identifications of marine and freshwater zooplankton and fish for over 15 years. Since this is a new field for me, and since many of the publications are unavailable, even in libraries, it is very difficult to get hold of some of the articles and books. (I do, of course, have a copy of your key to the larvae.)

I hope to hear from you soon with the results of these identifications (my deadline for reporting is 15 September), and I would appreciate it if you could return the samples to me at your convenience (collect). If you wish to keep any of the specimens for you own colelction, please feel free. Thank you for your assistance.

Sincerely

Nell Stallard, M.Sc.
Manager

Royal Ontario Museum
Musée royal de l'Ontario

100 Queen's Park
Toronto, Ontario
Canada M5S 2C6

ROM

Entomology

416-586-5532
FAX 416-586-5863

September 29, 1992

Ms. Nell Stallard, Manager
Applied Technical Services
P.O. Box 514
Saanichton, British Columbia
V0S 1M0

Dear Nell:

I hope the identifications reached you in time for your deadline. There was a little confusion between the labels in the vials and your typed locality list for # 9 - either Kootenay B or Waneta B - but # 9 nonetheless.

It is always interesting to see British Columbia Trichoptera, although most are representatives of widespread Nearctic or western Nearctic species. As far as publications for that fauna are concerned, the literature is scattered as you probably realize, and not really regional. Schmid 1980 (Genera des Trichoptéres du Canada et des Etats adjacents) part 7 of the Agriculture Canada series is out of print, but if you can get hold of a copy it is the only comprehensive treatment of northern genera. To find keys to species (particularly western species) is another story altogether. You could write to Dr. Andrew P. Nimmo, Department of Entomology, University of Alberta, Edmonton, Alberta, T6G 2E3. I believe he has a good handle on the available literature and he might be able to advise you.

I am enclosing our invoice for 12 hours of identification work. We would normally expect to charge $50.00 per hour for commercial identifications, but obviously you did not anticipate the time involved in sorting and specimen preparation, so we'll absorb some of the expense at this end. If you have more contracts of this sort, I might be able to help you locate an appropriate consultant.

I would be interested in the results of the pollutant absorption studies. Do you know whether they are studying effects on larvae as well as adults?

The specimens are being returned via courier-collect, as per your suggestion.

Best of luck to you, and let me know if we can be of future help.

Yours sincerely,

Pat MacCulloch

Patricia W. MacCulloch
Curatorial Assistant
Department of Entomology

encl.
PWM/cr

1.	Slocan River A	9 July 1992	Arctopsyche grandis Banks	1♂, 1♀
2.	Slocan River B	16? July 1992	Hydropsyche oslari Banks	1♂. 13♀
			Hydropsyche amblis Ross	3♀
		16? July 1992	Cheumatopsyche sp.	1♀
		16? July 1992	Lepidostoma pluviale (Milne)	1♂
3.	Waneta A	11 July 1992	Glossosoma montana Ross	2♂
4.	Arrow Lake Syringa Creek	12 July 1992	Hydropsyche oslari Banks	1♀
			Hydropsyche occidentalis Banks	4♀
			Ceraclea sp.	1♀
			Ecclisomyia (prob. conspersa)	1♀
5.	Celgar	13 July 1992	Ceraclea sp.	5♀
			Mystacides (prob. sepulchralis)	1♀
			Polycentropus (prob. cinereus)	1♀
			Glossosoma montana Ross	9♂, 7♀
			Hydroptila sp.	18♀
			Psychomyia flavida Hagen	1♀
6.	Kootenay River A.	14 July 1992	Hydropsyche occidentalis Banks	7♀
			Cheumatopsyche campyla Ross	42♀
			Hydropsyche occidentalis Banks	6♂
			Cheumatopsyche campyla Ross	16♂
			Psychomyia flavida Hagen	>50♀
			Psychomyia flavida Hagen	<50♂
			Oecetis sp.	1♀
			Mystacides alafimbriata Hill-Griffin	1♂
			Ceraclea (prob. annulicornis)	1♂
			Hydroptila wyomia Denning	1♂, (4♀)

9.	Kootenay B (labels in vials)	Hydropsyche occidentalis Banks	34♀
		Cheumatopsyche campyla Ross	91♀
		Ceraclea sp.	1♀
		Hydropsyche occientalis Banks	36♂
		Hydropsyche oslari Banks	4♂
		Cheumatopsyche campyla Ross	100♂
		Psychomyia flavida Hagen	all ♀
		Psychomyia flavida Hagen	15♂
		Hydroptila hamata Morton	1♂
		Hydroptila angusta Ross	2♂
		Hydroptila xera Ross	1♂
		Hydroptila sp.	6♀
		Ceraclea sp.	2♀
		Mystacides alafimbriata Hill-Griffen	1♂, 2♀
		Oecetis avara (Banks)	1♂
		Lepidostoma spp.	1♀ + 2♀
11.	Kootenay River 16 July 1992	Hydropsyche occidentalis Banks	3♂, 15♀
		Cheumatopsyche campyla Ross	8♂, 73♀
		Psychomyia flavida Hagen	all ♂♂, ♀♀
		Hydroptila sp.	27♀
		Ithytrichia ?	1♀
		Protoptila sp.	1♀
		Did not identify Petrophila specimens	

Larvae

MW230F069	March 1992	Hydropsyche (prob. centra)	12
		Hydropsyche sp.	1
MW240F070	March 1992	Brachycentrus sp.	1
		Ceraclea sp.	1
MW230F069	March 1992	Brachycentrus sp.	1
MW500F0357	March 1992	Glossosoma sp.	1
MW80F017	March 1992	Psychomyia sp.	1
MW96EC4384	July 1992	Ochrotrichia sp.	1