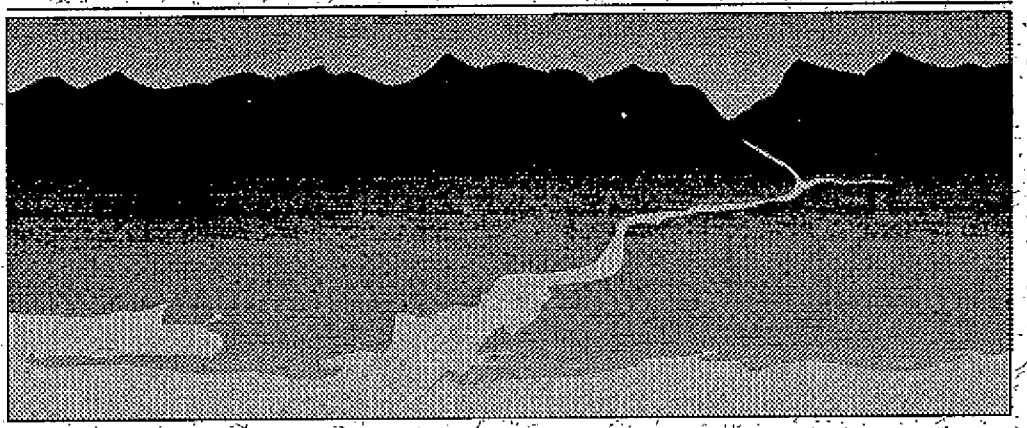
FINAL REPORT

LOWER COLUMBIA RIVER



BI-STATE PROGRAM

LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

VOLUME 2: DATA VALIDATION REPORT, (APPENDIX A)

DECEMBER 1993

Prepared By:

TETRA TECH

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TC 9497-05
FINAL REPORT

LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

VOLUME 2: DATA VALIDATION REPORT, (APPENDIX A)

DECEMBER 1993

Prepared For:

The Lower Columbia River
Bi-State Water Quality Program

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APPENDIX A
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
DATA VALIDATION REPORTS

INTRODUCTION

One of the main objectives of the Lower Columbia River Bi-State Water Quality Program (Bi-State Program) is to conduct reconnaissance surveys to determine the level of contaminants in water, sediment, and tissue. Data collected by the Bi-State Program during the fall of 1991 showed elevated levels of certain contaminants in all three of the above media (*Lower Columbia River Reconnaissance Survey*). Additional reconnaissance sampling of backwater areas was conducted by the Bi-State Program during July and August of 1993 to supplement data collected during the earlier survey. Three volumes describe the results obtained from this survey.

- Volume 1 Technical Report
- Volume 2 Data Validation Report (Appendix A)
- Volume 3 Data Appendix

This document (Volume 2) provides the Data Validation Reports (DVR) for the analytical data collected during the 1993 Backwater Reconnaissance survey. The information contained in this document is intended to be used by those individuals who want a detailed description of data quality as evaluated from the analysis of quality control (QC) data.

A separate DVR is included for each of the ten general chemical, or environmental assessment, categories analyzed as part of the Backwater Reconnaissance survey. The ten categories, as well as the media analyzed (i.e., water, sediment, tissue) are listed below:

Analytical Group	Matrices
Bacteria	Water
Water Conventionals	Water
Sediment Conventionals	Sediment
Toxicity	Sediment
Metals	Water, Sediment, Tissue
Semi-volatile organics	Sediment, Tissue
Pesticides and PCBs	Sediment, Tissue
Dioxins and furans	Sediment, Tissue
Polybutyl tins	Sediment, Tissue
Radionuclides	Sediment, Tissue

Each DVR includes a description of the number of samples collected, a summary of the analytical methodology, an evaluation of the quality control (QC) data collected by the laboratory in conjunction with the analysis of the field samples, and a data table which includes all data qualifiers assigned based

on the evaluation of QC data.

A brief summary of each of the DVRs is presented below:

Bacteria

Triplicate field samples were taken from each of the fifteen stations and analyzed for *E. coli*, fecal coliform, and enterococcus bacteria. All methods used the multiple-tube fermentation technique, results of which are reported in terms of the Most Probable Number (MPN). Results for all of the fecal coliform and *E. coli* samples were above the method reporting limit (MRL)(2 colonies/100 mL), while only one-half of the enterococcus samples were above the MRL. Those samples which were not detected above the MRL were qualified with a U. No data qualifiers other than U (undetected) were assigned to any of the sample results.

Water Conventionals

For this project, conventional variables in water have been defined as total phosphorous (total-P), soluble reactive phosphorus (SRP), dissolved ammonia, dissolved nitrate+nitrite, total Kjeldahl nitrogen (TKN), total suspended solids (TSS), hardness, chlorophyll/phaeophytin, cyanide, total organic carbon (TOC), dissolved organic carbon (DOC), and particulate organic carbon (POC). Triplicate field samples were collected and analyzed at every station for total-P, SRP, ammonia, nitrate+nitrite, and TKN. For all other parameters single samples were collected and analyzed at each station, except station 9, where triplicate samples were collected and analyzed.

The detection limits reported by the laboratory met the goals specified in the Sampling and QA/QC Plan (Tetra Tech 1993). For most of the parameters (total-P, ammonia, nitrate+nitrite, TSS, hardness, conductivity, cyanide, TOC, and POC), no data qualifiers, other than U (undetected), were assigned. For SRP, one of the forty-five samples was qualified as estimated based on laboratory precision data. For TKN, two of the forty-five samples was qualified as estimated based on laboratory precision data. For phaeophytin *a*, two of the seventeen samples were qualified as estimated based on laboratory precision data. All of the DOC data were qualified as unusable because of suspected blank contamination.

Sediment Conventionals

For this project, conventional variables in sediment have been defined as total solids, total volatile solids (TVS), total organic carbon (TOC), ammonia, total sulfides, total Kjeldahl nitrogen (TKN), sediment grain size, and cyanide. A total of seventeen samples were collected at fifteen stations. Triplicate samples were collected and analyzed at one station (9), while single samples were collected and analyzed at all other stations.

The detection limits reported by the laboratory met the goals specified in the Sampling and QA/QC Plan (Tetra Tech 1993). For all parameters except grain size, no data qualifiers, other than U (undetected), were assigned. For grain size, one of the seventeen samples was qualified as estimated based on laboratory precision data.

Toxicity

Seventeen sediment samples were analyzed for toxicity using both the solid-Phase Microtox test and the 10-day amphipod survival test with *Hyalella azteca*. Triplicate samples were collected and analyzed at one station (9), while single samples were collected and analyzed at all other stations.

Although the solid-phase Microtox test has only been recently developed, QC data collected during the test indicate that the results are comparable to other solid-phase Microtox test results. For the amphipod toxicity test, the survival from two replicates was abnormally low and could not be explained by the laboratory. Negative control data for both the Microtox and amphipod tests indicated that the reported results should be reasonable estimates of sediment toxicity.

Metals

Ninety water samples, seventeen sediment samples, and thirty-three tissue samples (15 crayfish and 18 fish) were collected at 15 different stations. For water samples, pairs of triplicate samples were collected and analyzed at every station for both dissolved and total recoverable metals. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13. Detection limits reported by the laboratory for water and sediment met the goals specified in the sampling and QA/QC plan (Tetra Tech 1993). For tissues, the detection limits reported for arsenic, lead, mercury, nickel, and selenium were approximately 3X greater than those specified in the QC plan. The laboratory could not meet the target detection limits for these metals because of matrix interference.

Sample results for several metals were qualified as estimated based on evaluation of QA/QC data. Three positive values for cadmium in water, one for lead in water, and approximately 15 for lead, selenium, and silver in tissue were qualified as estimates based on exceedance of continuing calibration verification criteria.

Because of metals detected in various blank samples, approximately 40 values for eight different metals in water (aluminum, cadmium, chromium, copper, lead, nickel, thallium, and zinc), 4 values for both lead and silver in sediment, and several values for chromium, lead, and mercury in tissue were qualified as undetected due to blank contamination.

Forty values for six different metals in water (aluminum, iron, lead, nickel, thallium, and zinc) were qualified as estimates based on exceedances of QC guidelines for matrix spikes. Because of a high spike recovery, all mercury values in sediment were qualified as estimates. For tissue, most of the values for lead and several values for silver were qualified as estimates based on exceedances of QC guidelines for matrix spikes.

Several values for aluminum, lead, and zinc in water; arsenic, beryllium, and cadmium in sediment; and approximately 15 values for six different metals in tissue (cadmium, chromium, lead, nickel, silver, and zinc) were qualified as estimates based on exceedances of QC guidelines for laboratory precision. All zinc values in tissue were qualified as estimates based on exceedance of the ICP serial dilution QC guidelines.

The precision, accuracy, and completeness of the metals analyses were generally within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Semi-volatile organics

Seventeen sediment samples and thirty-three tissue samples (15 crayfish and 18 fish) were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13.

All samples were analyzed for semi-volatile organics using both gas chromatography/mass spectrometry (GC/MS) and GC/MS with selective ion monitoring (SIM) for polycyclic aromatic hydrocarbons (PAHs). PAHs were analyzed using both methods, but the reported data were from the SIM analyses due to its lower achievable detection limits.

The detection limits reported by the laboratory for semi-volatile organics (excluding PAHs) met the goals specified in the Sampling and QA/QC Plan (Tetra Tech 1993) for sediment, but were higher for the tissue samples due to matrix interference with the phthalate compounds for crayfish samples and the high lipid content of the fish samples. The detection limits reported for PAHs using SIM met the goals for all three media.

Several sample results were qualified as undetected due to blank contribution. The compounds qualified in this manner included bis(2-ethylhexyl)phthalate (1 out 17 sediment samples), indeno(1,2,3-cd)pyrene (6 out of 17 sediment samples), benzo(g,h,i)perylene (9 out of 17 sediment samples), naphthalene (8 out of 15 crayfish samples), and 2-methyl naphthalene (2 out of 15 crayfish samples).

Several positive crayfish sample results were qualified as estimates because of internal standard recoveries outside of advisory QC limits. The compounds qualified in this manner included acenaphthalene (1 sample), dibenzofuran (1 sample), and fluorene (1 sample).

An evaluation of the QA/QC data indicates that the reported data are reliable measures of the semi-volatile organic compound concentrations in the three media analyzed.

Pesticides and PCBs

Seventeen sediment samples and thirty-three tissue samples (15 crayfish and 18 fish) were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13.

The detection limits reported by the laboratory were higher than the goals specified in the Sampling and QA/QC Plan (Tetra Tech 1993). The laboratory could not meet the detection limit goals because of matrix interference in all three media.

Several positive sample results for p,p'-DDT in fish were qualified as estimates based on exceedance of continuing calibration percent difference limits.

Very few compounds, specifically DDT and its derivatives and two of the Aroclor mixtures, were detected in any of the samples. An evaluation of the QA/QC data indicates that the reported data are reliable measures of the pesticide and PCB concentrations in the three media analyzed.

Dioxins and Furans

Seventeen sediment samples and thirty-three tissue samples (15 crayfish and 18 fish) were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13.

The detection limits reported by the laboratory met the goals specified in the Sampling and QA/QC Plan (Tetra Tech 1993). Most of the sample results were qualified as undetected at an estimated detection limit (qualifer code U/E) because the detection limit was estimated by examining the signal-to-noise ratio. For sediment data, three of the seventeen OCDD values were qualified as undetected due to blank

contamination and two values were qualified as estimates based on laboratory precision data. No data qualifiers, other than U/E, were added to the crayfish results. For the fish data, five of the eighteen values for 2378-TCDF were qualified as estimated based on high matrix spike recoveries.

Polybutyl tins

Seventeen sediment samples and thirty-three tissue samples (fifteen crayfish and eighteen fish) were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13.

Detection limits reported by the laboratory for sediment met the goals specified in the sampling and QA/QC plan (Tetra Tech 1993), but the reported detection limit for tissue was slightly higher (2X) due to the necessity of using gel permeation chromatography to remove tissue lipids. Low-level blank contamination was noted in several instances. Because of this contamination, three of the fifty values for n-butyltin trichloride and six of the values for tri-n-butyltin chloride were qualified as undetected. Data for all three of the tin congeners were qualified as estimates due to low surrogate recoveries in three of the fifty samples.

Radionuclides

Seventeen sediment samples and thirty-three tissue samples (fifteen crayfish and eighteen fish) were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9, while for crayfish and fish, triplicate field samples were collected at station 13.

For the majority of the sample results, with the exception of Pu-239/240 and Cs-137 in some sediment and fish samples, the data were reported as undetected at the sample-specific lower limit of detection (LLD). No data qualifiers were added to sample results based on the evaluation of QC data.

Appendix A-1

Data Validation Report
Bacteria in Surface Water

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Columbia Analytical Sciences

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 45 water samples collected for the 1993 Lower Columbia River Backwater Reconnaissance Survey and analyzed for fecal coliform bacteria, *Escherichia coli*, and enterococcus bacteria by Columbia Analytical Sciences (CAS) of Kelso, Washington. Samples were collected, placed in storage on ice, and transported to CAS within twenty-four hours of collection. The samples were delivered in eight separate batches. Triplicate samples were collected for each of the three bacterial tests at fifteen field stations. Samples were analyzed using standard method 9221C for fecal coliform bacteria, modified standard method 9221C for *E. coli*, and standard method 9230B for enterococcus bacteria (APHA 1989). Although unique samples were collected for both fecal coliform and *E. coli*, aliquots from only one of the samples were used to conduct both analyses. This was done to increase the correlation between the two results, one of which (*E. coli*), should be a subset of the other. All methods used the multiple-tube fermentation technique, results of which are reported in terms of the Most Probable Number (MPN). The data validation review was conducted according to guidelines presented in the method description and the Sampling and QA/QC Plan (APHA 1989, Tetra Tech 1993).

A. HOLDING TIMES

The holding time established for bacteria samples in this project was 30 hours. Ideally, bacterial samples are analyzed within 6 hours, but 30 hours is considered acceptable for data that are not collected for legal purposes. Table 1 gives the sample numbers, collection and analysis dates and times, and the holding time (in hours) for each sample. The analysis of all samples began within 26 hours, well within the applicable holding time.

Each test was divided into a presumptive phase and a confirmation phase. The presumptive phase should last for 48 $\pm$ 3 hours. All presumptive phases were concluded within the required time with the exception of the samples from stations 2 and 3. The presumptive phases for these samples lasted 52 hours. This deviation from method specifications was considered minor. No qualifiers were added to any of the sample results based on holding times.

B. METHOD BLANKS

One method blank was analyzed for each of the three analyses for all eight sample batches. These blanks consisted of 10-mL samples of reagent water incubated in identical growth media to the field samples. No evidence of bacterial growth was seen in any of the blank samples.

C. VERIFICATION OF SAMPLE RESULTS

All laboratory bench sheets were thoroughly reviewed. All tabulations of MPN results (from the MPN

index table) were checked and found to be accurate. For two of the samples (8-2-W for fecal coliform and 12-2-W for *E. coli*), the MPN results were calculated using Thomas' Simple Formula because the combination of positive and negative results was not included in the MPN index table (APHA 1989). These calculations were checked and found to be accurate. The accuracy of transcription from the bench sheets to the final report pages was checked. One error was found and corrected.

D. SUMMARY

The sample results for all samples are given in Table 2. Results for all of the fecal coliform and *E. coli* samples were above the method reporting limit (MRL)(2 colonies/100 mL), while only one-half of the enterococcus samples were above the MRL. Those samples which were not detected above the MRL were qualified with a U.

Each sample was taken completely through a confirmation phase. No other QC data, other than the method blanks, are required by the standard methods. No data qualifiers other than U (undetected) were assigned to any of the sample results. The results are acceptable for their intended use.

REFERENCES

American Public Health Association (APHA). 1989. Standard Methods for the Examination of Water and Wastewater. 17th edition. Edited by L.S. Clesceri, A.E. Greenberg, and R.R. Trussel. American Public Health Association, Washington, D.C.

Tetra Tech. 1993. Lower Columbia River Backwater Reconnaissance Survey. Sampling and quality assurance/quality control (QA/QC) plan. Prepared for the Lower Columbia River Bi-State Program. Tetra Tech, Inc. Redmond, Washington.

TABLE 1. BACTERIA ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	CAS Sample Number	Date Collected	Date Analyzed	Analysis Holding Time (hr)
1-1-W	K3704-1	6/28/93 11:15	6/29/93 11:05	24
1-2-W	K3704-2	6/28/93 11:15	6/29/93 11:05	24
1-3-W	K3704-3	6/28/93 11:15	6/29/93 11:05	24
2-1-W	K3689-1	6/27/93 16:00	6/28/93 12:00	20
2-2-W	K3689-2	6/27/93 16:00	6/28/93 12:00	20
2-3-W	K3689-3	6/27/93 16:00	6/28/93 12:00	20
3-1-W	K3689-4	6/27/93 11:00	6/28/93 12:00	25
3-2-W	K3689-5	6/27/93 11:00	6/28/93 12:00	25
3-3-W	K3689-6	6/27/93 11:00	6/28/93 12:00	25
4-1-W	K3688-1	6/26/93 11:45	6/27/93 13:00	25
4-2-W	K3688-2	6/26/93 11:45	6/27/93 13:00	25
4-3-W	K3688-3	6/26/93 11:45	6/27/93 13:00	25
5-1-W	K3688-4	6/26/93 16:00	6/27/93 13:00	21
5-2-W	K3688-5	6/26/93 16:00	6/27/93 13:00	21
5-3-W	K3688-6	6/26/93 16:00	6/27/93 13:00	21
6-1-W	K3677-1	6/25/93 17:15	6/26/93 9:05	16
6-2-W	K3677-2	6/25/93 17:15	6/26/93 9:05	16
6-3-W	K3677-3	6/25/93 17:15	6/26/93 9:05	16
7-1-W	K3677-4	6/25/93 10:30	6/26/93 9:05	23
7-2-W	K3677-5	6/25/93 10:30	6/26/93 9:05	23
7-3-W	K3677-6	6/25/93 10:30	6/26/93 9:05	23
8-1-W	K3654-1	6/24/93 14:30	6/25/93 9:35	19
8-2-W	K3654-2	6/24/93 14:30	6/25/93 9:35	19
8-3-W	K3654-3	6/24/93 14:30	6/25/93 9:35	19
9-1-W	K3742-1	6/29/93 11:00	6/30/93 12:45	26
9-2-W	K3742-2	6/29/93 11:00	6/30/93 12:45	26
9-3-W	K3742-3	6/29/93 11:00	6/30/93 12:45	26
10-1-W	K3704-4	6/28/93 18:20	6/29/93 11:05	17
10-2-W	K3704-5	6/28/93 18:20	6/29/93 11:05	17
10-3-W	K3704-6	6/28/93 18:20	6/29/93 11:05	17
11-1-W	K3742-4	6/29/93 15:30	6/30/93 12:45	21
11-2-W	K3742-5	6/29/93 15:30	6/30/93 12:45	21
11-3-W	K3742-6	6/29/93 15:30	6/30/93 12:45	21
12-1-W	K3777-1	6/30/93 10:40	7/1/93 10:55	24
12-2-W	K3777-2	6/30/93 10:40	7/1/93 10:55	24
12-3-W	K3777-3	6/30/93 10:40	7/1/93 10:55	24
13-1-W	K3804-1	7/1/93 11:00	7/2/93 9:40	23
13-2-W	K3804-2	7/1/93 11:00	7/2/93 9:40	23
13-3-W	K3804-3	7/1/93 11:00	7/2/93 9:40	23
14-1-W	K3804-4	7/1/93 8:00	7/2/93 9:40	26
14-2-W	K3804-5	7/1/93 8:00	7/2/93 9:40	26
14-3-W	K3804-6	7/1/93 8:00	7/2/93 9:40	26
15-1-W	K3777-4	6/30/93 17:40	7/1/93 10:55	17
15-2-W	K3777-5	6/30/93 17:40	7/1/93 10:55	17
15-3-W	K3777-6	6/30/93 17:40	7/1/93 10:55	17

TABLE 2. BACTERIA DATA SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Station	Sample Number	Fecal Coliform	*Escherichia coli*	Enterococcus	
1	1-1-W	50	50	2	U
	1-2-W	50	50	2	
	1-3-W	170	170	2	U
2	2-1-W	22	22	2	U
	2-2-W	50	50	4	
	2-3-W	8	8	2	U
3	3-1-W	130	80	8	
	3-2-W	170	130	8	
	3-3-W	170	50	2	
4	4-1-W	11	11	2	
	4-2-W	27	27	4	
	4-3-W	13	8	4	
5	5-1-W	8	8	2	U
	5-2-W	34	34	2	U
	5-3-W	4	2	2	
6	6-1-W	17	17	2	U
	6-2-W	7	7	2	U
	6-3-W	11	11	2	U
7	7-1-W	50	30	2	U
	7-2-W	50	30	2	U
	7-3-W	50	22	2	U
8	8-1-W	30	17	4	
	8-2-W	17	11	2	U
	8-3-W	27	27	2	U
9	9-1-W	22	22	2	U
	9-2-W	23	13	4	
	9-3-W	7	4	2	U
10	10-1-W	80	50	8	
	10-2-W	1600	500	2	U
	10-3-W	140	13	2	U
11	11-1-W	23	8	2	
	11-2-W	50	17	2	U
	11-3-W	23	8	2	
12	12-1-W	50	30	2	U
	12-2-W	240	75	2	
	12-3-W	80	80	4	
13	13-1-W	30	30	2	
	13-2-W	23	17	2	
	13-3-W	23	13	2	
14	14-1-W	110	110	2	U
	14-2-W	70	70	2	U
	14-3-W	80	80	2	U
15	15-1-W	30	30	4	
	15-2-W	280	50	6	
	15-3-W	50	50	4	

Qualifier codes: U = None detected at or above the method reporting limit

Appendix A-2

Data Validation Report
Water Conventionals

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Aquatic Research, Inc. and University of Washington

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of water samples collected from 15 stations for the 1993 Lower Columbia River Backwater Reconnaissance Survey and analyzed for conventional water quality variables. For this project, conventional variables have been defined as total phosphorous (TP), soluble reactive phosphorus (SRP), filtered ammonia, filtered nitrate+nitrite, total Kjeldahl nitrogen (TKN), total suspended solids (TSS), hardness, chlorophyll/phaeophytin, cyanide, total organic carbon (TOC), dissolved organic carbon (DOC), and particulate organic carbon (POC). All parameters but DOC and POC were analyzed by Aquatic Research, Inc. of Seattle, Washington. DOC and POC were analyzed by the Department of Oceanography at the University of Washington, Seattle, Washington. Samples were collected, placed in storage on ice, and transported to the laboratory within 2 days of collection, with the exception of DOC and POC samples, which were frozen in the field and returned to the laboratory after all samples were collected (approximately 10 days after the first sample was collected). Triplicate samples were collected and analyzed at every station for total-P, SRP, ammonia, nitrate+nitrite, and TKN. For all other parameters single samples were collected and analyzed at each station, except station 9, where triplicate samples were collected and analyzed. The analyses were performed using the following methodology: total-P and SRP by SM 4500PF, dissolved ammonia by SM 4500NH3H, dissolved nitrate+nitrite by SM 4500NO3F, TKN by SM 4500NORGC, TSS by SM 2540D, hardness by SM 2340C, chlorophyll/phaeophytin *a* by SM 10200H, cyanide by SM 4500CNE, TOC by SM 5310C (APHA 1989), POC by CHN analyzer (Hedges and Stern 1984), and DOC by high-temperature catalytic oxidation (Suzuki et al. 1992, Sugimura and Suzuki 1988). The data validation review was conducted according to guidelines presented in the method descriptions and the Sampling and QA/QC Plan (Tetra Tech 1993).

A. TOTAL PHOSPHORUS

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration

A seven-point standard curve was calculated using standards at the following concentrations: 0.0032, 0.0063, 0.0125, 0.025, 0.05, 0.1, and 0.2 mg/L. The correlation coefficient for the seven points was 0.999919, indicating that the standard curve was valid for quantitation of sample concentrations.

Method Blanks

A pair of method blanks were analyzed approximately every fifteen samples. No indication of phosphorus in any of the blanks was found up to the method detection limit of 0.002 mg/L.

Matrix Spikes

Matrix spikes were analyzed approximately every eight samples by adding phosphorus at a concentration of 0.05 mg/L. The results of the matrix spike analyses are given in Table 2A. The percent recoveries for the seven matrix spikes were within 82 and 118 percent. These recoveries are within the data quality

objectives for analytical accuracy (80-120 percent) specified in the QA plan (Tetra Tech 1993).

Reference Material Analysis
Two aliquots of reference materials of known concentration were analyzed before and after the analysis of the field samples (Table 2B). The measured concentration of each sample was within 16 percent of the known concentration, indicating acceptable analytical accuracy.

Laboratory Replicates
Laboratory replicates were analyzed approximately every eight samples (Table 2C). The RPD between the two values was less than 16 percent for each of the seven replicate pairs. These results satisfy the data quality objectives for precision (± 25 percent) specified in the QA plan (Tetra Tech 1993).

Field Replicates
Field triplicates samples were analyzed at each station. The RSD for each triplicate set is given in Table 3. The RSD was less than 25 percent at all stations except stations 4, 6, 7, and 8. At three of these stations (4, 6, and 8), two of the three values were relatively close together, while the third was 2-3X greater.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 3. The total-P concentration of all samples was within the seven point standard curve, with the exception of sample 8-1-W (0.312 mg/L). This was diluted 10X and reanalyzed. The method detection limit specified by the laboratory (0.002 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No data qualifiers were added to any of the sample results. The results are acceptable for their intended use.

B. SOLUBLE REACTIVE PHOSPHORUS (SRP)

Holding Times
The holding time established for this project is 48 hours. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration
SRP samples were analyzed in five different batches. For each batch, an eight-point standard curve was calculated using standards at the following concentrations: 0.0008, 0.0016, 0.00313, 0.00625, 0.0125, 0.025, 0.05, and 0.1 mg/L. The correlation coefficient for the eight points was greater than 0.9995 for each of the five batches, indicating that each of the standard curves was valid for quantitation of sample concentrations.

Method Blanks
A pair of method blanks were analyzed upon completion of analysis for each of the five batches. No indication of phosphorus in any of the blanks was found up to the method detection limit of 0.001 mg/L.

Matrix Spikes

One or more matrix spikes were analyzed with each of the five sample batches by adding phosphorus at a concentration of 0.02 mg/L. The results of the matrix spike analyses are given in Table 4A. The percent recoveries for the seven matrix spikes were within the data quality objectives for analytical accuracy (80-120 percent) specified in the QA plan (Tetra Tech 1993), with the exception of spiked samples 3-3-W (125 percent) and 10-3-W (149.5 percent). Because reference material results for the days these samples were analyzed (6/28 and 6/30/93, respectively) indicate acceptable analytical accuracy (see below), no data qualifiers were added to sample results based on the high percent recoveries.

Reference Material Analysis

Two aliquots of reference materials of known concentration were analyzed with each of the five sample batches (Table 4B). For the higher concentration reference material (0.029 mg/L), the measured concentration of each sample was within 10 percent of the known concentration. For the lower concentration reference material (0.0029 mg/L), the percent accuracy ranged from 72 to 124 percent. Because the concentration of this material was only 3X the detection limit, this wider range of percent accuracy still indicates acceptable analytical performance.

Laboratory Replicates

One or two laboratory replicates were analyzed with each of the five sample batches (Table 2C). The RPD between the two values satisfied the data quality objectives for precision ($\pm$ 25 percent) specified in the QA plan (Tetra Tech 1993), for six of the seven replicate pairs. For sample 15-3-W, the RPD was 28.6 percent. The result for this sample (0.008 mg/L) was qualified as estimated because the laboratory precision did not meet QA guidelines.

Field Replicates

Field triplicates samples were analyzed at each station. The RSD for each triplicate set is given in Table 3. The RSD was less than 30 percent for all stations at which it could be calculated, indicating that the field variability was relatively low.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary

Sample results were reported by the laboratory in mg/L and are presented in Table 3. The SRP concentration of all samples was within the eight-point standard curve. The method detection limit specified by the laboratory (0.001 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). The result for sample 15-3-W was qualified as an estimate (qualifier code "E") because the laboratory precision did not meet QA guidelines. The results are acceptable for their intended use.

C. AMMONIA AND NITRATE/NITRITE

Ammonia and nitrate/nitrite were analyzed simultaneously on the same instrument, so they will be discussed together.

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection and

analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration
All analyses were performed on a single day (7/13/93). An eight-point standard curve was calculated using standards ranging in concentration from the detection limit of 0.010 mg N/L to 1 mg N/L. The correlation coefficient for the eight points was greater than 0.9995 for both ammonia and nitrate/nitrite, indicating that each of the standard curves was valid for quantitation of sample concentrations.

Method Blanks
A method blank was analyzed upon the completion of the sample analyses. Neither ammonia or nitrate/nitrite were found in the blank up to the method detection limit of 0.010 mg N/L.

Matrix Spikes
Matrix spikes were analyzed approximately every eight samples by adding both ammonia and nitrate/nitrite at concentration of 0.200 mg N/L. The results of the matrix spike analyses are given in Tables 5A and 6A for ammonia and nitrate/nitrite, respectively. The percent recoveries for the six matrix spikes were 93-101 percent for ammonia and 92-104 percent for nitrate/nitrite. These recoveries are well within the data quality objectives for analytical accuracy (80-120 percent) specified in the QA plan (Tetra Tech 1993).

Reference Material Analysis
Two aliquots of reference materials of known concentration were analyzed for both ammonia and nitrate/nitrite (Tables 5B and 6B for ammonia and nitrate/nitrite, respectively). The measured concentration was within 12 percent of the true concentration for both ammonia and nitrate/nitrate, indicating acceptable analytical accuracy.

Laboratory Replicates
Laboratory replicates were analyzed approximately every eight samples (Tables 5C and 6C for ammonia and nitrate/nitrite, respectively). RPDs could not be calculated for any of the ammonia values, because either one or both of the values were non-detects. Given the lack of positive values for ammonia, laboratory precision could not be evaluated. For nitrate/nitrite, RPDs could be calculated for four of the seven replicate pairs and ranged from 0 to 14 percent. The RPDs for nitrate/nitrite satisfied the data quality objectives for precision ($\pm$ 25 percent) specified in the QA plan (Tetra Tech 1993).

Field Replicates
Field triplicates samples were analyzed at each station. The RSD for each triplicate set is given in Table 3. The RSD was less than 20 percent for all stations at which it could be calculated, indicating that the field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg N/L and are presented in Table 3. The ammonia and nitrate/nitrite concentrations of all samples were within the eight-point standard curve. The method detection limit specified by the laboratory (0.010 mg/L) met the quantitation limit goal specified in the

QA plan (Tetra Tech 1993). No data qualifiers were added to any of the sample results. The results are acceptable for their intended use.

D. TOTAL KJELDAHL NITROGEN (TKN)

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration
TKN analyses were performed on two different days (7/14 and 7/23/93). Six-point standard curves were calculated on each day using standards at the following concentrations: 0.156, 0.313, 0.625, 1.25, 2.5, and 5 mg/L. The correlation coefficient for the six points was greater than 0.9995 for the calibration on both days, indicating that each of the standard curves was valid for quantitation of sample concentrations.

Method Blanks
One method blank and one preparation blank were analyzed immediately prior to the analysis of the field samples. Neither of the blank samples contained measurable levels (detection limit of 0.10 mg/L) of TKN.

Matrix Spikes
Matrix spikes were analyzed approximately every eight samples by adding TKN at a concentration of 1.00 mg/L. The results of the matrix spike analyses are given in Table 7A. The percent recoveries for the seven matrix spikes were 65-91 percent. Only three of the seven recoveries were within the data quality objectives for analytical accuracy (80-120 percent) specified in the QA plan (Tetra Tech 1993). The recovery of the other four samples ranged from 65 to 79 percent. All of the samples which deviated from data quality objectives were analyzed on the same day (7/14/93). Because the reference material analysis performed on this day (see below) indicated acceptable analytical accuracy, no data qualifiers were added to sample results because of this minor deviation.

Reference Material Analysis
Reference materials of known concentration were analyzed on each of the two days on which TKN was analyzed (Table 7B). The measured concentrations were within 20 percent of the true concentration for all analyses of reference materials, indicating acceptable analytical accuracy.

Laboratory Replicates
Laboratory replicates were analyzed approximately every eight samples (Table 7C). RPDs ranged from 0 to 33 percent for those replicate pairs for which RPDs could be calculated. All but two of the RPDs satisfied the data quality objectives for precision (± 25 percent) specified in the QA plan (Tetra Tech 1993). The RPDs for the replicate analysis of sample 2-2-W (33) and sample 6-3-W (27 percent) exceeded QA guidelines. The results for these samples were qualified as estimated because the laboratory precision did not meet QA guidelines.

Field Replicates
Field triplicate samples were analyzed at each station. The RSD for each triplicate set is given in Table 3. The RSD was less than 25 percent for all stations at which it could be calculated, indicating that the

field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 3. The TKN concentrations of all samples were within the six-point standard curve. Samples from stations 2-8 were originally analyzed on 7/14/93, but were reanalyzed on 7/23/93 because too much preservative had been added to the samples. The method detection limit specified by the laboratory (0.100 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). The results for sample 2-2-W amd 6-3-W were qualified as estimates (qualifier code "E") because the laboratory precision did not meet QA guidelines. The results are acceptable for their intended use.

E. TOTAL SUSPENDED SOLIDS (TSS)

Holding Times
The holding time established for this project is 7 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Method Blanks
Two method blanks were analyzed for TSS by filtering 250 ml of reagent water. No indication of TSS in either of the blanks was found up to the method detection limit of 0.5 mg/L.

Laboratory Replicates
Laboratory replicates were analyzed approximately every three samples (Table 8). RPDs ranged from 0 to 12 percent. All RPDs satisfied the data quality objectives for precision (± 25 percent) specified in the QA plan (Tetra Tech 1993).

Field Replicates
Field triplicate samples were collected and analyzed at station 9. The RSD for the three analyses was 4.9 percent, indicating that the field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 9. The method detection limit specified by the laboratory (0.5 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

F. HARDNESS

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Standardization
Prior to the analysis of the samples, the EDTA titrant was standardized by performing triplicate titrations against reagent water (blank) and 3.00 ml $CaCO_3$. Based on these titrations, it was determined that 0.997782 mg o\f $CaCO_3$ was equivalent to 1.00 mL of EDTA. A check on the standardization was performed using a standard of 40 mg/L $CaCO_3$. The calculated hardness of this standard was 41.11 mg/L $CaCO_3$ (102.77 percent accuracy), indicating the standardization was valid.

Method Blanks
One method blank was analyzed prior to the analysis of the field samples. The calculated value (1.40 mg/L $CaCO_3$) was less than the specified method detection limit of 2 mg/L $CaCO_3$.

Matrix Spikes
Matrix spikes were analyzed approximately every three samples (Table 10A) by adding 20 mg/L $CaCO_3$ to each spiked sample. The percent recovery ranged from 98 to 105 percent, indicating excellent analytical accuracy.

Laboratory Replicates
Laboratory replicates were analyzed approximately every three samples (Table 10B). RPDs ranged from 0 to 1.3 percent. All RPDs satisfied the data quality objectives for precision ($\pm$ 5 percent) specified in the QA plan (Tetra Tech 1993).

Field Replicates
Field triplicate samples were collected and analyzed at station 9. The RSD for the three analyses was 1.7 percent, indicating that the field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L $CaCO_3$ and are presented in Table 9. The method detection limit specified by the laboratory (2 mg/L $CaCO_3$) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

G. CHLOROPHYLL AND PHAEOPHYTIN

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection and

analysis, and actual holding times are given in Table 1. All samples were analyzed within 8 days of collection.

Laboratory Replicates
Laboratory replicates were analyzed approximately every four samples (Table 11). RPDs ranged from 3 to 11 percent for chlorophyll *a* and 14 to 54 percent for phaeophytin *a*. All of the chlorophyll RPDs satisfied the data quality objectives for precision (± 25 percent) specified in the QA plan (Tetra Tech 1993), but two of the phaeophytin results (sample 5-W, RPD = 54 percent; sample 14-W, RPD = 34 percent) were outside the QC guidelines. The phaeophytin results for these two samples were qualified as estimates due to laboratory replicate results.

Field Replicates
Field triplicate samples were collected and analyzed at station 9. The RSD for the three analyses was 19.0 for chlorophyll *a* and 20.6 percent for phaeophytin *a*. These values are similar to the laboratory variability indicated by the laboratory replicate analyses, indicating that the field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in µg/L and are presented in Table 9. The method detection limit specified by the laboratory (0.1 µg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No method blanks, reference materials, or check standards were analyzed. Phaeophytin *a* results for samples 5-W and 14-W were qualified as estimates (qualifier code "E") because the laboratory precision did not meet QA guidelines. No other data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

H. CONDUCTIVITY

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Standardization
The standard reference solution (potassium chloride at 0.0100 M) was prepared and standardized at 25° C to 1413 µmhos/cm, the true conductivity of this solution.

Field Replicates
Field triplicate samples were collected and analyzed at station 9. The RSD for the three analyses was 0.5 percent, indicating that the field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary

Sample results were reported by the laboratory in μmhos/cm and are presented in Table 9. The method detection limit specified by the laboratory (1 μmhos/cm) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

I. CYANIDE

Holding Times

The holding time established for this project is 14 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration

A five-point standard curve was calculated on 7/6/93 using standards at the following concentrations: 0, 4, 20, 40, and 80 μg/L. The correlation coefficient for the five points was greater than 0.999, indicating that the standard curve was valid for quantitation of sample concentrations.

Method Blanks

One method blank was analyzed prior to the analysis of the field samples. No cyanide was detected in the blank. The calculated concentration for the 0 μg/L standard used in the calibration was 0.92 μg/L, well below the method detection limit of 2 μg/L. The absorbance noted for this standard was subtracted from the absorbance of each of the field samples before the calculation of a final concentrations. In other words, all sample values were blank-corrected.

Matrix Spikes

Two matrix spikes were analyzed by adding cyanide at a concentration of 23.15 μg/L (Table 12A). The percent recoveries were 93 and 120 percent. Although no data quality objectives for analytical accuracy were specified in the QA plan (Tetra Tech 1993), these recoveries are consistent with the range specified for other colorimetric analyses (80-120 percent).

Check Standards Analysis

Check standards of two different concentrations were analyzed before and after the analysis of the field samples (Table 12B). The measured concentrations were within 15 percent of the true concentration for the analyses of check standards, indicating acceptable analytical accuracy.

Laboratory Replicates

Two laboratory replicates were analyzed for cyanide (Table 12C). Because cyanide was not detected in any of the samples, RPDs could not be calculated, making it impossible to evaluate laboratory precision.

Field Replicates

Field triplicate samples were analyzed at station 9 (samples 9-1-W, 9-2-W, and 9-3-W). Because cyanide was not detected in any of the samples, a RSD could not be calculated, making it impossible to evaluate field variability.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets

and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 9. The method detection limit specified by the laboratory (0.002 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). Cyanide was not detected in any of the field samples. No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

J. TOTAL ORGANIC CARBON (TOC)

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within the established holding time.

Calibration
All TOC samples were analyzed on 7/16/93. A two-point calibration using a blank and a 10 mg/L calibration standard was performed. Calibration data were not available for review.

Method Blanks
Seven method blanks were analyzed before, during, and after the analysis of the field samples. No TOC was detected in any of the blanks up to the detection limit of 0.05 mg/L.

Matrix Spikes
Two matrix spikes were analyzed by adding TOC at a concentration of 4 mg/L (Table 13A). The percent recoveries were 105 and 111 percent. These recoveries are well within the data quality objectives for analytical accuracy (75-125 percent) specified in the QA plan (Tetra Tech 1993).

Reference Material Analysis
Reference materials were analyzed before and after the analysis of the field samples (Table 13B). The measured concentrations were within 20 percent of the true concentration for the analyses of reference materials, indicating acceptable analytical accuracy.

Laboratory Replicates
Two laboratory replicates were analyzed for TOC (Table 13C). The RPD between the two replicates was 1 percent or less, indicating excellent laboratory precision.

Field Replicates
Field triplicate samples were analyzed at station 9 (samples 9-1-W, 9-2-W, and 9-3-W). The RSD between the three analyses was 1.3 percent, indicating that field variability is very low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 9. The method detection limit specified by the laboratory (0.05 mg/L) met the quantitation limit goal specified in the QA plan (Tetra Tech 1993). No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

K. PARTICULATE ORGANIC CARBON (POC)

Holding Times
The holding time established for this project for frozen POC samples is 6 months. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within 90 days, well within the established holding time.

Calibration
All POC samples were analyzed on a CHN analyzer. An eight-point standard curve was constructed by analyzing eight aliquots of a standard with 71.09 percent carbon. The correlation coefficient for the eight points was 0.998, indicating that the standard curve was valid for quantitation of sample concentrations.

Method Blanks
Replicate filter blanks were analyzed for POC prior to analysis of the field samples. The mean carbon content of the two filters was 14.22 μg. This value was subtracted from all sample carbon values.

Reference Material Analysis
A certified reference material from BCSSI was analyzed upon the completion of the field sample analyses. The calculated value (0.194 mg/L) was extremely close to the certified value of 0.195 mg/L (99.5 percent accuracy).

Field Replicates
Field triplicate samples were analyzed at station 9 (samples 9-1-W, 9-2-W, and 9-3-W). The RSD between the three analyses was 7.5 percent, indicating that field variability was relatively low.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Sample results were reported by the laboratory in mg/L and are presented in Table 9. All reported values were corrected for the contribution from the blank filters. No method detection limit was specified by the laboratory, but all samples contained measurable amounts of POC. The sample from station 5 (5-W) was lost during analyses. No data qualifiers were added to sample results based on evaluation of QC data. The results are acceptable for their intended use.

L. DISSOLVED ORGANIC CARBON (DOC)

Holding Times
The holding time established for this project for frozen DOC samples is 6 months. Sample numbers,

dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within 105 days, well within the established holding time.

Calibration
A five-point calibration curve was calculated using potassium hydrogen phthalate at nominal concentrations of 2.50, 5.00, 10.00, 25.00, and 50.00 mg/L.

Method Blanks
The instrument used to quantify DOC underwent a complete overhaul prior to the analysis of the samples. An entire day was devoted to running method blanks with carbon-free reagent water. By the end of the day, no carbon could be detected in any of the blanks.

Reference Material Analysis
No certified reference material was available for analysis, however, an aliquot of a standard previously calibrated against a certified reference material (Standard Reference Material 84j) was analyzed. The mean of two burns was 4.76 mg/L, which compares favorably (97.9 percent accuracy) with the known concentration (4.86 mg/L). This result indicates that the analytical system was operating with a high degree of accuracy.

Field Replicates
Field triplicate samples were analyzed at station 9 (samples 9-1-W, 9-2-W, and 9-3-W). The RSD between the three analyses was 6.6 percent, indicating that field variability was relatively low.

Sample Result Verification
Three or more burns were performed on each sample. The analyst used professional judgement to discard some of the early burns on each sample when it was determined that the operating conditions were insufficient to purge all of the CO_2 from the samples. The reported means are from two or more consecutive burns for which the RSD was less than or equal to 2 percent. All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Interlaboratory Comparison
DOC was measured directly by the University of Washington (UW) laboratory, but it can also be calculated by subtracting the POC values from the TOC values. DOC values derived from both of these methods are given in Table 14 (Columns B and G). Because the difference between the two values were large for every sample (measured DOC values were 2-4 times higher than the calculated values), an interlaboratory comparison was performed. Three of the samples that were analyzed for DOC by UW were also analyzed by Aquatic Research, the laboratory responsible for the TOC analyses. Conversely, three samples analyzed for TOC by Aquatic Research were analyzed by UW. Two different aliquots for each sample were analyzed by UW, one treated with sulfuric acid and one which had been filtered. This was necessary because the original TOC samples had been discarded. Each laboratory performed the reanalysis using the same methodology that was used to analysis the original batch of samples.

The results of Aquatic Research's reanalyses are given in Column C of Table 14, while the results of UW's reanalyses are given in Columns I and J of Table 14. The values for Aquatic Research's reanalysis were higher than the original UW values, while the values for the UW reanalysis were higher than both the Aquatic Research values and the calculated DOC values. The results of this comparison are somewhat inconclusive. It appears possible that the UW samples were contaminated in some way, because the DOC

values from this laboratory were much higher than would be expected from historical data, and much higher than the calculated DOC values (Dahm et al 1981). Because of this uncertainty, all DOC values were qualified as unusable (qualifier code "R").

Summary

Sample results were reported by the laboratory in mg/L and are presented in Table 9. No method detection limit was specified by the laboratory, but all samples contained measurable amounts of DOC. No data qualifiers were added to sample results based on evaluation of QC data. However, upon examination of the DOC data in conjunction with the TOC and POC data, all DOC data were qualified as unusable based on assumed blank contamination. The blank contamination could not be confirmed because the appropriate blanks (e.g., filter and bottle) were not performed. The DOC results used in the data report (Volume 1) will be derived by subtracting the POC results from the TOC results. These values are given in Table 14 (Column G).

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TABLE 1. WATER CONVENTIONALS ANALYSIS SUMMARY (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Date and Time Collected	Total-P		SRP		Ammonia and NO2/NO3		TKN	
		Date Analyzed	Analysis Holding Time (d)	Date and Time Analyzed	Analysis Holding Time (hr)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)
1-1-W	6/28/93 10:30	7/22/93	24	6/30/93 9:00	47	7/13/93	15	7/14/93	16
1-2-W	6/28/93 10:30	7/22/93	24	6/30/93 9:00	47	7/13/93	15	7/14/93	16
1-3-W	6/28/93 10:30	7/22/93	24	6/30/93 9:00	47	7/13/93	15	7/14/93	16
2-1-W	6/27/93 15:00	7/22/93	24	6/28/93 10:00	19	7/13/93	15	7/23/93	25
2-2-W	6/27/93 15:00	7/22/93	24	6/28/93 10:00	19	7/13/93	15	7/23/93	25
2-3-W	6/27/93 15:00	7/22/93	24	6/28/93 10:00	19	7/13/93	15	7/23/93	25
3-1-W	6/27/93 10:00	7/22/93	25	6/28/93 10:00	24	7/13/93	16	7/23/93	26
3-2-W	6/27/93 10:00	7/22/93	25	6/28/93 10:00	24	7/13/93	16	7/23/93	26
3-3-W	6/27/93 10:00	7/22/93	25	6/28/93 10:00	24	7/13/93	16	7/23/93	26
4-1-W	6/26/93 10:45	7/22/93	26	6/28/93 10:00	47	7/13/93	17	7/23/93	27
4-2-W	6/26/93 10:45	7/22/93	26	6/28/93 10:00	47	7/13/93	17	7/23/93	27
4-3-W	6/26/93 10:45	7/22/93	26	6/28/93 10:00	47	7/13/93	17	7/23/93	27
5-1-W	6/26/93 15:30	7/22/93	25	6/28/93 10:00	42	7/13/93	16	7/23/93	26
5-2-W	6/26/93 15:30	7/22/93	25	6/28/93 10:00	42	7/13/93	16	7/23/93	26
5-3-W	6/26/93 15:30	7/22/93	25	6/28/93 10:00	42	7/13/93	16	7/23/93	26
6-1-W	6/25/93 17:30	7/22/93	26	6/26/93 2:00	9	7/13/93	17	7/23/93	27
6-2-W	6/25/93 17:30	7/22/93	26	6/26/93 2:00	9	7/13/93	17	7/23/93	27
6-3-W	6/25/93 17:30	7/22/93	26	6/26/93 2:00	9	7/13/93	17	7/23/93	27
7-1-W	6/25/93 11:15	7/22/93	27	6/26/93 2:00	15	7/13/93	18	7/23/93	28
7-2-W	6/25/93 11:15	7/22/93	27	6/26/93 2:00	15	7/13/93	18	7/23/93	28
7-3-W	6/25/93 11:15	7/22/93	27	6/26/93 2:00	15	7/13/93	18	7/23/93	28
8-1-W	6/24/93 15:00	7/22/93	27	6/26/93 2:00	35	7/13/93	18	7/23/93	28
8-2-W	6/24/93 15:00	7/22/93	27	6/26/93 2:00	35	7/13/93	18	7/23/93	28
8-3-W	6/24/93 15:00	7/22/93	27	6/26/93 2:00	35	7/13/93	18	7/23/93	28
9-1-W	6/29/93 10:00	7/22/93	23	7/1/93 9:30	48	7/13/93	14	7/14/93	15
9-2-W	6/29/93 10:00	7/22/93	23	7/1/93 9:30	48	7/13/93	14	7/14/93	15
9-3-W	6/29/93 10:00	7/22/93	23	7/1/93 9:30	48	7/13/93	14	7/14/93	15
10-1-W	6/28/93 18:00	7/22/93	23	6/30/93 9:00	39	7/13/93	14	7/14/93	15
10-2-W	6/28/93 18:00	7/22/93	23	6/30/93 9:00	39	7/13/93	14	7/14/93	15
10-3-W	6/28/93 18:00	7/22/93	23	6/30/93 9:00	39	7/13/93	14	7/14/93	15
11-1-W	6/29/93 16:00	7/22/93	22	7/1/93 9:30	42	7/13/93	13	7/14/93	14
11-2-W	6/29/93 16:00	7/22/93	22	7/1/93 9:30	42	7/13/93	13	7/14/93	14
11-3-W	6/29/93 16:00	7/22/93	22	7/1/93 9:30	42	7/13/93	13	7/14/93	14
12-1-W	6/30/93 10:20	7/22/93	22	7/2/93 9:30	47	7/13/93	13	7/14/93	14
12-2-W	6/30/93 10:20	7/22/93	22	7/2/93 9:30	47	7/13/93	13	7/14/93	14
12-3-W	6/30/93 10:20	7/22/93	22	7/2/93 9:30	47	7/13/93	13	7/14/93	14
13-1-W	7/1/93 12:00	7/22/93	21	7/2/93 9:30	22	7/13/93	12	7/14/93	13
13-2-W	7/1/93 12:00	7/22/93	21	7/2/93 9:30	22	7/13/93	12	7/14/93	13
13-3-W	7/1/93 12:00	7/22/93	21	7/2/93 9:30	22	7/13/93	12	7/14/93	13
14-1-W	7/1/93 9:00	7/22/93	21	7/2/93 9:30	25	7/13/93	12	7/14/93	13
14-2-W	7/1/93 9:00	7/22/93	21	7/2/93 9:30	25	7/13/93	12	7/14/93	13
14-3-W	7/1/93 9:00	7/22/93	21	7/2/93 9:30	25	7/13/93	12	7/14/93	13
15-1-W	6/30/93 17:20	7/22/93	21	7/2/93 9:30	40	7/13/93	12	7/14/93	13
15-2-W	6/30/93 17:20	7/22/93	21	7/2/93 9:30	40	7/13/93	12	7/14/93	13
15-3-W	6/30/93 17:20	7/22/93	21	7/2/93 9:30	40	7/13/93	12	7/14/93	13

TABLE 1. WATER CONVENTIONALS ANALYSIS SUMMARY (Page 2 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Date Collected	TSS		Hardness		Chlorophyll/ Phaeophytin		Conductivity		Cyanide		TOC		POC		DOC	
		Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)
1-W	6/28/93	7/6/93	8	7/21/93	23	7/1/93	3	7/13/93	15	7/6/93	8	7/16/93	18	9/21/93	85	10/5/93	99
2-W	6/27/93	7/1/93	4	7/21/93	24	6/30/93	3	7/13/93	16	7/6/93	9	7/16/93	19	9/21/93	86	10/5/93	100
3-W	6/27/93	7/1/93	4	7/21/93	24	6/30/93	3	7/13/93	16	7/6/93	9	7/16/93	19	9/21/93	86	10/5/93	100
4-W	6/26/93	6/30/93	4	7/21/93	25	6/29/93	3	7/13/93	17	7/6/93	10	7/16/93	20	9/21/93	87	10/5/93	101
5-W	6/26/93	6/30/93	4	7/21/93	25	6/29/93	3	7/13/93	17	7/6/93	10	7/16/93	20	9/21/93	87	10/5/93	101
6-W	6/25/93	6/29/93	4	7/21/93	26	6/28/93	3	7/13/93	18	7/6/93	11	7/16/93	21	9/21/93	88	10/5/93	102
7-W	6/25/93	6/29/93	4	7/21/93	26	6/28/93	3	7/13/93	18	7/6/93	11	7/16/93	21	9/21/93	88	10/5/93	102
8-W	6/24/93	6/29/93	5	7/21/93	27	6/28/93	4	7/13/93	19	7/6/93	12	7/16/93	22	9/21/93	89	10/5/93	103
9-1-W	6/29/93	7/6/93	7	7/21/93	22	7/2/93	3	7/13/93	14	7/6/93	7	7/16/93	17	9/21/93	84	10/5/93	98
9-2-W	6/29/93	7/6/93	7	7/21/93	22	7/2/93	3	7/13/93	14	7/6/93	7	7/16/93	17	9/21/93	84	10/5/93	98
9-3-W	6/29/93	7/6/93	7	7/21/93	22	7/2/93	3	7/13/93	14	7/6/93	7	7/16/93	17	9/21/93	84	10/5/93	98
10-W	6/28/93	7/6/93	8	7/21/93	23	7/1/93	3	7/13/93	15	7/6/93	8	7/16/93	18	9/21/93	85	10/5/93	99
11-W	6/29/93	7/6/93	7	7/21/93	22	7/2/93	3	7/13/93	14	7/6/93	7	7/16/93	17	9/21/93	84	10/5/93	98
12-W	6/30/93	7/6/93	6	7/21/93	21	7/8/93	8	7/13/93	13	7/6/93	6	7/16/93	16	9/21/93	83	10/5/93	97
13-W	7/1/93	7/6/93	5	7/21/93	20	7/8/93	7	7/13/93	12	7/6/93	5	7/16/93	15	9/21/93	82	10/5/93	96
14-W	7/1/93	7/6/93	5	7/21/93	20	7/8/93	7	7/13/93	12	7/6/93	5	7/16/93	15	9/21/93	82	10/5/93	96
15-W	6/30/93	7/6/93	6	7/21/93	21	7/8/93	8	7/13/93	13	7/6/93	6	7/16/93	16	9/21/93	83	10/5/93	97

TABLE 2. QC ANALYSIS SUMMARY FOR TOTAL PHOSPHORUS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/L)	Original Concentration (mg/L)	Total Concentration (mg/L)	Percent Recovery
6-3-W	0.050	0.129	0.170	82.0
4-3-W	0.050	0.048	0.098	100.0
2-3-W	0.050	0.059	0.118	118.0
10-3-W	0.050	0.177	0.220	86.0
11-3-W	0.050	0.049	0.095	92.0
15-3-W	0.050	0.041	0.097	112.0
14-3-W	0.050	0.063	0.117	108.0

B. REFERENCE MATERIAL RESULTS

	True concentration (mg/L)	Found concentration (mg/L)	Percent Accuracy	
	0.081	0.070	86.4	
	0.028	0.029	103.6	
	0.0081	0.0089	109.9	
	0.030	0.029	96.7	

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
6-3-W	0.129	0.124	0.127	4.0
4-3-W	0.048	0.045	0.047	6.5
2-3-W	0.059	0.069	0.064	15.6
10-3-W	0.177	0.161	0.169	9.5
11-3-W	0.049	0.050	0.050	2.0
15-3-W	0.041	0.041	0.041	0.0
14-3-W	0.063	0.062	0.063	1.6

TABLE 3. WATER CONVENTIONALS DATA (Part 1)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Total-P Conc. (mg/L)	RSD	SRP Conc. (mg/L)	RSD	Ammonia Conc. (mg/L)	RSD	NO2/NO3 Conc. (mg/L)	RSD	TKN Conc. (mg/L)	RSD
1-1-W	0.058		0.014		0.021		0.032		0.236	
1-2-W	0.076		0.014		0.022		0.033		0.238	
1-3-W	0.057	16.8	0.014	0.0	0.018	10.2	0.032	1.8	0.221	4.0
2-1-W	0.039		0.014		0.010 U		0.016		0.241	
2-2-W	0.045		0.013		0.010 U		0.017		0.198 E	
2-3-W	0.059	21.5	0.018	17.6	0.010 U	NC	0.020	11.8	0.206	10.6
3-1-W	0.062		0.009		0.010 U		0.024		0.309	
3-2-W	0.043		0.016		0.010 U		0.027		0.305	
3-3-W	0.040	24.7	0.015	28.4	0.010	NC	0.032	14.6	0.254	10.6
4-1-W	0.090		0.010		0.011		0.034		0.387	
4-2-W	0.052		0.010		0.010 U		0.029		0.292	
4-3-W	0.048	36.6	0.010	0.0	0.014	NC	0.035	9.8	0.257	21.6
5-1-W	0.045		0.014		0.010 U		0.040		0.221	
5-2-W	0.040		0.011		0.010 U		0.040		0.209	
5-3-W	0.052	13.2	0.012	12.4	0.011	NC	0.042	2.8	0.310	22.4
6-1-W	0.048		0.009		0.017		0.179		0.144	
6-2-W	0.054		0.010		0.024		0.178		0.149	
6-3-W	0.129	58.6	0.009	6.2	0.024	18.7	0.186	2.4	0.175	10.7
7-1-W	0.066		0.012		0.013		0.037		0.191	
7-2-W	0.040		0.012		0.010 U		0.035		0.230	
7-3-W	0.076	30.6	0.013	4.7	0.010 U	NC	0.035	3.2	0.183	12.5
8-1-W	0.312		0.011		0.010 U		0.010 U		0.264	
8-2-W	0.044		0.011		0.010 U		0.010 U		0.242	
8-3-W	0.060	108.4	0.011	0.0	0.010 U	NC	0.010 U	NC	0.217	9.8
9-1-W	0.045		0.001 U		0.013		0.010 U		0.177	
9-2-W	0.037		0.003		0.010 U		0.010 U		0.180	
9-3-W	0.045	10.9	0.002	NC	0.010 U	NC	0.010 U	NC	0.184	1.9
10-1-W	0.159		0.013		0.026		0.010 U		0.436	
10-2-W	0.181		0.014		0.021		0.010 U		0.487	
10-3-W	0.177	6.8	0.013	4.3	0.010 U	NC	0.010 U	NC	0.498	7.0
11-1-W	0.042		0.009		0.010 U		0.044		0.157	
11-2-W	0.036		0.013		0.010 U		0.042		0.142	
11-3-W	0.049	15.4	0.009	22.3	0.010 U	NC	0.039	6.0	0.137	7.2
12-1-W	0.108		0.004		0.010 U		0.010 U		0.373	
12-2-W	0.118		0.004		0.013		0.010 U		0.362	
12-3-W	0.113	4.4	0.005	13.3	0.010 U	NC	0.010 U	NC	0.419	7.9
13-1-W	0.026		0.007		0.010 U		0.040		0.177	
13-2-W	0.027		0.006		0.015		0.046		0.219	
13-3-W	0.025	3.8	0.005	16.7	0.010 U	NC	0.042	7.2	0.184	11.6
14-1-W	0.056		0.010		0.010 U		0.010 U		0.304	
14-2-W	0.058		0.009		0.010 U		0.010 U		0.349	
14-3-W	0.063	6.1	0.008	11.1	0.010 U	NC	0.010	NC	0.352	8.0
15-1-W	0.044		0.008		0.010 U		0.037		0.179	
15-2-W	0.042		0.008		0.010		0.042		0.166	
15-3-W	0.041	3.6	0.008 E	0.0	0.010 U	NC	0.038	6.8	0.216	13.9

U = Not detected
E = Estimated value due to evaluation of QC data
NC = Not calculated due to one or more non-detect value

TABLE 4. QC ANALYSIS SUMMARY FOR SOLUBLE REACTIVE PHOSPHORUS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/L)	Original Concentration (mg/L)	Total Concentration (mg/L)	Percent Recovery
8-3-W	0.020	0.011	0.031	100.0
5-1-W	0.020	0.014	0.030	80.0
3-3-W	0.020	0.015	0.040	125.0
10-3-W	0.020	0.013	0.043	149.5
11-3-W	0.020	0.009	0.027	90.0
15-3-W	0.020	0.008	0.025	85.0
14-3-W	0.020	0.008	0.025	85.0

B. REFERENCE MATERIAL RESULTS

Date Analyzed	True concentration (mg/L)	Found concentration (mg/L)	Percent Accuracy
6/26/93	0.0029	0.0021	72.4
6/26/93	0.029	0.031	106.9
6/28/93	0.0029	0.0036	124.1
6/28/93	0.029	0.031	106.9
6/30/93	0.0029	0.0032	110.3
6/30/93	0.029	0.031	106.9
7/1/93	0.0029	0.0021	72.4
7/1/93	0.029	0.032	110.3
7/2/93	0.0029	0.0027	93.1
7/2/93	0.029	0.029	100.0

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
8-3-W	0.011	0.011	0.011	0.0
5-1-W	0.014	0.011	0.013	24.0
3-3-W	0.015	0.013	0.014	14.3
10-3-W	0.013	0.013	0.013	0.0
11-3-W	0.009	0.009	0.009	0.0
15-3-W	0.008	0.006	0.007	28.6
14-3-W	0.008	0.008	0.008	0.0

TABLE 5. QC ANALYSIS SUMMARY FOR AMMONIA
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg N/L)	Original Concentration (mg N/L)	Total Concentration (mg N/L)	Percent Recovery
8-3-W	0.200	0.010 U	0.189	94.5
4-3-W	0.200	0.014	0.206	96.0
2-3-W	0.200	0.010 U	0.198	99.0
10-3-W	0.200	0.010 U	0.186	93.0
11-3-W	0.200	0.010 U	0.201	100.5
15-3-W	0.200	0.010 U	0.200	100.0

B. REFERENCE MATERIAL RESULTS

	True concentration (mg N/L)	Found concentration (mg N/L)	Percent Accuracy	
	0.276	0.286	103.6	
	0.276	0.308	111.6	

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg N/L)	Result 2 (mg N/L)	Average (mg N/L)	RPD
8-3-W	0.010 U	0.010 U	NC	NC
4-3-W	0.014	0.010 U	NC	NC
2-3-W	0.010 U	0.010 U	NC	NC
10-3-W	0.010 U	0.010 U	NC	NC
11-3-W	0.010 U	0.010 U	NC	NC
15-3-W	0.010 U	0.010 U	NC	NC
14-3-W	0.010 U	0.010 U	NC	NC

U = Undetected at given method detection limit
NC = Not calculated due to one or more non-detected value

TABLE 6. QC ANALYSIS SUMMARY FOR NITRATE/NITRITE LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg N/L)	Original Concentration (mg N/L)	Total Concentration (mg N/L)	Percent Recovery
8-3-W	0.200	0.010 U	0.188	94.0
4-3-W	0.200	0.035	0.242	103.5
2-3-W	0.200	0.023	0.213	95.0
10-3-W	0.200	0.010 U	0.184	92.0
11-3-W	0.200	0.039	0.238	99.5
15-3-W	0.200	0.038	0.236	99.0

B. REFERENCE MATERIAL RESULTS

	True concentration (mg N/L)	Found concentration (mg N/L)	Percent Accuracy	
	0.188	0.189	100.5	
	0.188	0.175	93.1	

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg N/L)	Result 2 (mg N/L)	Average (mg N/L)	RPD
8-3-W	0.010 U	0.010 U	NC	NC
4-3-W	0.035	0.031	0.033	12.1
2-3-W	0.023	0.020	0.022	14.0
10-3-W	0.010 U	0.010 U	NC	NC
11-3-W	0.039	0.039	0.039	0.0
15-3-W	0.038	0.037	0.038	2.7
14-3-W	0.010 U	0.010 U	NC	NC

U = Undetected at given method detection limit
NC = Not calculated due to one or more non-detected value

TABLE 7. QC ANALYSIS SUMMARY FOR TKN
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/L)	Original Concentration (mg/L)	Total Concentration (mg/L)	Percent Recovery
6-3-W	1.00	0.175	1.084	90.9
4-3-W	1.00	0.257	1.092	83.5
2-2-W	1.00	0.198	1.091	89.3
10-3-W	1.00	0.498	1.288	79.0
11-3-W	1.00	0.137	0.789	65.2
15-3-W	1.00	0.216	0.862	64.6
14-3-W	1.00	0.342	1.118	77.6

B. REFERENCE MATERIAL RESULTS

Date Analyzed	True concentration (mg/L)	Found concentration (mg/L)	Percent Accuracy	
7/14/93	0.465	0.449	96.6	
7/23/93	0.465	0.517	111.2	
7/23/93	0.750	0.740	98.7	
7/23/93	0.750	0.780	104.0	
7/23/93	0.465	0.560	120.4	

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
6-3-W	0.175	0.229	0.202	26.7
4-3-W	0.257	0.262	0.260	1.9
2-2-W	0.198	0.276	0.237	32.9
10-3-W	0.498	0.498	0.498	0.0
11-3-W	0.137	0.159	0.148	14.9
15-3-W	0.216	0.191	0.204	12.3
14-3-W	0.352	0.342	0.347	2.9

TABLE 8. QC ANALYSIS SUMMARY FOR TSS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
8-W	9.43	9.43	9.43	0.0
4-W	15.4	16.0	15.7	3.8
2-W	13.4	13.4	13.4	0.0
1-W	19.6	19.5	19.6	0.5
11-W	12.0	12.0	12.0	0.0
12-W	24.8	25.2	25.0	1.6
14-W	18.8	21.2	20.0	12.0

TABLE 9. WATER CONVENTIONALS DATA (Part 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	TSS Conc. (mg/L)	Hardness Conc. (mg CaCO3/L)	Chlorophyll Conc. (µg/L)	Phaeophytin Conc. (µg/L)	Conductivity Conc. (µmhos/cm)	Cyanide Conc. (mg/L)	TOC Conc. (mg/L)	POC Conc. (mg/L)	DOC Conc. (mg/L)
1-W	20	359	10	9.3	2940	0.002 U	4.97	1.16 Z	6.81 R
2-W	13	44.3	17	15	124.6	0.002 U	2.58	0.64 Z	3.78 R
3-W	16	44.5	14	23	122.0	0.002 U	2.30	0.56 Z	4.19 R
4-W	15	41.9	13	26	118.8	0.002 U	2.88	0.76 Z	8.08 R
5-W	14	44.7	20	9.8 E	125.9	0.002 U	2.32	* Z	4.78 R
6-W	6.4	38.9	6.7	6.8	103.3	0.002 U	2.21	0.46 Z	3.89 R
7-W	15	45.9	11	9.3	131.2	0.002 U	2.47	0.68 Z	12.71 R
8-W	9.4	51.7	9.6	5.7	122.3	0.002 U	2.72	1.35 Z	3.98 R
9-1-W	6.8	54.9	6.9	11	139.7	0.002 U	2.99	1.12 Z	5.04 R
9-2-W	7.4	53.1	9.4	7.3	138.6	0.002 U	2.93	1.05 Z	4.81 R
9-3-W	7.0	53.9	10	7.9	138.5	0.002 U	2.92	0.73 Z	4.42 R
10-W	63	35.7	35	31	107.4	0.002 U	9.44	4.60 Z	14.08 R
11-W	12	52.9	14	9.2	131.1	0.002 U	2.75	0.64 Z	4.40 R
12-W	25	85.8	32	12	159.6	0.002 U	4.95	3.09 Z	5.03 R
13-W	8.0	53.1	13	2.6	125.3	0.002 U	2.44	0.63 Z	9.67 R
14-W	19	51.3	16	12 E	136.5	0.002 U	3.28	0.53 Z	5.73 R
15-W	20	59.9	14	2.8	131.8	0.002 U	2.36	0.85 Z	3.69 R

U = Not detected at the specified detection limit
Z = Corrected for blank contribution
R = Data are unusable
E = Value should be considered an estimate based on evaluation of QC data
* = Sample lost by laboratory

TABLE 10. QC ANALYSIS SUMMARY FOR HARDNESS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/L)	Original Concentration (mg/L)	Total Concentration (mg/L)	Percent Recovery
7-W	20.0	45.9	66.9	104.8
5-W	20.0	44.7	65.1	101.8
3-W	20.0	44.5	64.5	99.8
10-W	20.0	35.7	55.9	100.8
9-1-W	20.0	54.9	75.8	104.8
15-W	20.0	59.9	79.4	97.8
14-W	20.0	51.3	71.8	102.8

B. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
7-W	45.9	46.5	46.2	1.3
5-W	44.7	44.9	44.8	0.4
3-W	44.5	44.1	44.3	0.9
1-W	358.6	358.2	358.4	0.1
10-W	35.7	35.7	35.7	0.0
9-1-W	54.9	55.1	55.0	0.4
15-W	59.9	59.3	59.6	1.0
14-W	51.3	51.7	51.5	0.8

TABLE 11. QC ANALYSIS SUMMARY FOR CHLOROPHYLL/PHAEOPHYTIN
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. LABORATORY REPLICATES

Sample Number	Result 1 (µg/L)	Result 2 (µg/L)	Average (µg/L)	RPD
Chlorophyll				
5-W	20.36	21.03	20.70	3.2
10-W	34.71	38.71	36.71	10.9
11-W	14.24	13.65	13.95	4.2
14-W	16.35	15.35	15.85	6.3
Phaeophytin				
5-W	9.78	5.61	7.70	54.2
10-W	30.70	25.77	28.24	17.5
11-W	9.23	10.65	9.94	14.3
14-W	11.91	8.48	10.20	33.6

TABLE 12. QC ANALYSIS SUMMARY FOR CYANIDE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (µg/L)	Original Concentration (µg/L)	Total Concentration (µg/L)	Percent Recovery
6-W	23.15	2 U	21.61	93.3
9-3-W	23.15	2 U	27.89	120.5

B. CHECK STANDARD RESULTS

	True concentration (µg/L)	Found concentration (µg/L)	Percent Accuracy	
	381.00	328.15	86.1	
	8.52	8.35	98.0	

C. LABORATORY REPLICATES

Sample Number	Result 1 (µg/L)	Result 2 (µg/L)	Average (µg/L)	RPD
5-W	2 U	2 U	NC	NC
15-W	2 U	2 U	NC	NC

U = Undetected at given method detection limit
NC = Not calculated due to one or more non-detected value

TABLE 13. QC ANALYSIS SUMMARY FOR TOTAL ORGANIC CARBON LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/L)	Original Concentration (mg/L)	Total Concentration (mg/L)	Percent Recovery
6-W	4.00	2.18	6.63	111.3
13-W	4.00	2.44	6.65	105.3

B. REFERENCE MATERIAL RESULTS

	True concentration (mg/L)	Found concentration (mg/L)	Percent Accuracy	
	1.32	1.29	97.7	
	2.63	2.72	103.4	
	5.27	5.60	106.3	
	1.32	1.09	82.6	
	2.63	2.69	102.3	
	5.27	5.57	105.7	
	0.66	0.65	98.5	

C. LABORATORY REPLICATES

Sample Number	Result 1 (mg/L)	Result 2 (mg/L)	Average (mg/L)	RPD
6-W	2.18	2.21	2.20	1.4
13-W	2.44	2.45	2.45	0.4

TABLE 14. INTERLAB COMPARISON OF ORGANIC CARBON RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Station	A UW POC (mg/L)	B UW DOC (mg/L)	C AR DOC (mg/L)	D UW POC+DOC (mg/L)	E AR TOC (mg/L)	F RPD	G DOC (TOC-POC) (mg/L)	H UW DOC (mg/L)	I UW w/ H2SO4 TOC	J UW filtered DOC
1	1.16	6.81		7.97	4.97	46.3	3.8	6.81		
2	0.64	3.78		4.42	2.58	52.5	1.9	3.78		
3	0.56	4.19		4.75	2.3	69.4	1.7	4.19		
4	0.76	8.08		8.84	2.88	101.7	2.1	8.08		
5*	-	4.78	9.18	-	2.32	-		4.78		
6	0.46	3.89		4.35	2.21	65.2	1.8	3.89	2.81	4.13
7	0.68	12.71		13.39	2.47	137.7	1.8	12.71		
8	1.35	3.98		5.33	2.72	64.9	1.4	3.98	5.00	5.40
9-1	1.12	5.04		6.16	2.99	69.2	1.9	5.04		
9-2	1.05	4.81		5.86	2.93	66.7	1.9	4.81		
9-3	0.73	4.42	14.28	5.15	2.92	55.3	2.2	4.42		
10	4.60	14.08		18.68	9.44	65.7	4.8	14.08	6.62	3.56
11	0.64	4.4		5.04	2.75	58.8	2.1	4.4		
12	3.09	5.03		8.12	4.95	48.5	1.9	5.03		
13	0.63	9.67		10.30	2.44	123.4	1.8	9.67		
14	0.53	5.73	7.72	6.26	3.28	62.5	2.8	5.73		
15	0.85	3.69		4.54	2.36	63.2	1.5	3.69		

UW = Carbon analyses conducted by the University of Washington-Laboratory
AR = Carbon analyses conducted by Aquatic Research
*Sample destroyed during analysis

Appendix A-3

Data Validation Report
Sediment Conventionals

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: AmTest, Inc. and Aquatic Research, Inc.

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples collected for the 1993 Lower Columbia River Backwater Reconnaissance Survey and analyzed for conventional sediment variables. For this project, conventional variables have been defined as total solids, total volatile solids (TVS), total organic carbon (TOC), ammonia, total sulfides, total Kjeldahl nitrogen (TKN), sediment grain size, and cyanide. Samples were collected, placed in storage on ice, and transported to the laboratory within 5 days of collection. The samples were delivered in two separate batches. Triplicate samples were collected and analyzed at one station (9), while single samples were collected and analyzed at all other stations. The analyses were performed using the following methodology: total solids, TVS, and total sulfides by PSEP (Tetra Tech 1989); TOC by Standard Method 5310B; ammonia by Plumb (1981); TKN by Standard Method 4500N-Mod; grain size by the ASTM method with hydrometer; and cyanide by SM 4500CN.E. The data validation review was conducted according to guidelines presented in the method descriptions and the Sampling and QA/QC Plan (Tetra Tech 1993).

A. TOTAL SOLIDS

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within 6 days, well within the established holding time.

Laboratory Replicates

Laboratory triplicate analyses were conducted on one sample (15-S) and are reported in Table 2A. The relative standard deviation (RSD) was less than five percent for the analyses. The percent solid value for one of the three replicates was 5 percent different than the other two, possibly indicating that the sample was incompletely homogenized prior to removal of the aliquots. No data qualifiers were added to the sample results, however, because the RSD was within the data quality objective for precision (20 percent RPD for duplicates) stated in the Sampling and QA/QC plan (Tetra Tech 1993).

Field Replicates

One set of field triplicates from station 9 were analyzed for percent solids. Results of the field triplicate analyses are presented in Table 2B. The RSD between the three analyses was 2.5 percent, indicating relatively low field variability.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. Percent solids results were recalculated. One error was noted (sample 9-3-S) and corrected. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary

Sample results were reported by the laboratory in percent and are presented in Table 3. No data qualifiers were added to any of the sample results. The results are acceptable for their intended use.

B. TOTAL VOLATILE SOLIDS (TVS)

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection and analysis, and actual holding times are given in Table 1. All samples were analyzed within 7 days, well within the established holding time.

Laboratory Replicates

Laboratory triplicate analyses were conducted on one sample (15-S) and are reported in Table 4A. The RSD was less than ten percent for the analyses. The RSD was within the data quality objective for precision (20 percent RPD for duplicates) stated in the Sampling and QA/QC plan (Tetra Tech 1993), so no data qualifiers were added to the sample results.

Field Replicates

One set of field triplicates from station 9 were analyzed for TVS. Results of the field triplicate analyses are presented in Table 4B. The RSD between the three analyses was approximately 12 percent. Based on the results of the laboratory triplicate analyses, most of this variability can be attributed to the analytical methodology of the laboratory.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. TVS results were recalculated. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary

Sample results were reported by the laboratory in percent and are presented in Table 3. No data qualifiers were added to any of the sample results. The results are acceptable for their intended use.

C. TOTAL ORGANIC CARBON (TOC)

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection, analysis, and actual holding times are given in Table 1. All samples were analyzed within 9 days, well within the established holding time.

Calibration and Instrument Performance

TOC analyses were performed on two different days (Table 1). Calibration of the carbon analyzer was conducted per instrument manufacturer's instructions on each day using a two-point curve generated from the analysis of a blank and 2,000 ppm standard. Each blank and standard value used in constructing the calibration curve was the result of at least two replicate burns. Results of the standards analyses are presented in Table 5A. The mean TOC values were 116 to 117 percent of the true value. These results are within the laboratory and project-specific guidelines, indicating that the instrument calibration was valid.

Method Blanks

Method blank analyses were performed for each day on which TOC samples were analyzed as part of the calibration procedure. Raw data for all method blanks were examined. Method blank results are

presented in Table 5B. All method blanks contained less than 100 ppm (0.01 percent) TOC. It should be noted that these values are less than the method reporting limit of 500 ppm (0.05 percent) and may be subject to considerable uncertainty. Sample concentrations were not corrected for the associated method blank.

Reference Material Analyses

The reference material NBS 2704 was analyzed before and after the analysis of each of the two sample batches. The results of the reference material analyses are presented in Table 5C. All but one of the replicate analyses were accurate within the data quality objectives for accuracy (± 25 percent) established for this project (Tetra Tech 1993). The one replicate outside the established range (130 percent of the certified value) was analyzed before the second sample batch on 7/8/93. A second replicate analyzed immediately afterward showed a percent accuracy of 111 percent. Because the mean of these two values (121 percent) was within project guidelines, no data qualifiers were assigned based on the results of standard reference material analyses.

Laboratory Triplicates

Laboratory triplicate analyses were conducted on two samples (1-S and 13-S) and are reported in Table 5D. The RSD was 2 percent and 11 percent for samples 1-S and 13-S, respectively. The RSDs were within the data quality objective for precision (25 percent RPD for duplicates) stated in the Sampling and QA/QC plan (Tetra Tech 1993).

Field Triplicates

One set of field triplicates from station 9 were analyzed for TOC. Results of the field triplicate analyses are presented in Table 5E. The RSD between the three analyses was approximately 11 percent. Based on the results of the laboratory triplicate analyses, most of this variability can be attributed to the analytical methodology of the laboratory.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary

TOC sample data are presented in Table 3. All sample data were reported in percent TOC. The data package submitted by the laboratory contained all the required deliverables. The method reporting limit given by the laboratory (500 ppm) was slightly higher than that specified for the project (200 ppm), but since all sample results were at least an order of magnitude greater than the reporting limit, this deviation from project specifications will not affect the usefulness of the data. No data qualifiers were assigned to TOC results. The accuracy and precision of the analyses indicate the results are acceptable for their intended use.

D. AMMONIA

Holding Times

The holding time established for this project is 28 days. Sample numbers, dates of collection, analysis, and actual holding times are given in Table 1. All samples were analyzed within 14 days, well within the established holding time.

Calibration and Instrument Performance
Ammonia analyses were performed on three different days (Table 1). Calibration of the spectrophotometer was conducted per method protocols on each day using a five-point curve generated from the analysis of standards at the following concentrations: 0.3, 0.2, 0.1, 0.05, and 0.01 μg/ml. The calibration curves calculated for each of the three days on which analyses were run showed very high correlation coefficients (>0.999), indicating that the initial calibrations were valid.

Method Blanks
Method blanks were analyzed approximately every six samples and between each standard during the initial calibration. With one exception, ammonia was not detected in any of the blanks above the method reporting limit of 0.03 mg/kg. The exception was noted for a blank analyzed during the calibration on 7/13/93, for which a concentration of 0.55 mg/kg was calculated. Because the calculated ammonia values for the samples analyzed on 7/13/93 were all at least 20X greater than the amount detected in the blank, no data qualifiers were added to sample data based on method blank results. Sample results were not corrected for concentrations observed in the blank.

Matrix Spike Analysis
Two matrix spike samples were analyzed for ammonia. The results are presented in Table 6A. Percent recovery for both samples was 98 and 105 percent, indicating that the analytical system was performing with a high degree of accuracy.

Reference Material Analyses
The standard reference material ERA 8035 was analyzed approximately every 15 samples. The results for all reference material analyses performed immediately before or after the analysis of the samples for this project are given in Table 6B. The percent accuracy for all analyses ranged from 99 to 110, indicating that the analytical system was performing with a high degree of accuracy.

Laboratory Triplicates
Two laboratory triplicates were analyzed. The results are presented in Table 6C. The RSD for the two sets of analyses was very low (1.9 and 3.3 percent), indicating that the analytical system was performing with a high degree of precision.

Field Triplicates
One set of field triplicates from station 9 were analyzed for ammonia. The results are presented in Table 6D. The RSD for the three samples was 7.1, indicating that field variability was slightly greater than laboratory variability.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. All dry weight calculations were recalculated. Several discrepancies were noted and corrected.

Summary
Ammonia sample data are presented in Table 3. All laboratory bench sheets reported results in mg/kg (wet). These values were converted to mg/kg (dry) using the percent solids results. Matrix spike, reference material, and triplicate results indicate the analytical system was performing with a high degree of accuracy and precision. No data qualifiers were added to any of the sample results. The data are acceptable for their intended use.

E. TOTAL SULFIDES

Holding Times
The holding time established for this project is 7 days. Sample numbers, dates of collection, analysis, and actual holding times are given in Table 1. All samples were analyzed within 7 days, within the established holding time.

Method Blanks
One method blank was analyzed for each of the three days on which samples were analyzed for total sulfides. For all three blanks, sulfides were undetected at the method reporting limit of 1 mg/kg (wet).

Matrix Spike Analysis
Two matrix spike samples were analyzed for sulfides. The results are presented in Table 7A. Percent recovery was 79 and 93 percent. Both of these values are within the data quality objectives specified for accuracy (60 to 140 percent), indicating that the analytical system was performing adequately.

Laboratory Triplicates
Two laboratory triplicates were analyzed. The results are presented in Table 7B. The RSD for the two sets of analyses was very low (3.5 and 0.5 percent), indicating that the analytical system was performing with a high degree of precision.

Field Triplicates
One set of field triplicates from station 9 were analyzed for sulfides. The results are presented in Table 6D. The RSD for the three samples was 12.2, indicating that field variability was greater than laboratory variability.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. All dry weight calculations were recalculated. Several discrepancies were noted and corrected.

Summary
Total sulfide sample data are presented in Table 3. All laboratory bench sheets reported results in mg/kg (wet). These values were converted to mg/kg (dry) using the percent solids results. The method reporting limit given by the laboratory (1 mg/kg wet) was much less than the limit specified for the project (20 mg/kg dry). Matrix spike and triplicate results indicate the analytical system was performing adequately with respect to accuracy and precision. No data qualifiers were added to any of the sample results. The data are acceptable for their intended use.

F. TOTAL KJELDAHL NITROGEN (TKN)

Holding Times
The holding time established for this project is 28 days. Sample numbers, dates of collection, analysis, and actual holding times are given in Table 1. All samples were analyzed within 15 days, well within the established holding time.

Method Blanks
Three method blanks were analyzed for TKN. The results are given in Table 8A. The concentrations detected in the blanks represent 1 percent or less of the values detected in the field samples. None of the TKN results presented in Table 3 were corrected for blank contribution, nor were any data qualifiers added to sample results.

Matrix Spike Analysis
Sample 13-S was analyzed as a matrix spike sample. The results are presented in Table 8B. Percent recovery was 98, indicating excellent analytical accuracy.

Reference Material Analyses
One sample of the reference material USDC Pine Needles was analyzed on each of the two days on which TKN samples were analyzed. The results are presented in Table 8C. The percent accuracy for both analyses was greater than 91 percent, indicating that the analytical system was performing with a high degree of accuracy.

Laboratory Triplicates
Three laboratory triplicates were analyzed. The results are presented in Table 8D. The RSDs for the three sets of analyses were very low (5 percent or less), indicating that the analytical system was performing with a high degree of precision.

Field Triplicates
One set of field triplicates from station 9 were analyzed for TKN. The results are presented in Table 8E. The RSD for the three samples was 2.7, indicating that field variability was minimal.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. All dry weight calculations were recalculated. One discrepancy, due to incorrectly calculated percent solids (sample 9-3-S), was noted and corrected.

Summary
TKN sample data are presented in Table 3. All laboratory bench sheets reported results in mg/kg (wet). These values were converted to mg/kg (dry) using the percent solids results. The method reporting limit given by the laboratory (22 mg/kg wet) was approximately the same as the limit specified for the project (10 mg/kg dry). Matrix spike, reference material, and triplicate results indicate the analytical system was performing adequately with respect to accuracy and precision. No data qualifiers were added to any of the sample results. The data are acceptable for their intended use.

G. GRAIN SIZE ANALYSES

Holding Times
The holding time established for this project is 6 months for sediment samples. Sample numbers, dates of collection, analysis, and actual holding times are given in Table 1. All samples were analyzed within 7 days, well within the established holding time.

Laboratory Duplicate
A laboratory duplicate analysis was conducted on sample 9-2-S and is reported in Table 9A. A laboratory

triplicate, which was specified in the QA plan (Tetra Tech 1993), could not be performed for any of the samples because of insufficient sample weight. The RPD indicates the precision of the analyses was highly variable, even for the most abundant fractions (phi classes 3, 4, and 5). The data quality objective for precision, based on a laboratory triplicate, was a RSD of 10 percent. While RPDs and RSDs are not directly comparable, the RPDs for phi classes 3, 4, and 5 are all high enough that, given any possible third measurement, the RSD would exceed 10 percent. Based on the laboratory duplicate results, the results for sample 9-2-S were qualified as estimates.

Field Triplicates

One set of field triplicates from station 9 were analyzed for grain size. The results are presented in Table 9B. The RSDs for the three most abundant fractions (phi classes 3, 4, and 5) were all less than 10 percent. Although the data quality objectives specified in the QA plan (Tetra Tech 1993) did not include the results of field triplicate analyses, these analyses can give some indication of laboratory performance. Because of the relatively good laboratory precision shown for the analyses of these samples, no other data qualifiers were added to grain size sample results.

Sample Result Verification

All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. All dry weight calculations were recalculated. One discrepancy, due to incorrectly calculated percent solids (sample 9-3-S), was noted and corrected.

Summary

Sample results were reported by the laboratory in fractional percent passing each size class and are presented in Table 10. The method used by the laboratory (hydrometer) was not the method specified in the QA plan (Tetra Tech 1993) or the scope of work provided to the laboratory. The results of the hydrometer method, however, are generally comparable to the pipette method specified in the QA plan, in that both are based on the same theoretical underpinnings. Based on the results of the laboratory duplicate analyses, results from sample 9-2-S were qualified as estimates. The results are acceptable for their intended use.

H. CYANIDE

Holding Times

The holding time established for this project is 28 days. All samples were analyzed on 7/12/93, within 20 days of sample collection.

Calibration and Instrument Performance

Calibration of the colorimeter was conducted per method protocols using a five-point curve generated from the analysis of standards at the following nominal concentrations: 80, 40, 20, 4, and 0 μg/L. The calibration curve calculated showed a very high correlation coefficient (> 0.999), indicating that the initial calibration was valid. An analysis of a calibration check standard (18.52 μg/L) at the end of the field samples analyses indicated that the calibration remained valid throughout the run (percent accuracy 110.8).

Method Blanks

One preparation blank analyzed prior to the analysis of the field samples did not contain a detectable level of cyanide.

Matrix Spike Analysis
One matrix spike sample was analyzed for cyanide. The results are presented in Table 11A. Percent recovery was 76.2 percent. Although no data quality objective for matrix spikes was specified in the QC plan (Tetra Tech 1993), this degree of accuracy is typical for the analytical method.

Reference Material Analyses
The standard reference material ERA 9946 was analyzed prior to the analysis of the field samples (Table 11B). The percent accuracy (89.9) indicates that the analytical system was performing adequately.

Laboratory Duplicates
Two laboratory duplicates were analyzed. The results are presented in Table 11C. Cyanide was not detected in any of the samples, making it impossible to assess laboratory precision.

Field Triplicates
One set of field triplicates from station 9 were analyzed for cyanide. The results are presented in Table 11D. Cyanide was not detected in any of the samples, making it impossible to assess field variability.

Sample Result Verification
All laboratory bench sheets were carefully reviewed. The accuracy of transcription between bench sheets and final report pages was checked. No errors were noted.

Summary
Cyanide sample data are presented in Table 3. The detection limit reported by the laboratory (0.1 mg/kg) met was lower than the goal (0.5 mg/kg) specified in the QC plan (Tetra Tech 1993). Matrix spike and reference material results indicate the analytical system was performing with a high degree of accuracy. No data qualifiers were added to any of the sample results. The data are acceptable for their intended use.

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TABLE 1. SEDIMENT CONVENTIONALS ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	AmTest Sample Number	Date Collected	Total Solids		Total Volatile Solids		Total Organic Carbon		Ammonia		Total Sulfides		Total Kjeldahl Nitrogen		Grain Size	
			Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)
1-S	93-A010073	6/28/93	6/30/93	2	7/1/93	3	7/1/93	3	6/30/93	2	6/30/93	2	7/2/93	4	7/1/93	3
2-S	93-A010074	6/27/93	6/30/93	3	7/1/93	4	7/1/93	4	6/30/93	3	6/30/93	3	7/2/93	5	7/1/93	4
3-S	93-A010075	6/27/93	6/30/93	3	7/1/93	4	7/1/93	4	6/30/93	3	6/30/93	3	7/2/93	5	7/1/93	4
4-S	93-A010076	6/26/93	6/30/93	4	7/1/93	5	7/1/93	5	6/30/93	4	6/30/93	4	7/2/93	6	7/1/93	5
5-S	93-A010077	6/26/93	6/30/93	4	7/1/93	5	7/1/93	5	6/30/93	4	6/30/93	4	7/2/93	6	7/1/93	5
6-S	93-A010078	6/25/93	6/30/93	5	7/1/93	6	7/1/93	6	6/30/93	5	7/1/93	6	7/2/93	7	7/1/93	6
7-S	93-A010079	6/25/93	6/30/93	5	7/1/93	6	7/1/93	6	6/30/93	5	7/1/93	6	7/2/93	7	7/1/93	6
8-S	93-A010080	6/24/93	6/30/93	6	7/1/93	7	7/1/93	7	6/30/93	6	7/1/93	7	7/2/93	8	7/1/93	7
9-1-S	93-A010317	6/29/93	7/2/93	3	7/2/93	3	7/8/93	9	7/13/93	14	7/2/93	3	7/14/93	15	7/2/93	3
9-2-S	93-A010318	6/29/93	7/2/93	3	7/2/93	3	7/8/93	9	7/13/93	14	7/2/93	3	7/14/93	15	7/2/93	3
9-3-S	93-A010319	6/29/93	7/2/93	3	7/2/93	3	7/8/93	9	7/13/93	14	7/2/93	3	7/14/93	15	7/2/93	3
10-S	93-A010081	6/28/93	6/30/93	2	7/1/93	3	7/1/93	3	6/30/93	2	7/1/93	3	7/2/93	4	7/1/93	3
11-S	93-A010320	6/29/93	7/2/93	3	7/2/93	3	7/8/93	9	7/13/93	14	7/2/93	3	7/14/93	15	7/2/93	3
12-S	93-A010321	6/30/93	7/2/93	2	7/2/93	2	7/8/93	8	7/13/93	13	7/2/93	2	7/14/93	14	7/2/93	2
13-S	93-A010322	7/1/93	7/2/93	1	7/2/93	1	7/8/93	7	7/14/93	13	7/2/93	1	7/14/93	13	7/2/93	1
14-S	93-A010323	7/1/93	7/2/93	1	7/2/93	1	7/8/93	7	7/13/93	12	7/2/93	1	7/14/93	13	7/2/93	1
15-S	93-A010324	6/30/93	7/2/93	2	7/2/93	2	7/8/93	8	7/13/93	13	7/2/93	2	7/14/93	14	7/2/93	2

TABLE 2. QC ANALYSIS SUMMARY FOR PERCENT SOLIDS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. LABORATORY TRIPLICATE

Sample Number	Result 1 (%)	Result 2 (%)	Result 3 (%)	RSD
15-S	55.1	50.7	55.2	4.79

B. FIELD TRIPLICATE

Station	9-1-S (%)	9-2-S (%)	9-3-S (%)	RSD
9	47.7	45.4	46.5	2.47

TABLE 3. SEDIMENT CONVENTIONALS DATA
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Total Solids 120° C percent	TVS 550° C percent	TOC dry. wt. percent	Ammonia dry. wt. mg/kg	Sulfides dry. wt mg/kg	TKN dry. wt mg/kg	Cyanide dry. wt mg/kg
1-S	41.8	5.26	2.1	11.2	133.9	1,600	0.100 U
2-S	48.0	5.88	1.9	24.7	21.7	1,400	0.100 U
3-S	48.0	5.21	1.3	17.4	22.6	1,400	0.100 U
4-S	43.6	4.71	1.5	25.4	18.4	1,500	0.100 U
5-S	44.7	4.76	1.5	24.0	18.4	1,300	0.100 U
6-S	43.6	7.06	3.6	9.6	64.0	1,300	0.172
7-S	55.6	2.88	1.1	4.3	1.8 U	700	0.100 U
8-S	42.8	3.37	2.1	22.5	3.4	1,600	0.100 U
9-1-S	47.7	8.42	3.3	47.8	16.0	1,200	0.100 U
9-2-S	45.4	8.86	3.0	46.3	19.8	1,200	0.100 U
9-3-S	46.5	6.98	3.8	52.0	21.0	1,200	0.100 U
10-S	36.2	8.45	2.6	19.0	15.8	2,000	0.100 U
11-S	57.6	3.42	0.65	24.7	5.8	650	0.100 U
12-S	39.1	6.56	1.8	41.6	19.3	1,700	0.100 U
13-S	48.3	4.60	1.5	63.8	11.4	1,400	0.100 U
14-S	43.1	6.17	3.7	54.1	20.8	1,800	0.100 U
15-S	55.1	4.42	0.94	33.0	6.2	950	0.100 U

TABLE 4. QC ANALYSIS SUMMARY FOR TVS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. LABORATORY TRIPLICATE

Sample Number	Result 1 (%)	Result 2 (%)	Result 3 (%)	RSD
15-S	4.42	3.67	3.91	9.58

B. FIELD TRIPLICATE

Station	9-1-S (%)	9-2-S (%)	9-3-S (%)	RSD
9	8.42	8.86	6.98	12.16

TABLE 5. QC ANALYSIS SUMMARY FOR TOC
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. STANDARDS ANALYSIS

Date Analyzed	Conc. (ppm C)	Mean TOC (ppm C)	RPD	Percent Accuracy
7/1/93	2,000	2,336	3.0	116.8
7/8/93	2,000	2,323	5.9	116.2

B. METHOD BLANK RESULTS

Date Analyzed		Mean TOC (ppm C)		RPD
7/1/93		56.4		149.7
7/8/93		33.4		181.1

C. REFERENCE MATERIAL RESULTS

Date Analyzed		TOC (ppm C)		Percent Accuracy*
7/1/93		34,530		103.1
7/1/93		39,360		117.5
7/8/93		43,460		129.7
7/8/93		37,330		111.4
7/8/93		38,180		114.0

* Certified value is 33,500 ppm

D. LABORATORY TRIPLICATES

Sample Number	Result 1 (ppm C)	Result 2 (ppm C)	Result 3 (ppm C)	RSD
1-S	21,070	21,400	20,650	1.8
13-S	15,010	18,700	16,200	11.3

E. FIELD TRIPLICATE

Station	9-1-S (ppm C)	9-2-S (ppm C)	9-3-S (ppm C)	RSD
9	33,340	30,110	37,560	11.1

TABLE 6. QC ANALYSIS SUMMARY FOR AMMONIA
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/kg wet)	Original Concentration (mg/kg wet)	Total Concentration (mg/kg wet)	Percent Recovery
5-S	9.95	10.74	20.49	98.0
13-S	19.97	30.82	51.77	104.9

B. REFERENCE MATERIAL RESULTS

Date Analyzed	Ammonia (μg/mL)	Percent Accuracy*
6/30/93	4.22	109.6
6/30/93	4.19	108.8
6/30/93	3.85	100.0
6/30/93	3.81	99.0
7/13/93	3.84	99.7
7/13/93	3.85	100.0
7/13/93	3.88	100.8
7/14/93	4.06	105.5
7/14/93	4.11	106.8
7/14/93	4.00	103.9
7/14/93	4.07	105.7

* Certified value is 3.85 μg/mL

C. LABORATORY TRIPLICATES

Sample Number	Result 1 (mg/kg wet)	Result 2 (mg/kg wet)	Result 3 (mg/kg wet)	RSD
4-S	11.08	10.79	10.67	1.9
13-S	30.82	29.64	28.87	3.3

D. FIELD TRIPLICATE

Station	9-1-S (mg/kg wet)	9-2-S (mg/kg wet)	9-3-S (mg/kg wet)	RSD
9	22.79	21.00	24.20	7.1

TABLE 7. QC ANALYSIS SUMMARY FOR TOTAL SULFIDES
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/kg wet)	Original Concentration (mg/kg wet)	Total Concentration (mg/kg wet)	Percent Recovery
2-S	58.00	10.40	55.97	78.6
13-S	48.39	5.52	50.54	93.0

B. LABORATORY TRIPLICATES

Sample Number	Result 1 (mg/kg wet)	Result 2 (mg/kg wet)	Result 3 (mg/kg wet)	RSD
1-S	55.99	55.99	59.45	3.5
13-S	5.52	5.49	5.55	0.5

C. FIELD TRIPLICATE

Station	9-1-S (mg/kg wet)	9-2-S (mg/kg wet)	9-3-S (mg/kg wet)	RSD
9	7.65	9.00	9.77	12.2

TABLE 8. QC ANALYSIS SUMMARY FOR TKN
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. METHOD BLANK RESULTS

Date Analyzed				TKN (mg/kg wet)
7/2/93				5.6
7/2/93				16.8
7/14/93				22.4

B. MATRIX SPIKE ANALYSES

Sample Number	Spiked Concentration (mg/kg wet)	Original Concentration (mg/kg wet)	Total Concentration (mg/kg wet)	Percent Recovery
13-S	733	679	1396	97.8

C. REFERENCE MATERIAL RESULTS

Date Analyzed		TKN (mg/kg wet)		Percent Accuracy*
7/2/93		11,400		95.0
7/14/93		11,000		91.7

* Certified value is 12,000 mg/kg

D. LABORATORY TRIPLICATES

Sample Number	Result 1 (mg/kg wet)	Result 2 (mg/kg wet)	Result 3 (mg/kg wet)	RSD
1-S	656	698	683	3.1
10-S	713	713	726	1.0
13-S	679	748	739	5.2

E. FIELD TRIPLICATE

Station	9-1-S (mg/kg wet)	9-2-S (mg/kg wet)	9-3-S (mg/kg wet)	RSD
9	577	549	573	2.7

TABLE 9. QC ANALYSIS SUMMARY FOR GRAIN SIZE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. LABORATORY DUPLICATE

SAMPLE 9-2-S				
SIZE	RESULT 1 (%)	RESULT 2 (%)		RPD
PHI CLASS-SIEVES				
< -2	0.4	0.1		120.0
-2	0.2	0.1		66.7
-1	0.9	0.4		76.9
0	0.7	0.5		33.3
+1	1.1	0.6		58.8
+2	1.5	1.0		40.0
+3	21.4	9.0		81.6
+4	31.1	22.3		33.0
PHI CLASS-HYDROMETER				
+5	24.4	47.5		64.3
+6	6.2	6.2		0.0
+7	4.6	5.3		14.1
+8	4.6	6.0		26.4
+9	0.7	0.8		13.3
+10	<0.1	<0.1		--
> 10	2.2	<0.1		--

B. FIELD TRIPLICATE

STATION 9				
SIZE	9-1-S (%)	9-2-S (%)	9-3-S (%)	RSD
PHI CLASS-SIEVES				
< -2	0.2	0.4	0.4	34.6
-2	<0.1	0.2	0.2	--
-1	0.4	0.9	0.2	72.1
0	0.8	0.7	0.7	7.9
+1	1.0	1.1	0.9	10.0
+2	2.1	1.5	1.7	17.3
+3	19.3	21.4	21.5	6.0
+4	32.9	31.1	27.3	9.4
PHI CLASS-HYDROMETER				
+5	27.1	24.4	23.2	8.0
+6	4.5	6.2	8.3	30.1
+7	3.8	4.6	5.4	17.4
+8	4.8	4.6	8.1	33.7
+9	0.8	0.7	1.2	29.4
+10	<0.1	<0.1	<0.1	--
> 10	2.1	2.2	<0.1	--

TABLE 10. SEDIMENT GRAIN SIZE DATA
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Fractional Percent in Each Phi Class														
	Gravel			Sand					Silt				Clay		
	< -2	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10	> 10
1-S	0.0	0.0	0.2	0.2	0.0	0.2	0.7	3.3	33.6	23.5	19.6	7.8	2.7	1.2	6.7
2-S	0.0	0.0	0.2	0.6	0.8	2.1	48.5	16.5	12.4	7.4	2.2	4.4	0.7	0.0	4.2
3-S	0.0	0.0	0.1	0.1	0.0	0.6	12.1	14.0	47.9	10.6	5.2	4.4	0.7	0.0	4.2
4-S	0.2	0.0	0.2	0.2	0.2	5.0	26.1	16.7	22.6	6.6	6.6	7.3	1.2	0.0	6.9
5-S	0.0	0.7	0.2	0.0	0.2	0.4	5.6	35.6	27.1	9.7	6.1	8.6	1.3	0.0	4.5
6-S	0.2	0.0	0.2	0.0	1.4	15.1	37.2	16.7	12.2	4.8	4.8	4.4	0.6	0.0	2.3
7-S	0.2	0.0	0.0	0.0	0.4	4.7	33.1	21.9	22.8	6.5	4.3	3.8	0.6	0.0	1.8
8-S	0.1	0.3	0.1	0.1	0.4	0.5	4.7	24.4	59.8	2.7	2.7	2.5	0.3	0.0	1.3
9-1-S	0.2	0.0	0.4	0.8	1.0	2.1	19.3	32.9	27.1	4.5	3.8	4.8	0.8	0.0	2.1
9-2-S	0.4 E	0.2 E	0.9 E	0.7 E	1.1 E	1.5 E	21.4 E	31.1 E	24.4 E	6.2 E	4.6 E	4.6 E	0.7 E	0.0 E	2.2 E
9-3-S	0.4	0.2	0.2	0.7	0.9	1.7	21.5	27.3	23.2	8.3	5.4	8.1	1.2	0.0	0.0
10-S	0.0	0.0	0.0	0.0	0.3	0.8	8.3	52.2	7.4	10.1	8.0	7.6	2.2	0.7	2.5
11-S	0.2	0.2	0.0	0.2	0.2	3.5	12.8	45.5	21.8	6.1	3.6	3.6	0.5	0.0	1.7
12-S	0.0	0.0	0.0	0.0	0.0	0.5	1.3	14.3	47.7	13.1	10.6	8.7	1.2	0.0	2.6
13-S	0.6	0.0	0.2	0.4	0.4	0.6	9.9	35.8	28.6	7.4	5.8	5.3	0.7	0.0	4.1
14-S	0.1	0.0	0.0	0.3	0.8	4.9	8.7	10.3	53.2	6.6	6.0	5.9	0.9	0.0	2.3
15-S	0.2	0.2	0.0	0.0	0.0	0.5	9.8	23.4	34.1	15.7	7.2	5.4	0.7	0.0	2.7

Data qualifiers: E = Estimated value

TABLE 11. QC ANALYSIS SUMMARY FOR CYANIDE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. MATRIX SPIKE ANALYSIS

Sample Number	Spiked Concentration (mg/kg)	Original Concentration (mg/kg)	Total Concentration (mg/kg)	Percent Recovery
5-S	1.51	0.100 U	1.15	76.2

B. REFERENCE MATERIAL RESULTS

Date Analyzed		Cyanide (mg/kg)		Percent Accuracy*
7/12/93		0.342		89.8

* Certified value is 0.381 mg/kg

C. LABORATORY DUPLICATES

Sample Number	Result 1 (mg/kg)		Result 2 (mg/kg)	RPD
5-S	0.100 U		0.100 U	NC
14-S	0.100 U		0.100 U	NC

D. FIELD TRIPLICATE

Station	9-1-S (mg/kg)	9-2-S (mg/kg)	9-3-S (mg/kg)	RSD
9	0.100 U	0.100 U	0.100 U	NC

NC = Not calculated due to one or more non-detect values

Appendix A-4

Data Validation Report
Sediment Toxicity

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Lauck's Testing Laboratories (Microtox)
Northwestern Aquatic Sciences (Amphipods)

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples collected for the 1993 Lower Columbia River Backwater Reconnaissance Survey and analyzed for toxicity. Two different tests were performed on each of the 17 samples. The Microtox (solid-phase) test was performed by Lauck's Testing Laboratories of Seattle, Washington, while the acute amphipod survival test (ASTM Method E. 1383-90) was performed by Northwestern Aquatic Sciences of Newport, Oregon. Samples were collected, placed in storage on ice, and transported to the laboratories within 5 days of collection. The samples were delivered in two separate batches. Triplicate samples were collected and analyzed at one station (9), while single samples were collected and analyzed at all other stations. The data validation review was conducted according to guidelines presented in the method descriptions, Sampling and QA/QC Plan, and the Dredged Material Testing Manual (Microbics 1992, ASTM 1990, Tetra Tech 1993, and U.S. ACOE/U.S. EPA 1991).

A. MICROTOX

The solid-phase Microtox test differs from the elutriate and pore water tests commonly performed in that the bacteria are in direct contact with the sediment being tested. In the solid-phase test, the sediment is first centrifuged to separate the solids from the pore water. Solids are then mixed to restore homogeneity, diluent and reagent solution are added, and the sample is filtered and analyzed. The solid-phase test is best suited for ranking multiple samples and identifying toxicity hot spots (Microbics 1992).

Holding Times

The holding time established for sediments in the Microtox test is 14 days. Table 1 gives the sample numbers, collection and analysis dates, and the holding time for each sample. The analysis of all samples was completed within 14 days.

Control Samples

Triplicate control samples were run for each sample. A control sample consists of only the saline diluent used in the test; no sediment is added. The luminescence seen in the control samples serves as the baseline with which to compare all test sediment dilutions. The results for all control samples are given in Table 2. The relative standard deviation (RSD) between the three replicates was generally small (less than 10 percent). Only two samples (9-3-S and 12-S) had an RSD of greater than 8.5 percent, but both were still less than 12 percent. The mean luminescence for all samples ranged from 77 to 120 luminescence units. Intersample variability in control sample results does not bias the calculation of the EC_{50} because the luminescence results for each sediment treatment are compared to the control sample results for that sample only. The control sample results indicate the analytical system was in control.

Reference Toxicant Tests

Duplicate reference toxicant tests, using phenol at 170 ppm, were run each of the four days on which sediment tests were performed. Four serial dilutions (85, 42.5, 21.25, and 10.625 ppm) were tested for each replicate. The results of the reference toxicant tests are given in Table 3. The mean EC_{50} for the

tests ranged from 20.6 to 22.8 ppm phenol. A highly significant dose-response relationship (regression $p \leq 0.01$) was found for all replicates except replicate 1 of the test performed on 7/8/93. The p value for this test was slightly greater than 0.05. This result explains the relatively high relative percent difference (RPD)(27.2 percent) calculated for this test. The results of the reference toxicant tests indicate that the test results from the four different days on which tests were performed may be compared to each other.

Laboratory Duplicates

Two samples (10-S and 15-S) were tested in duplicate by the laboratory. The EC_{50} values for these samples are given in Table 4. The RPDs for the two sets of duplicates were high (approximately 50 percent), indicating relatively low precision in the analytical methodology. No laboratory precision data quality objectives were established for this project, however, due to the high variability typically seen for the Microtox test (Bennett and Cubbage 1992). The high RPDs between the laboratory duplicates may indicate that the sediment samples were incompletely homogenized before the aliquots were removed. No data qualifiers were assigned based on laboratory duplicate results.

Field Replicates

Three replicate samples (9-1-S, 9-2-S, and 9-3-S) were collected at station 9. The EC_{50} values for these samples are given in Table 5. The RSD for these replicates was 8.6 percent. The precision indicated by the field replicates contrasts the lack of precision shown for the laboratory duplicate results.

Sample Result Verification

The accuracy of transcription from the bench sheets to the final report pages was checked. No errors were found.

Summary

The EC_{50} values (in ppm sediment) for all samples are given in Table 6. The results of the control samples run with each sediment sample indicate acceptable laboratory precision. The high RPDs between the laboratory duplicates, however, belie this precision, indicating that the sediment sample may have been incompletely homogenized before the aliquots were removed. The close agreement between the EC_{50}s calculated for the four reference toxicant tests indicates that the bacterial population used in these tests maintained a consistent dose-response relationship throughout the several day period over which the tests were performed. This indicates that the test results from the four different days on which tests were performed may be compared to each other. No data qualifiers were assigned to any of the sample results. The results are acceptable for their intended use.

B. AMPHIPOD TOXICITY

A 10-day acute toxicity test using the amphipod *Hyalella azteca* was performed for fifteen sediment samples. Prior to the initiation of the tests, salinity tolerance tests were performed with *H. azteca* and *Eohaustorius estuarius*. From these test results, it was concluded that either species could be used since interstitial sediment salinities ranged from 0.0 to 2.0 ppt, and the tolerance of both species ranged from 0.0 to > 12.0 ppt. *H. azteca* was selected as the test species because it has been more commonly used in freshwater sediment toxicity tests than *E. estuarius*.

Holding Time

The holding time established for sediments in the acute amphipod toxicity test is 14 days until test initiation. Table 7 gives the sample numbers, collection and analysis dates, and the holding time for each

sample. The analysis of all samples began within 14 days.

Test Preparation

The animals used for the tests were cultured by NAS, from stock originally purchased from ESE, Gainesville, Florida. The amphipod culture was maintained under the following water quality conditions: temperature, 24.3 ± 0.3 °C; dissolved oxygen, 7.9 ± 0.2 mg/L; pH, 7.6 ± 0.3; conductivity, 336 ± 20 µmhos/cm; hardness, 93 ± 12 mg/L as $CaCO_3$; alkalinity, 63 ± 6 mg/L as $CaCO_3$ for the three weeks prior to testing. Amphipods of the appropriate length (2.0 - 3.0 mm) were acclimated for one day prior to test initiation in moderately hard synthetic water at the test temperature (20 ± 2 °C).

Test sediments were equilibrated overnight with test water. Control sediment was thoroughly washed with test water, and stored at 4 °C in the dark until used.

All test preparation procedures were performed according to NAS and ASTM test protocols (ASTM 1990).

Water Quality

The temperature, dissolved oxygen, conductivity, and pH were measured in all test containers on days 0 and 10 of the test and in one replicate of each test sample on days 2, 4, 6, and 8 of the test. Hardness and alkalinity were measured in one replicate container of each sample on days 0 and 10. The water quality data collected during the 10-day tests are summarized in Table 8. All water quality conditions were within NAS and ASTM test protocols (ASTM 1990).

Control Test

A replicated control toxicity test, whereby amphipods were exposed to sediments known to be free of contaminants, was conducted simultaneously with Columbia River test sediments. The control sediment was collected from Beaver Creek, Oregon, near Ona Beach State Park. In order for the test results to be considered valid, the mean amphipod survival in the control sediment must be ≥ 80 percent. All 100 amphipods from the five replicates of the control sediment test survived, indicating that the test results were valid.

Reference Toxicant Test

A 96-hr reference toxicant test, using cadmium chloride, was initiated on 7/6/93. This replicated test (3 replicates) is designed to determine the sensitivity of the particular group of amphipods used in the sediment toxicity tests to a known toxicant. The LC_{50} calculated for this test was 14.5 µg/L. This result is within the laboratory's control chart warning limits, indicating that the amphipods used in the sediment toxicity tests are not unusually sensitive to the reference toxicant.

Sample Result and Verification

The accuracy of transcription from the bench sheets to the final report pages was checked. No errors were found. All mean survival and standard deviations were recalculated in a spreadsheet and found to be accurate.

Summary

The percent survival for each replicate of the sediment toxicity test, as well as the means and standard deviations, are reported in Table 9. The survival from two replicates, one from sample 8-S and one from sample 13-S, was abnormally low. In the case narrative that accompanied the final report, the laboratory could not explain the observed anomaly. Because water quality and test conditions (i.e., feeding, air

supply) were all within normal parameters for these two replicates, these data were not qualified as estimates. All data are acceptable for their intended use.

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TABLE 1. MICROTOX ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Lauck's Sample Number	Date Collected	Date Analyzed	Analysis Holding Time (d)
1-S	B25-1	6/28/93	7/9/93	11
2-S	B25-2	6/27/93	7/9/93	12
3-S	B25-3	6/27/93	7/9/93	12
4-S	B25-4	6/26/93	7/9/93	13
5-S	B25-5	6/26/93	7/9/93	13
6-S	B25-6	6/25/93	7/8/93	13
7-S	B25-7	6/25/93	7/8/93	13
8-S	B25-9	6/24/93	7/8/93	14
9-1-S	B25-10	6/29/93	7/12/93	13
9-2-S	B25-11	6/29/93	7/12/93	13
9-3-S	B25-12	6/29/93	7/12/93	13
10-S	B25-8	6/28/93	7/9/93	11
11-S	B25-13	6/29/93	7/12/93	13
12-S	B25-14	6/30/93	7/12/93	12
13-S	B25-15	7/1/93	7/12/93	11
14-S	B25-16	7/1/93	7/13/93	12
15-S	B25-17	6/30/93	7/13/93	13

TABLE 2. MICROTOX CONTROL SAMPLE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Luminescence Units				
	Rep. 1	Rep. 2	Rep. 3	Mean	RSD
1-S	95.00	86.00	102.00	94.3	8.5
2-S	96.00	104.00	100.00	100.0	4.0
3-S	94.00	98.00	88.00	93.3	5.4
4-S	96.30	95.78	96.29	96.1	0.3
5-S	94.00	86.00	87.00	89.0	4.9
6-S	98.02	86.63	86.49	90.4	7.3
7-S	96.82	89.27	91.22	92.4	4.2
8-S	95.13	101.61	97.32	98.0	3.4
9-1-S	96.00	92.00	91.00	93.0	2.8
9-2-S	97.00	88.00	89.00	91.3	5.4
9-3-S	96.00	76.00	87.00	86.3	11.6
10-S	97.00	100.00	98.00	98.3	1.6
10-S (duplicate)	90.00	82.00	84.00	85.3	4.9
11-S	82.00	88.00	77.00	82.3	6.7
12-S	98.00	122.00	120.00	113.3	11.7
13-S	120.00	116.00	116.00	117.3	2.0
14-S	95.00	104.00	107.00	102.0	6.1
15-S	96.00	93.00	100.00	96.3	3.6
15-S (duplicate)	95.00	90.00	83.00	89.3	6.7

TABLE 3. MICROTOX REFERENCE TOXICANT RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	EC50 (ppm phenol)			
Date Analyzed	Rep. 1	Rep. 2	Mean	RPD
7/8/93	23.4	17.8	20.6	27.2
7/9/93	24.3	20.6	22.5	16.5
7/12/93	23.3	22.3	22.8	4.4
7/13/93	23.4	21.2	22.3	9.9

TABLE 4. MICROTOX LABORATORY DUPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	EC50 (ppm sediment)			
Station	Rep. 1	Rep. 2	Mean	RPD
10	35,373	60,764	48,069	52.8
15	50,754	31,744	41,249	46.1

TABLE 5. MICROTOX FIELD REPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	EC50 (ppm sediment)				
Station	9-1-S	9-2-S	9-3-S	Mean	RSD
9	45,026	37,933	41,076	41,345	8.6

TABLE 6. MICROTOX SAMPLE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	EC50 (ppm sediment)
1-S	3,587
2-S	79,074
3-S	40,815
4-S	24,513
5-S	23,690
6-S	113,084
7-S	94,650
8-S	152,657
9-1-S	45,026
9-2-S	37,933
9-3-S	41,076
10-S	35,373
10-S (duplicate)	60,764
11-S	106,163
12-S	56,746
13-S	24,013
14-S	26,730
15-S	50,754
15-S (duplicate)	31,744

TABLE 7. AMPHIPOD TOXICITY ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	NAS Sample Number	Date Collected	Receipt Date	Date Test Began	Analysis Holding Time (d)
1-S	9788D	6/28/93	6/30/93	7/6/93	8
2-S	9789D	6/27/93	6/30/93	7/6/93	9
3-S	9790D	6/27/93	6/30/93	7/6/93	9
4-S	9791D	6/26/93	6/30/93	7/6/93	10
5-S	9792D	6/26/93	6/30/93	7/6/93	10
6-S	9793D	6/25/93	6/30/93	7/6/93	11
7-S	9794D	6/25/93	6/30/93	7/6/93	11
8-S	9795D	6/24/93	6/30/93	7/6/93	12
9-1-S	9801D	6/29/93	7/2/93	7/6/93	7
10-S	9796D	6/28/93	6/30/93	7/6/93	8
11-S	9804D	6/29/93	7/2/93	7/6/93	7
12-S	9805D	6/30/93	7/2/93	7/6/93	6
13-S	9806D	7/1/93	7/2/93	7/6/93	5
14-S	9807D	7/1/93	7/2/93	7/6/93	5
15-S	9808D	6/30/93	7/2/93	7/6/93	6

TABLE 8. WATER QUALITY CONDITIONS[1] DURING AMPHIPOD TOXICITY TESTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Temperature (° C)	DO (mg/L)	Conductivity (μmhos/cm)	pH	Hardness (mg/L)	Alkalinity (mg/L)
Control	20.8 ± 0.6	8.4 ± 0.2	415 ± 90	8.0 ± 0.2	100 ± 0	80 ± 0
1-S	20.6 ± 0.4	8.5 ± 0.2	780 ± 220	8.0 ± 0.1	95 ± 7	85 ± 7
2-S	20.7 ± 0.5	8.4 ± 0.2	370 ± 73	7.8 ± 0.1	150 ± 42	80 ± 0
3-S	20.7 ± 0.6	8.4 ± 0.2	404 ± 95	7.8 ± 0.2	115 ± 7	80 ± 0
4-S	20.6 ± 0.4	8.4 ± 0.2	363 ± 76	7.9 ± 0.2	95 ± 35	60 ± 28
5-S	20.6 ± 0.6	8.5 ± 0.1	377 ± 70	7.9 ± 0.2	120 ± 0	80 ± 0
6-S	20.7 ± 0.6	8.4 ± 0.2	382 ± 89	7.8 ± 0.2	110 ± 14	75 ± 7
7-S	20.7 ± 0.5	8.4 ± 0.2	394 ± 91	7.9 ± 0.1	105 ± 7	75 ± 7
8-S	20.6 ± 0.5	8.4 ± 0.2	386 ± 85	7.9 ± 0.2	110 ± 14	80 ± 0
9-1-S	20.7 ± 0.5	8.5 ± 0.2	355 ± 62	7.9 ± 0.1	110 ± 14	70 ± 14
10-S	20.7 ± 0.5	8.5 ± 0.2	353 ± 70	7.9 ± 0.1	90 ± 14	60 ± 0
11-S	20.5 ± 0.4	8.5 ± 0.2	382 ± 91	7.9 ± 0.1	90 ± 14	60 ± 0
12-S	20.7 ± 0.5	8.4 ± 0.2	393 ± 79	7.9 ± 0.1	130 ± 14	80 ± 0
13-S	20.7 ± 0.5	8.4 ± 0.2	393 ± 83	7.9 ± 0.2	120 ± 0	85 ± 7
14-S	20.8 ± 0.5	8.4 ± 0.3	361 ± 63	7.9 ± 0.1	90 ± 14	70 ± 14
15-S	20.4 ± 0.5	8.4 ± 0.2	397 ± 90	7.9 ± 0.1	115 ± 7	85 ± 21

[1] Values given are mean ± standard deviation (n = 14 for temp., DO, cond., & pH; n = 2 for hardness & alkalinity

TABLE 9. PERCENT SURVIVAL OF HYALELLA AZTECA DURING SEDIMENT TOXICITY TESTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5	Mean	S.D.
Control	100.0	100.0	100.0	100.0	100.0	100.0	0.0
1-S	70.0	75.0	85.0	95.0	100.0	85.0	12.7
2-S	100.0	70.0	80.0	90.0	85.0	85.0	11.2
3-S	100.0	100.0	100.0	100.0	100.0	100.0	0.0
4-S	90.0	100.0	100.0	100.0	100.0	98.0	4.5
5-S	100.0	100.0	100.0	100.0	100.0	100.0	0.0
6-S	95.0	100.0	90.0	100.0	95.0	96.0	4.2
7-S	70.0	90.0	80.0	100.0	75.0	83.0	12.0
8-S	100.0	100.0	95.0	100.0	45.0	88.0	24.1
9-1-S	100.0	100.0	100.0	100.0	100.0	100.0	0.0
10-S	95.0	100.0	100.0	100.0	100.0	99.0	2.2
11-S	100.0	90.0	85.0	95.0	100.0	94.0	6.5
12-S	90.0	100.0	95.0	95.0	95.0	95.0	3.5
13-S	100.0	95.0	20.0	100.0	85.0	80.0	34.1
14-S	80.0	95.0	80.0	75.0	75.0	81.0	8.2
15-S	95.0	90.0	90.0	85.0	95.0	91.0	4.2

Appendix A-5

Data Validation Report
Metals Analyses

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by: Tetra Tech, Inc.

Samples analyzed by: Aquatic Research, Inc.

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 90 water samples, 17 sediment samples, and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey, and analyzed for trace metals by Aquatic Research, Inc. The samples were collected at 15 different stations. For water samples, two sets of triplicate field samples were collected at every station. One set was filtered in the field before analysis and represents "dissolved" metals (sample number designation "D"). The other set was delivered to the laboratory unfiltered and represents "total recoverable metals" (sample number designation "T"). For sediment samples, triplicate field samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Of the 33 tissue samples, 15 were crayfish and 18 were fish, either largescale sucker or carp. Crayfish samples were collected at only 13 of the 15 stations (all except stations 1 and 15). Triplicate field samples were collected at station 13 (samples 13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale suckers) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS).

Sediment and water samples were analyzed for sixteen different trace metals, while tissue samples were analyzed for twelve different trace metals. The analytical method used for each metal in the three different media are specified in the table below:

	Water	Sediment	Tissue
Aluminum	GFAA	ICP	not analyzed
Antimony	GFAA	GFAA	GFAA
Arsenic	GFAA	GFAA	GFAA
Barium	ICP	ICP	ICP
Beryllium	ICP	ICP	not analyzed
Cadmium	GFAA	GFAA	GFAA
Chromium	GFAA	ICP	GFAA
Copper	GFAA	ICP	ICP
Iron	ICP	ICP	not analyzed
Lead	GFAA	GFAA	GFAA
Mercury	CVAA	CVAA	CVAA
Nickel	ICP	ICP	ICP
Selenium	GFAA	GFAA	GFAA
Silver	GFAA	GFAA	GFAA
Thallium	GFAA	GFAA	not analyzed
Zinc	ICP	ICP	ICP

GFAA = Graphite furnace atomic absorption spectroscopy
ICP = Inductively-coupled plasma emission spectroscopy
CVAA = Cold vapor atomic absorption spectroscopy

These methods are identical to those specified in the QA Plan (Tetra Tech 1993), with the exception of chromium in sediment and copper in sediment and tissue, which were originally to be analyzed by GFAA, but had to be reanalyzed by ICP because sample concentrations were outside the calibration range of the GFAA instrumentation.

The samples were delivered and logged by the laboratory in ten different Sample Delivery Groups (SDGs). The first seven SDGs consisted of sediment and water samples from the following stations: SDG 1 (stations 6, 7, and 8); SDG 2 (stations 4 and 5); SDG 3 (stations 2 and 3); SDG 4 (stations 1 and 10); SDG 5 (stations 9 and 11); SDG 6 (stations 12 and 15); and SDG 7 (stations 13 and 14). SDGs 8 and 9 consisted of crayfish samples, while SDG 10 consisted of all of the fish samples. Most of the analyses were conducted on more than one SDG simultaneously, but the QC data referenced below will be evaluated relative to a particular SDG where appropriate. Tissue samples were not originally analyzed for barium. These analyses were performed several weeks after the original tissue analyses.

The data validation review was conducted according to QC criteria presented in the U.S. EPA Contract Laboratory Program Statement of Work (SOW) for inorganics analyses (U.S. EPA 1991), the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses (U.S. EPA 1988), and the approved Sampling and QA/QC Plan for this project (Tetra Tech 1993). Results of the data validation review are presented below.

A. HOLDING TIMES

Sediment and tissue samples were collected, placed on ice or frozen (tissue) in a cooler, and transported to the laboratory within 6 days of collection. Holding times established for this project are 28 days for mercury and 6 months for all other metals. Table 1 presents a summary of sample numbers, collection dates, analysis dates, and holding times. All metals analyzed by either GFAA or ICP were analyzed well within the 6 month holding time.

Six of the 90 water samples, 9 of the 17 sediment samples, and all of the crayfish samples were analyzed for mercury slightly outside (1-8 days) the applicable holding time. The original analyses for mercury were performed within the 28-day holding time, but the samples were reanalyzed because several QC samples were outside control limits. This deviation was considered minor and no data qualifiers were added. Four additional water samples (3-1-W-D, 5-2-W-D, 5-2-W-T, and 7-3-W-D) which originally contained detectable levels of mercury were reanalyzed on 10/8/93 at the request of Tetra Tech. Although these samples were reanalyzed more than 90 days after they were collected, they were fixed with preservative before the expiration of the 28-day holding time. It is not likely that the mercury concentration changed appreciably after that time. Nonetheless, because of the holding time exceedances, these four sample results (three of which were non-detects) for mercury were qualified as estimates.

B. CALIBRATION

Initial calibration was conducted per method protocols using the appropriate number of standards (i.e., one blank and three standards for ICP and one blank and four standards for GFAA and CVAA).

Water and Sediment

Water and sediment samples were analyzed simultaneously as part of the same SDGs. Correlation

coefficients for CVAA and GFAA calibrations were ≥ 0.995. Correlation coefficients were recalculated from raw data for confirmation. Initial calibration verification (ICV) was performed following initial calibration as required for the analytical methods (GFAA, ICP, and CVAA). All ICV recoveries were within QC limits, with the exception of nickel in the 9/4/93 ICV, which was recovered at 111 percent, just outside the applicable QC limit of 90-110 percent. This deviation was considered minor and no qualifiers were added.

Continuing calibration verification (CCV) standard analyses were performed as required in Contract Lab Program (CLP) protocols. All CCV results were within 90-110 percent of the true value, with the exception of those listed in Table 2. For those results greater than 110 percent, all positive results were qualified as estimates (qualifier code "E"). For those results less than 90 percent, both positive and negative (i.e., undetected) results were qualified as estimates. The only positive values that were qualified in this manner were lead from samples 1-1-W-T, 1-2-W-D, and 14-1-W-T and cadmium from sample 5-3-W-T. Approximately 20 undetected values from stations 3-7 were also qualified (qualifier code "U/E").

Tissue

All tissue samples were analyzed simultaneously as part of the same SDGs. Correlation coefficients for CVAA and GFAA calibrations were ≥ 0.995. Correlation coefficients were recalculated from raw data for confirmation. Initial calibration verification (ICV) was performed following initial calibration as required for the analytical methods (GFAA, ICP, and CVAA). All ICV recoveries were within QC limits.

Continuing calibration verification (CCV) standard analyses were performed as required by CLP protocols. All CCV results were within 90-110 percent of the true value, with the exception of those listed in Table 2. For those results greater than 110 percent, all positive results were qualified as estimates (qualifier code "E"). For those results less than 90 percent, both positive and negative (i.e., undetected) results were qualified as estimates. The only positive values qualified in this manner were for lead (samples 2-CF, 3-CF, 4-CF, 5-CF, 10-CF, and 12-CF), selenium (samples 2-CF, 10-CF, 14-CF, 1-LS, 1-C, 3-LS, 7-LS, 8-LS, 9-LS, and 12-LS), and silver (sample 3-CF). Approximately 20 undetected values for arsenic and selenium were also qualified (qualifier code "U/E").

C. BLANK RESULTS

Water

Several types of blank samples were analyzed as part of this project. Initial and continuing calibration blanks (ICBs and CCBs) were analyzed after each ICV and CCV sample. Preparation blanks were prepared in conjunction with the digestion of the unfiltered water samples (samples designated "T" for total metals). Finally, a series of filter blanks which were prepared in the field were analyzed. One filter blank consisted of reagent water filtered through the Nalgene nylon filters used for the filtered (samples designated "D" for dissolved metals) samples at the beginning of the cruise, while a pair of filter blanks (samples FIL_BL A and FIL_BL B) were prepared using Millipore filters, which were used at stations 1-2 and 9-15 during the second half of the cruise.

Table 3 lists the metals detected in the blank samples, as well as the field samples associated with each blank. In accordance with U.S. EPA guidelines (U.S. EPA 1988), field sample concentrations which were less than 5X the amount detected in the associated blank sample were qualified as undetected due to blank contamination (qualifier code "U/B"). In the cases where more than one preparation blank was

associated with the identical group of field samples, the highest detected concentration was used to determine if qualifiers were warranted. Sample concentrations which were originally reported by the laboratory as non-detected were not qualified in any way. Sample results for 8 different metals were qualified in this manner (Table 4).

Sediment

Two different types of blank samples were analyzed for sediment samples. Initial and continuing calibration blanks (ICBs and CCBs) were analyzed after each ICV and CCV sample. Preparation blanks were prepared in conjunction with the digestion of the sediment samples.

Table 3 lists the metals detected in the blank samples, as well as the field samples associated with each blank. In accordance with U.S. EPA guidelines (U.S. EPA 1988), field sample concentrations which were less than 5X the amount detected in the associated blank sample were qualified as undetected due to blank contamination (qualifier code "U/B"). Because blank sample results were given in units of weight/volume (e.g., mg/L or μg/L) and sediment sample results were reported in units of mg/kg, the "5X rule" was applied to the raw values, rather than the reported results. In the cases where more than one preparation blank was associated with the identical group of field samples, the highest detected concentration was used to determine if qualifiers were warranted. Sample concentrations which were originally reported by the laboratory as non-detected were not qualified in any way. Four sample results for both lead and silver were qualified in this manner (Table 4).

Tissue

Two different types of blank samples were analyzed for tissue samples. Initial and continuing calibration blanks (ICBs and CCBs) were analyzed after each ICV and CCV sample. Preparation blanks were prepared in conjunction with the digestion of the tissue samples.

Table 3 lists the metals detected in the blank samples, as well as the field samples associated with each blank. In accordance with U.S. EPA guidelines (U.S. EPA 1988), field sample concentrations which were less than 5X the amount detected in the associated blank sample were qualified as undetected due to blank contamination (qualifier code "U/B"). Because blank sample results were given in units of weight/volume (e.g., mg/L or μg/L) and tissue sample results were reported in units of mg/kg, the "5X rule" was applied to the raw values, rather than the reported results. In the cases where more than one preparation blank was associated with the identical group of field samples, the highest detected concentration was used to determine if qualifiers were warranted. Sample concentrations which were originally reported by the laboratory as non-detected were not qualified in any way. Two results for chromium, 7 results for lead, and 2 results for mercury were qualified in this manner (Table 4).

D. MATRIX SPIKE ANALYSES

Water

Matrix spikes of twenty different samples (10 dissolved, 10 total) were analyzed. The results are presented in Table 5. The QC limits for spike recovery specified in the method protocol and the QA/QC plan (Tetra Tech 1993) are 75-125 percent. According to U.S. EPA (1988) guidelines, these QC limits do not apply when the amount spiked was less than one-fourth the sample concentration. This occurred for several of the total aluminum and iron spikes. In situations such as these, an alternate formula can be used to calculate percent recovery. The standard formula for calculating percent recovery for matrix

spikes is ((SSR-SR)/SA)x100, where SSR, SR, SA are spiked sample result, sample result, and spike added, respectively. By using the alternate formula (SSR/SR+SA)x100, a reasonable approximation of spike recovery can be made. Recoveries calculated using the alternate formula have been footnoted in Table 5.

Spike recoveries were outside the acceptable range of 75-125 percent in at least one spike for 11 of the 16 metals (Table 5). For spike recoveries greater than 125 percent, all positive values in the associated SDG were qualified as estimated, while negative (undetected) values were not qualified. For spike recoveries less than 75 percent but greater than 30 percent, all sample values from the associated SDG were qualified as estimated. In cases where the out-of-range recovery was limited to either the dissolved or total samples, only samples of that type were qualified in the particular SDG. The differentiation between dissolved and total samples was deemed appropriate because of the different preparation methods required for the two types of samples (dissolved samples underwent no preparation) and the fact that concentrations in the total samples were often much higher than in the dissolved samples.

The positive sample results that were qualified as estimates due to matrix spike results are listed in Table 6. Several sample results for 6 metals (aluminum, iron, lead, nickel, thallium, and zinc) were qualified in this manner. In addition, several sample results for antimony, beryllium, nickel, silver, and zinc were qualified as undetected and estimated (qualifier code "U/E") based on low matrix spike recoveries.

Sediment

Matrix spikes of five different samples were analyzed. The results are presented in Table 5. The QC limits for spike recovery specified in the method protocol and the QA/QC plan (Tetra Tech 1993) are 75-125 percent. According to U.S. EPA (1988) guidelines, these QC limits do not apply when the amount spiked was less than one-fourth the sample concentration. This occurred for the iron spikes. In situations such as these, an alternate formula can be used to calculate percent recovery. The standard formula for calculating percent recovery for matrix spikes is ((SSR-SR)/SA)x100, where SSR, SR, SA are spiked sample result, sample result, and spike added, respectively. By using the alternate formula (SSR/SR+SA)x100, a reasonable approximation of spike recovery can be made. Recoveries calculated using the alternate formula have been footnoted in Table 5.

Spike recoveries for several metals (arsenic, beryllium, copper, selenium, and zinc) were just slightly less (71-73 percent) than the lower QC guideline of 75 percent. These deviations were considered minor and no qualifiers were added. The percent recovery for mercury in sample 9-1-S was well outside QC guidelines (203 percent). Because of this exceedance, all mercury sample results were qualified as estimates. Low recoveries were noted for selenium and thallium. All sample results for these two metals were qualified as undetected and estimated (qualifier code "U/E"). No other data qualifiers were added based on matrix spike results.

Tissue

Matrix spikes of nine different samples (5 crayfish and 4 largescale sucker) were analyzed. The results are presented in Table 5. The QC limits for spike recovery specified in the method protocol and the QA/QC plan (Tetra Tech 1993) are 75-125 percent. According to U.S. EPA (1988) guidelines, these QC limits do not apply when the amount spiked was less than one-fourth the sample concentration. This occurred for two of the barium, one of the chromium, and all of the mercury spikes. In situations such as these, an alternate formula can be used to calculate percent recovery. The standard formula for calculating percent recovery for matrix spikes is ((SSR-SR)/SA)x100, where SSR, SR, SA are spiked sample result, sample result, and spike added, respectively. By using the alternate formula

(SSR/SR+SA)x100, a reasonable approximation of spike recovery can be made. Recoveries calculated using the alternate formula have been footnoted in Table 5.

For most of the spikes of undiluted samples, the percent recovery was below acceptable QC limits (75-125 percent) for at least one element. Because the final analysis of the field samples was conducted on diluted samples because of matrix interference, a post-digestion spike for arsenic, lead, and selenium was also prepared on the 100X diluted samples. Recoveries for these spikes were within QC limits with the exception of lead. One of the original spikes (sample 9-CF) which showed out-of-range recoveries was not repeated using the diluted samples because a spike sample from the same SDG had already been analyzed. No qualifiers were added based on the results from spike sample 9-CF.

Three of the four spike recoveries for lead were greater than 125 percent. All positive results from the associated SDGs were qualified as estimates. One of the two spike recoveries for silver was below 75 percent. Both positive and negative (undetected) values for the associated SDG were qualified as estimates. The positive sample results that were qualified as estimates due to matrix spike results are listed in Table 6.

E. LABORATORY DUPLICATE ANALYSES

Water

Laboratory duplicate analyses were performed for the same samples used for matrix spike analyses. The results of these analyses are presented in Table 7. RPDs between the two duplicates of each sample could only be calculated for 8 of the 16 metals because of non-detect values. The data quality objective for precision specified in the QC plan (Tetra Tech 1993) was a RPD of 20 percent. Most of the relative percent differences (RPDs) met this goal, with the exception of samples 5-1-W-D and 8-1-W-T for aluminum, sample 13-2-W-T for lead, and samples 12-3-W-T, 13-2-W-T, 14-3-W-T, and 15-3-W-T for zinc. For the sample results listed above, the reported values were qualified as estimated (qualifier code "E") because of laboratory duplicate results. It should be noted that several of the sample results listed above also warranted qualification due to matrix spike results (see Table 6).

Sediment

Laboratory duplicate analyses were performed for the same samples used for matrix spike analyses. The results of these analyses are presented in Table 7. Laboratory duplicates were not analyzed for antimony and copper. The data quality objective for precision specified in the QC plan (Tetra Tech 1993) was a RPD of 20 percent. Most of the RPDs met this goal, with the exception of sample 14-S for arsenic and sample 5-S for beryllium and cadmium. For the sample results listed above, the reported values were qualified as estimated (qualifier code "E") because of laboratory duplicate results.

Tissue

Laboratory duplicate analyses were performed for the same samples used for matrix spike analyses. The results of these analyses are presented in Table 7. RPDs between the two duplicates of each sample could not be calculated for arsenic and selenium because of non-detect values. The data quality objective for precision specified in the QC plan (Tetra Tech 1993) was a RPD of 20 percent. Most of the RPDs met this goal, with the exception of sample 7-LS for cadmium; samples 2-CF and 7-LS for chromium; samples 6-CF, 9-CF, 7-LS, 8-LS, and 13-1-LS for lead; samples 9-CF and 3-LS for nickel; samples 6-CF, 9-CF, 13-2-CF, and 7-LS for silver; and sample 9-CF for zinc. For the sample results listed above, the reported values were qualified as estimated (qualifier code "E") because of laboratory duplicate results. It should

be noted that several of the sample results listed above also warranted qualification due to matrix spike results (see Table 6).

F. FIELD REPLICATE ANALYSES

Water

Three field triplicates were collected and analyzed at every station for both dissolved and total metals. Stations at which a relative standard deviation (RSD) between the triplicate analyses could be calculated (i.e., all positive values) for either the dissolved or total fraction are given in Table 8. The calculated RSDs were generally less than 30 percent, with the exception of aluminum at stations 5 and 8 (both dissolved); barium at stations 1 and 2 (both total); chromium at station 10 (total); copper at stations 3, 8, and 10 (all total); iron at stations 4, 12, and 15 (all total); and zinc at stations 1, 9, 10, 12, 13, and 15 (all total). It is not appropriate to assign data qualifiers based on field replicate results.

Sediment

Three field triplicates were collected and analyzed at station 9. RSDs between the three analyses could be calculated for all metals except antimony, lead, selenium, silver, and thallium and are given in Table 9. The calculated RSDs were all less than 25 percent, indicating relatively low field variability.

Tissue

Triplicate field samples were collected at station 13 for both crayfish and largescale sucker. RSDs between the three analyses could be calculated for all metals except arsenic and selenium and are given in Table 9. The RSDs were all less than 30 percent, with the exception of chromium in fish (30.9 percent), lead in fish (34.0 percent), and zinc in fish (111 percent).

G. REFERENCE MATERIAL ANALYSES

Sediment

Two certified reference materials distributed by the National Institute of Standards and Technology (NIST) were analyzed for all metals. NIST 1646 is an estuarine sediment certified for 10 of the 16 metals (all but antimony, barium, beryllium, selenium, silver, and thallium) analyzed in this project, while NIST 2704 is a freshwater sediment from Buffalo River certified for 13 of the 16 (all but beryllium, selenium, and silver) metals. In general, the certified concentrations of the Buffalo River sediments are higher (approximately 2-3X) than those in the estuarine sediment. It should be noted that the certified concentrations for both of these reference sediments are based on total metals analysis, while Aquatic Research used extraction methodology consistent with total recoverable metals.

The results of the reference material analysis are given in Table 10. The percent accuracy ranged from 22 percent for barium in NIST 2704 to 129 percent for mercury in NIST 2704. The metals for which the percent accuracy was less than 50 percent in at least one of the reference materials included aluminum, barium, and chromium. Low recoveries of these metals for these SRMs are typical for this laboratory (Lazoff, S, personal communication, 6 October 1993), particularly when using a total recoverable extraction. The recoveries obtained are consistent with the results other laboratories have obtained using a total recoverable extraction (Rowan and Kalff 1993). No data quality objective for accuracy based on SRMs was specified in the QC plan (Tetra Tech 1993). Therefore, it would be inappropriate to assign data qualifiers based on SRM results.

H. ICP SERIAL DILUTION

Water

Sample 6-1-W-D was diluted five-fold and analyzed in duplicate for ICP elements to provide information on potential matrix effects. ICP serial dilution raw data were examined to verify the reported results. Only two elements were detected in both the original and the diluted sample. The %D for the metals (copper, 25 percent and iron, 33.8 percent) exceeded the acceptance criteria ($\pm$ 10 percent) established by U.S. EPA (1988). In accordance with U.S. EPA guidelines, however, no data qualifiers were added to sample results because the concentration of the metals in the original samples was not a factor of 50 or greater than the detection limit.

Sediment

Sample 10-S was diluted five-fold and analyzed in duplicate for ICP elements to provide information on potential matrix effects. ICP serial dilution raw data were examined to verify the reported results. Eight of the nine ICP elements (all except beryllium) were detected in both the original and diluted samples. For those elements for which sample results were greater than 50X the detection limit, the %D criterion of $\pm$ 10 percent was met except for chromium (12.7 percent), iron (17.5 percent), and zinc (21.9 percent). All three of these elements exhibited negative interference (i.e., diluted samples have higher concentrations than undiluted samples). Because the sediment results reported for ICP were not from diluted samples, the exceedance of QC guidelines for ICP serial dilution should not affect the quality of the data. No data qualifiers were added.

Tissue

Sample 9-CF was diluted five-fold and analyzed in duplicate for ICP elements (copper, nickel, and zinc) to provide information on potential matrix effects. ICP serial dilution raw data were examined to verify the reported results. All three of the ICP elements were detected in both the original and diluted samples. For those elements for which sample results were greater than 50X the detection limit (copper and zinc), the %D criterion of $\pm$ 10 percent was met for copper, but not for zinc (37.6 percent). Zinc exhibited negative interference (i.e., diluted samples have higher concentrations than undiluted samples). Because the tissue results run by ICP were diluted 1:5, the exceedance of QC guidelines by zinc warranted the qualification (data qualifier "E") of all zinc data. No other data qualifiers were added.

SUMMARY

Water

All sample data were reported by the laboratory in µg/L and are presented in Table 11. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (0.1-5 µg/L) met the goals specified in the sampling and QA/QC plan (Tetra Tech 1993).

Sample results for several metals were qualified as estimated based on evaluation of QA/QC data. Three positive values for cadmium and one for lead were qualified as estimates based on exceedance of continuing calibration verification criteria. Several metals were found in continuing calibration blanks and preparation blanks at concentrations near the detection limit. Approximately 40 values (see Table 4) for eight different metals (aluminum, cadmium, chromium, copper, lead, nickel, thallium, and zinc) were qualified as undetected due to blank contamination (qualifier code "U/B"). An additional 40 values (see Table 6) for six different metals (aluminum, iron, lead, nickel, thallium, and zinc) were qualified as estimates based on exceedances of QC guidelines for matrix spikes. Several values for aluminum, lead, and zinc were qualified as estimates based on exceedances of QC guidelines for laboratory precision.

The precision, accuracy, and completeness of the metals analyses for water were generally within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Sediment

All sample data were reported by the laboratory in mg/kg (dry) and are presented in Table 11. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (0.002-10 mg/kg) met the goals specified in the sampling and QA/QC plan (Tetra Tech 1993).

Sample results for several metals were qualified as estimated based on evaluation of QA/QC data. Several metals were found in continuing calibration blanks and preparation blanks at concentrations near the detection limit. Four values for both lead and silver (see Table 4) were qualified as undetected due to blank contamination (qualifier code "U/B"). Because of a very high spike recovery, all mercury values were qualified as estimates. One value for each of the metals arsenic, beryllium, and cadmium was qualified as an estimate based on exceedances of QC guidelines for laboratory precision.

The precision, accuracy, and completeness of the metals analyses for sediment were generally within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Tissue

All sample data were reported by the laboratory in mg/kg (wet) and are presented in Table 11. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (0.0004-0.1 mg/kg) met the goals specified in the sampling and QA/QC plan (Tetra Tech 1993) for some metals, but not for others. The detection limits reported for arsenic, lead, mercury,

nickel, and selenium were approximately 3X greater than those specified in the QC plan. The laboratory could not meet the target detection limits for these metals because of matrix interference.

Sample results for several metals were qualified as estimated based on evaluation of QA/QC data. Approximately 15 values for lead, selenium, and silver were qualified as estimates based on exceedance of continuing calibration verification criteria. Several metals were found in continuing calibration blanks and preparation blanks at concentrations near the detection limit. Several values for chromium, lead, and mercury (see Table 4) were qualified as undetected due to blank contamination (qualifier code "U/B"). Most of the values for lead and several values for silver (see Table 6) were qualified as estimates based on exceedances of QC guidelines for matrix spikes. Approximately 15 values for six different metals (cadmium, chromium, lead, nickel, silver, and zinc) were qualified as estimates based on exceedances of QC guidelines for laboratory precision. All zinc values were qualified as estimates based on exceedance of the ICP serial dilution QC guideline.

The precision, accuracy, and completeness of the metals analyses for sediment were generally within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

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TABLE 1. METALS ANALYSIS SUMMARY (Page 1 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Laboratory Sample Number	Date Collected	ICP Metals[1] Date Analyzed	ICP Metals[1] Analysis Holding Time (d)	GFAA Metals[2] Date Analyzed	GFAA Metals[2] Analysis Holding Time (d)	Mercury Date Analyzed	Mercury Analysis Holding Time (d)
Water								
1-1-W-D	TT020401	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
1-1-W-T	TT020402	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
1-2-W-D	TT020403	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
1-2-W-T	TT020404	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
1-3-W-D	TT020405	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
1-3-W-T	TT020406	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
2-1-W-D	TT020307	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
2-1-W-T	TT020308	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
2-2-W-D	TT020309	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
2-2-W-T	TT020310	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
2-3-W-D	TT020311	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
2-3-W-T	TT020312	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-1-W-D	TT020301	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-1-W-T	TT020302	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-2-W-D	TT020303	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-2-W-T	TT020304	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-3-W-D	TT020305	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
3-3-W-T	TT020306	6/27/93	9/4/93	69	8/17-9/14/93	79	7/23/93	26
4-1-W-D	TT020207	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
4-1-W-T	TT020208	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
4-2-W-D	TT020209	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
4-2-W-T	TT020210	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
4-3-W-D	TT020211	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
4-3-W-T	TT020212	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-1-W-D	TT020201	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-1-W-T	TT020202	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-2-W-D	TT020203	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-2-W-T	TT020204	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-3-W-D	TT020205	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
5-3-W-T	TT020206	6/26/93	9/4/93	70	8/17-9/14/93	80	7/23/93	27
6-1-W-D	TT020113	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
6-1-W-T	TT020114	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
6-2-W-D	TT020115	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
6-2-W-T	TT020116	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
6-3-W-D	TT020117	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
6-3-W-T	TT020118	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-1-W-D	TT020107	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-1-W-T	TT020108	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-2-W-D	TT020109	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-2-W-T	TT020110	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-3-W-D	TT020111	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
7-3-W-T	TT020112	6/25/93	9/4/93	71	8/17-9/14/93	81	7/23/93	28
8-1-W-D	TT020101	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
8-1-W-T	TT020102	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
8-2-W-D	TT020103	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
8-2-W-T	TT020104	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
8-3-W-D	TT020105	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
8-3-W-T	TT020106	6/24/93	9/4/93	72	8/17-9/14/93	82	7/23/93	29
9-1-W-D	TT020501	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
9-1-W-T	TT020502	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26

TABLE 1. METALS ANALYSIS SUMMARY (Page 2 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Laboratory Sample Number	Date Collected	ICP Metals[1]		GFAA Metals[2]		Mercury	
			Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)	Date Analyzed	Analysis Holding Time (d)
9-2-W-D	TT020503	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
9-2-W-T	TT020504	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
9-3-W-D	TT020505	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
9-3-W-T	TT020506	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
10-1-W-D	TT020407	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
10-1-W-T	TT020408	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
10-2-W-D	TT020409	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
10-2-W-T	TT020410	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
10-3-W-D	TT020411	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
10-3-W-T	TT020412	6/28/93	9/4/93	68	8/17-9/14/93	78	7/25/93	27
11-1-W-D	TT020507	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
11-1-W-T	TT020508	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
11-2-W-D	TT020509	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
11-2-W-T	TT020510	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
11-3-W-D	TT020511	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
11-3-W-T	TT020512	6/29/93	8/20/93	52	8/17-9/14/93	77	7/25/93	26
12-1-W-D	TT020601	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
12-1-W-T	TT020602	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
12-2-W-D	TT020603	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
12-2-W-T	TT020604	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
12-3-W-D	TT020605	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
12-3-W-T	TT020606	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
13-1-W-D	TT020701	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
13-1-W-T	TT020702	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
13-2-W-D	TT020703	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
13-2-W-T	TT020704	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
13-3-W-D	TT020705	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
13-3-W-T	TT020706	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-1-W-D	TT020707	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-1-W-T	TT020708	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-2-W-D	TT020709	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-2-W-T	TT020710	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-3-W-D	TT020711	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
14-3-W-T	TT020712	7/1/93	8/20/93	50	8/17-9/14/93	75	7/25/93	24
15-1-W-D	TT020607	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
15-1-W-T	TT020608	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
15-2-W-D	TT020609	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
15-2-W-T	TT020610	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
15-3-W-D	TT020611	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25
15-3-W-T	TT020612	6/30/93	8/20/93	51	8/17-9/14/93	76	7/25/93	25

[1] barium, beryllium, chromium, iron, nickel, and zinc

[2] aluminum, antimony, arsenic, cadmium, copper, lead, selenium, silver, and thallium

TABLE 1. METALS ANALYSIS SUMMARY (Page 3 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Laboratory Sample Number	Date Collected	ICP Metals[1] Date Analyzed	ICP Metals[1] Analysis Holding Time (d)	GFAA Metals[2] Date Analyzed	GFAA Metals[2] Analysis Holding Time (d)	Mercury Date Analyzed	Mercury Analysis Holding Time (d)
Sediment								
1-S	TT020441	6/28/93	9/4/93	68	8/17-9/14/93	78	7/27/93	29
2-S	TT020342	6/27/93	9/4/93	69	8/17-9/14/93	79	7/27/93	30
3-S	TT020341	6/27/93	9/4/93	69	8/17-9/14/93	79	7/27/93	30
4-S	TT020242	6/26/93	9/4/93	70	8/17-9/14/93	80	7/27/93	31
5-S	TT020241	6/26/93	9/4/93	70	8/17-9/14/93	80	7/27/93	31
6-S	TT020143	6/25/93	9/4/93	71	8/17-9/14/93	81	7/27/93	32
7-S	TT020142	6/25/93	9/4/93	71	8/17-9/14/93	81	7/27/93	32
8-S	TT020141	6/24/93	9/4/93	72	8/17-9/14/93	82	7/27/93	33
9-1-S	TT020541	6/29/93	8/20/93	52	8/17-9/14/93	77	7/27/93	28
9-2-S	TT020542	6/29/93	8/20/93	52	8/17-9/14/93	77	7/27/93	28
9-3-S	TT020543	6/29/93	8/20/93	52	8/17-9/14/93	77	7/27/93	28
10-S	TT020442	6/28/93	9/4/93	68	8/17-9/14/93	78	7/27/93	29
11-S	TT020544	6/29/93	8/20/93	52	8/17-9/14/93	77	7/27/93	28
12-S	TT020641	6/30/93	8/20/93	51	8/17-9/14/93	76	7/27/93	27
13-S	TT020741	7/1/93	8/20/93	50	8/17-9/14/93	75	7/27/93	26
14-S	TT020742	7/1/93	8/20/93	50	8/17-9/14/93	75	7/27/93	26
15-S	TT020642	6/30/93	8/20/93	51	8/17-9/14/93	76	7/27/93	27
Crayfish								
2-CF	TT020971	7/22/93	10/2-10/26/93	96	9/30-10/11/93	81	8/21/93	30
3-CF	TT020972	7/22/93	10/2-10/26/93	96	9/30-10/11/93	81	8/21/93	30
4-CF	TT020973	7/24/93	10/2-10/26/93	94	9/30-10/11/93	79	8/21/93	28
5-CF	TT020974	7/23/93	10/2-10/26/93	95	9/30-10/11/93	80	8/21/93	29
6-CF	TT020871	7/16/93	10/2-10/26/93	102	9/30-10/11/93	87	8/21/93	36
7-CF	TT020872	7/16/93	10/2-10/26/93	102	9/30-10/11/93	87	8/21/93	36
8-CF	TT020873	7/16/93	10/2-10/26/93	102	9/30-10/11/93	87	8/21/93	36
9-CF	TT020874	7/16/93	10/2-10/26/93	102	9/30-10/11/93	87	8/21/93	36
10-CF	TT020975	7/20/93	10/2-10/26/93	98	9/30-10/11/93	83	8/21/93	32
11-CF	TT020875	7/18/93	10/2-10/26/93	100	9/30-10/11/93	85	8/21/93	34
12-CF	TT020976	7/20/93	10/2-10/26/93	98	9/30-10/11/93	83	8/21/93	32
13-1-CF	TT020876	7/18/93	10/2-10/26/93	100	9/30-10/11/93	85	8/21/93	34
13-2-CF	TT020877	7/18/93	10/2-10/26/93	100	9/30-10/11/93	85	8/21/93	34
13-3-CF	TT020878	7/18/93	10/2-10/26/93	100	9/30-10/11/93	85	8/21/93	34
14-CF	TT020879	7/18/93	10/2-10/26/93	100	9/30-10/11/93	85	8/21/93	34
Fish								
1-LS	TT021071	8/6/93	10/2-10/26/93	81	9/30-10/11/93	66	8/21/93	15
1-C	TT021072	8/6/93	10/2-10/26/93	81	9/30-10/11/93	66	8/21/93	15
2-LS	TT021073	8/6/93	10/2-10/26/93	81	9/30-10/11/93	66	8/21/93	15
3-LS	TT021074	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
4-LS	TT021075	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
5-LS	TT021076	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
6-LS	TT021077	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
7-LS	TT021078	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
8-LS	TT021079	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
9-LS	TT021080	8/5/93	10/2-10/26/93	82	9/30-10/11/93	67	8/21/93	16
10-LS	TT021081	8/4/93	10/2-10/26/93	83	9/30-10/11/93	68	8/21/93	17
11-LS	TT021082	8/4/93	10/2-10/26/93	83	9/30-10/11/93	68	8/21/93	17
12-LS	TT021083	8/4/93	10/2-10/26/93	83	9/30-10/11/93	68	8/21/93	17
13-1-LS	TT021084	8/3/93	10/2-10/26/93	84	9/30-10/11/93	69	8/21/93	18
13-2-LS	TT021085	8/3/93	10/2-10/26/93	84	9/30-10/11/93	69	8/21/93	18
13-3-LS	TT021086	8/3/93	10/2-10/26/93	84	9/30-10/11/93	69	8/21/93	18
14-LS	TT021087	8/3/93	10/2-10/26/93	84	9/30-10/11/93	69	8/21/93	18
15-C	TT021088	8/3/93	10/2-10/26/93	84	9/30-10/11/93	69	8/21/93	18

[1] aluminum, beryllium, cadmium, chromium, iron (sed. only); barium, copper, nickel, and zinc

[2] antimony, arsenic, cadmium (tissue only), chromium (tissue only), lead, selenium, silver, and thallium (sed. only)

TABLE 2. CONTINUING CALIBRATION VERIFICATION SAMPLE RESULTS OUTSIDE QC LIMITS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. WATER

Sample Number	Date	Element	Percent Accuracy	Associated Field Samples
CCV1	8/19/93	Arsenic	129.9	13-3-W-T, 14-1-W-D, 14-1-W-T, 1-1-W-T, 1-2-W-D
CCV4	8/20/93	Cadmium	144.0	5-3-W-T, 4-1-W-D, 4-1-W-T, 4-2-W-D, 4-2-W-T, 4-3-W-D, 4-3-W-T, 3-1-W-D, 3-1-W-T
CCV1	8/19/93	Lead	130.0	13-3-W-T, 14-1-W-D, 14-1-W-T, 1-1-W-T, 1-2-W-D
CCV2	8/17/93	Lead	89.2	7-2-W-T, 7-3-W-D, 7-3-W-T, 6-1-W-D, 6-1-W-T, 6-2-W-D, 6-2-W-T, 6-3-W-D, 6-3-W-T, 5-1-W-D
CCV4	8/17/93	Lead	87.6	5-3-W-T, 4-1-W-D, 4-1-W-T, 4-2-W-D, 4-2-W-T, 4-3-W-D, 4-3-W-T, 3-1-W-D, 3-1-W-T
CCV1	8/19/93	Selenium	133.3	13-3-W-T, 14-1-W-D, 14-1-W-T, 1-1-W-T, 1-2-W-D

B. TISSUE

Sample Number	Date	Element	Percent Accuracy	Associated Field Samples
CCV1	10/11/93	Arsenic	74.7	11-CF, 13-1-CF, 13-2-CF, 13-3-CF, 14-CF, 2-CF, 3-CF
CCV3	10/11/93	Arsenic	171.5	6-LS, 7-LS, 8-LS, 9-LS, 10-LS, 11-LS, 12-LS
CCV5	10/1/93	Cadmium	117.6	8-CF
CCV1	10/11/93	Lead	119.0	11-CF, 13-1-CF, 13-2-CF, 13-3-CF, 14-CF, 2-CF, 3-CF
CCV2	10/11/93	Lead	139.7	4-CF, 5-CF, 10-CF, 12-CF, 1-LS, 1-C, 2-LS, 3-LS, 4-LS, 5-LS
CCV3	10/11/93	Lead	148.2	6-LS, 7-LS, 8-LS, 9-LS, 10-LS, 11-LS, 12-LS
CCV1	10/11/93	Selenium	63.0	11-CF, 13-1-CF, 13-2-CF, 13-3-CF, 14-CF, 2-CF, 3-CF
CCV2	10/11/93	Selenium	63.9	4-CF, 5-CF, 10-CF, 12-CF, 1-LS, 1-C, 2-LS, 3-LS, 4-LS, 5-LS
CCV3	10/11/93	Selenium	149.6	6-LS, 7-LS, 8-LS, 9-LS, 10-LS, 11-LS, 12-LS
CCV1	10/2/93	Silver	83.9	3-CF
CCV2	10/2/93	Silver	117.0	7-LS, 13-1-LS

TABLE 3. METALS DETECTED IN BLANK SAMPLES (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. WATER

Sample Number	Date	Element	Conc. (µg/L)	Associated Field Samples
FIL BL B	8/24/93	Aluminum	3.8	all filtered samples from stations 1-2, 9-15
PBLK1	8/27/93	Aluminum	11.6	10-1-W-T, 13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T, 15-3-W-T
PBLK2	8/27/93	Aluminum	13.9	10-1-W-T, 13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T, 15-3-W-T
PBLK3	8/27/93	Aluminum	31.0	10-1-W-T, 13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T, 15-3-W-T
ICB	8/20/93	Cadmium	0.13	8-1-W-D, 8-1-W-T
CCB1	8/20/93	Cadmium	0.13	8-2-W-D, 8-2-W-T, 8-3-W-D, 8-3-W-T, 7-1-W-D, 7-1-W-T, 7-2-W-D
CCB2	8/20/93	Cadmium	0.18	7-2-W-T, 7-3-W-D, 7-3-W-T, 6-1-W-D, 6-1-W-T, 6-2-W-D, 6-2-W-T, 6-3-W-D, 6-3-W-T, 5-1-W-D
CCB3	8/20/93	Cadmium	0.13	5-1-W-T, 5-2-W-D, 5-2-W-T, 5-3-W-D
CCB4	8/20/93	Cadmium	0.16	5-3-W-T, 4-1-W-D, 4-1-W-T, 4-2-W-D, 4-2-W-T, 4-3-W-D, 4-3-W-T, 3-1-W-D, 3-1-W-T
CCB5	8/20/93	Cadmium	0.20	3-2-W-D, 3-2-W-T, 3-3-W-D, 3-3-W-T, 2-1-W-D, 2-1-W-T, 2-2-W-D, 2-2-W-T
CCB1	8/20/93	Cadmium	0.12	1-1-W-T, 1-2-W-D, 1-2-W-T, 1-3-W-D, 1-3-W-T, 10-1-W-D, 10-1-W-T, 10-2-W-D, 10-2-W-T, 10-3-W-D
CCB2	8/20/93	Cadmium	0.27	10-3-W-T, 9-1-W-D, 9-1-W-T, 9-2-W-D, 9-2-W-T, 9-3-W-D, 9-3-W-T, 11-1-W-D
CCB3	8/20/93	Cadmium	0.20	11-1-W-T, 11-2-W-D, 11-2-W-T, 11-3-W-D, 11-3-W-T, 12-1-W-D, 12-1-W-T
CCB4	8/20/93	Cadmium	0.17	12-2-W-D, 12-2-W-T, 12-3-W-D, 12-3-W-T, 15-1-W-D, 15-1-W-T, 15-2-W-D, 15-2-W-T, 15-3-W-D
CCB5	8/20/93	Cadmium	0.13	15-3-W-T, 13-1-W-D
PBLK2	8/17/93	Chromium	2.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T
PBLK3	8/20/93	Chromium	2.0	8-1-W-T, 8-2-W-T, 8-3-W-T, 7-1-W-T, 7-2-W-T, 7-3-W-T, 6-1-W-T, 6-2-W-T, 6-3-W-T, 5-1-W-T
PBLK-W-7/27	9/14/93	Copper	1.9	13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T
CCB3	8/18/93	Lead	0.83	11-1-W-T, 11-2-W-D, 11-2-W-T, 11-3-W-D, 11-3-W-T, 12-1-W-D, 12-1-W-T
PBLK1	8/17/93	Nickel	13.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T
PBLK2	8/17/93	Nickel	17.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T
PBLK3	8/17/93	Nickel	9.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T
PBLK1	8/20/93	Nickel	8.0	8-1-W-T, 8-2-W-T, 8-3-W-T, 7-1-W-T, 7-2-W-T, 7-3-W-T, 6-1-W-T, 6-2-W-T, 6-3-W-T, 5-1-W-T
PBLK3	8/20/93	Nickel	17.0	8-1-W-T, 8-2-W-T, 8-3-W-T, 7-1-W-T, 7-2-W-T, 7-3-W-T, 6-1-W-T, 6-2-W-T, 6-3-W-T, 5-1-W-T
CCB5	8/18/93	Selenium	3.1	15-3-W-T, 13-1-W-D, 13-1-W-T
CCB3	8/20/93	Silver	3.0	5-1-W-T, 5-2-W-D, 5-2-W-T, 5-3-W-D
CCB3	8/20/93	Silver	3.3	11-1-W-T, 11-2-W-D, 11-2-W-T, 11-3-W-D, 11-3-W-T, 12-1-W-D, 12-1-W-T
CCB2	8/17/93	Thallium	1.2	7-2-W-T, 7-3-W-D, 7-3-W-T, 6-1-W-D, 6-1-W-T, 6-2-W-D, 6-2-W-T, 6-3-W-D, 6-3-W-T, 5-1-W-D
CCB4	8/17/93	Thallium	1.2	5-3-W-T, 4-1-W-D, 4-1-W-T, 4-2-W-D, 4-2-W-T, 4-3-W-D, 4-3-W-T, 3-1-W-D, 3-1-W-T
PBLK1	8/17/93	Zinc	4.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T
PBLK3	8/17/93	Zinc	8.0	5-2-W-T, 5-3-W-T, 4-1-W-T, 4-2-W-T, 4-3-W-T, 3-1-W-T, 3-2-W-T, 3-3-W-T, 2-1-W-T

TABLE 3. METALS DETECTED IN BLANK SAMPLES (Page 2 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

B. SEDIMENT

Sample Number	Date	Element	Conc. (µg/L)	Associated Field Samples
PBLK2	9/4/93	Aluminum	185.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBS1	9/30/93	Chromium	4.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBS2	9/30/93	Chromium	6.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBS1	9/30/93	Copper	6.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBS2	9/30/93	Copper	8.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBLK1	9/4/93	Iron	52.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBLK2	9/4/93	Iron	189.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
S PBL1 8/18	9/24/93	Lead	1.5	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
S PBL2 8/18	9/24/93	Lead	6.8	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBLK1	9/4/93	Nickel	8.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBLK2	9/4/93	Nickel	10.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
CCB3	8/22/93	Silver	2.4	7-S, 8-S, 4-S, 5-S, 2-S, 3-S, 1-S
PBLK1	9/4/93	Zinc	5.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S
PBLK2	9/4/93	Zinc	21.0	1-S, 2-S, 3-S, 4-S, 5-S, 6-S, 7-S, 8-S, 9-1-S, 9-2-S, 9-3-S, 10-S, 11-S, 12-S, 13-S, 14-S, 15-S

C. TISSUE

Sample Number	Date	Element	Conc. (µg/L)	Associated Field Samples
PBT2	9/30/93	Chromium	1.8	All
PBT2	10/11/93	Lead	1.5	All
PBLK1	8/21/93	Mercury	0.9	All
PBLK2	8/21/93	Mercury	0.6	All
PBLK1	9/22/93	Zinc	46.0	All fish
PBLK2	9/22/93	Zinc	38.0	All fish
PBLK1	9/22/93	Zinc	16.0	All crayfish
PBLK2	9/22/93	Zinc	82.0	All crayfish

TABLE 4. SAMPLE RESULTS QUALIFIED AS UNDETECTED DUE TO BLANK CONTRIBUTION LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. WATER

Metal	Sample Numbers
Aluminum	9-1-W-D, 9-2-W-D, 9-3-W-D, 13-1-W-D, 13-2-W-D, 13-3-W-D, 14-1-W-D, 14-2-W-D, 14-3-W-D
Cadmium	3-2-W-T, 5-3-W-T, 6-1-W-D, 7-2-W-T, 15-1-W-T, 15-2-W-T, 15-3-W-T
Chromium	5-2-W-T
Copper	13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T
Lead	1-2-W-D, 11-2-W-T, 11-3-W-T, 12-1-W-T
Nickel	7-1-W-T, 7-2-W-T, 7-3-W-T
Thallium	3-1-W-D, 4-2-W-D, 4-2-W-T, 4-3-W-T, 5-1-W-D, 5-3-W-T, 6-2-W-T, 7-2-W-T, 7-3-W-D
Zinc	2-1-W-T, 3-3-W-T, 4-2-W-T, 5-2-W-T, 7-1-W-T, 8-3-W-T

B. SEDIMENT

Metal	Sample Numbers
Lead	2-S, 6-S, 9-1-S, 10-S
Silver	4-S, 5-S, 7-S, 8-S

C. TISSUE

Metal	Sample Numbers
Chromium	1-C, 4-LS
Lead	11-CF, 11-LS, 2-LS, 5-LS, 6-LS, 7-LS, 9-LS
Mercury	7-CF, 3-CF

TABLE 5. MATRIX SPIKE ANALYSIS FOR METALS (Percent recovery)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
A. WATER																
1-1-W-D											120.6					
1-1-W-T											98.8					
3-3-W-D				86.7	90.0				112.0			60.0				106.7
3-3-W-T				100.0	90.0				90.9[1]			96.0				66.7
5-1-W-D	161.2	57.6	160.9			78.4	90.6	90.4		192.6	126.6		95.5	75.7	166.1	
5-1-W-T	101.3[1]	59.2	154.8			133.2	108.5	98.1		200.1			104.2	32.1	192.3	
8-1-W-D	108.6	80.6	110.4	93.3	110.0	85.2	95.8	100.1	80.0	154.0	99.6	72.0	92.1	67.3	85.1	113.3
8-1-W-T	109.8[1]	77.9	116.4	106.7	130.0	323.0	97.1	91.8	101.6[1]	164.7	109.0	128.0	97.5	130.5	100.7	126.7
10-1-W-D											99.2					
10-1-W-T											101.0					
12-1-W-D											103.8					
12-1-W-T											94.8					
12-3-W-D				106.7	70.0				96.0			48.0				93.3
12-3-W-T				106.7	80.0				103.1[1]			108.0				60.0
13-2-W-D	98.5	87.0	116.4	93.3	70.0	178.0	97.8	111.4	108.0	139.3		72.0	88.3	86.2	92.9	153.3
13-2-W-T	163.1	89.0	116.4	113.3	70.0	116.0	107.8	106.2	107.6[1]	130.4		88.0	99.7	139.7	94.9	226.7
14-3-W-D				106.7	90.0				148.0			84.0				140.0
14-3-W-T		85.0		106.7	70.0		117.7	105.1	100.3[1]			88.0				66.7
15-3-W-D				100.0	70.0				136.0			84.0				313.3
15-3-W-T				86.7	70.0				96.3[1]			96.0				106.7
B. SEDIMENT																
2-S			72.2							110.9			72.8		47.5	
5-S				74.4	79.9	84.9	76.1	71.3	101.3[1]	86.3		83.3		96.0		72.6
9-1-S											203.3					
11-S			72.5							109.1			54.0		44.4	
14-S				82.3	72.1	80.2	78.6	83.2	94.2[1]	88.1		84.9		98.0		71.2
C. TISSUE																
2-CF											104.4[1]					
3-CF			27.8							119.5			61.2			
3-CF/100X			90.1							117.5			110.1			
6-CF		117.1	0.0				84.7[1]			67.9			0.0	118.1		
6-CF/100X			74.8							130.7			111.1			
9-CF			0.0	98.6[1]						24.5		52.0	38.6			
13-2-CF				99.6[1]												
3-LS				89.0												
7-LS		109.1	0.0			75.0	121.5			109.5	96.6[1]		43.5	57.4		
7-LS/100X			81.2							141.9			115.4			
8-LS				95.0		123.1		101.0				92.0				
13-1-LS			0.0							86.8	103.9[1]		57.0			
13-1-LS/100X			69.4							142.0			115.0			

[1] = Amount spiked too low (<0.25X sample concentration) to calculate percent recovery using standard formula; alternate formula used (see sec. D of text)

TABLE 6. POSITIVE SAMPLE RESULTS QUALIFIED AS ESTIMATED DUE TO MATRIX SPIKE RESULTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. WATER

Metal	Sample Numbers
Aluminum	4-1-W-D, 4-2-W-D, 4-3-W-D, 5-1-W-D, 5-2-W-D, 5-3-W-D, 13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-T, 14-3-W-T
Iron	14-1-W-D, 14-2-W-D, 14-3-W-D, 15-1-W-D, 15-3-W-D
Lead	12-2-W-T, 12-3-W-T, 13-1-W-T, 13-2-W-T
Nickel	2-1-W-D, 3-3-W-D
Thallium	5-2-W-D, 5-3-W-D
Zinc	2-2-W-T, 2-3-W-T, 12-1-W-T, 12-2-W-T, 12-3-W-T, 13-1-W-T, 13-2-W-T, 13-3-W-T, 14-1-W-T, 14-2-W-D, 14-2-W-T, 14-3-W-T, 15-1-W-T, 15-2-W-T, 15-3-W-T

B. SEDIMENT

Metal	Sample Numbers
Mercury	All

C. TISSUE

Metal	Sample Numbers
Lead	1-C, 1-LS, 2-LS, 3-LS, 5-LS, 6-LS, 7-LS, 8-LS, 9-LS, 10-LS, 11-LS, 12-LS, 13-1-LS, 13-2-LS, 13-3-LS, 15-C
	6-CF, 7-CF, 8-CF, 9-CF, 11-CF, 13-1-CF, 13-2-CF, 13-3-CF, 14-CF
Silver	1-C, 15-C, 5-LS, 7-LS

TABLE 7. LABORATORY DUPLICATE ANALYSIS FOR METALS (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. WATER (µg/L)

Sample Number	Aluminum			Antimony			Arsenic			Barium			Beryllium			Cadmium			Chromium			Copper		
	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD
1-1-W-D																								
1-1-W-T																								
3-3-W-D										14.0	12.0	15.38	2.0U	2.0U	NC									
3-3-W-T										15.0	16.0	6.452	2.0U	2.0U	NC									
5-1-W-D	41.86	23.59	55.83	3.0U	3.0U	NC	3.0U	3.0U	NC							0.10U	0.10U	NC	1.0U	1.0U	NC	1.0U	1.0U	NC
5-1-W-T	64.19	64.24	0.078	3.0U	3.0U	NC	3.0U	3.0U	NC							0.10U	0.10U	NC	1.0U	1.0U	NC	1.95	1.91	2.073
8-1-W-D	7.715	7.62	1.239	3.0U	3.0U	NC	3.0U	3.0U	NC	14.0	13.0	7.407	2.0U	2.0U	NC	0.10U	0.10U	NC	1.0U	1.0U	NC	1.0U	1.0U	NC
8-1-W-T	386.8	287.9	29.32	3.0U	3.0U	NC	3.0U	3.0U	NC	16.0	16.0	0	2.0U	2.0U	NC	0.10U	0.10U	NC	1.0U	1.0U	NC	1.66	1.60	3.994
10-1-W-D																								
10-1-W-T																								
12-1-W-D																								
12-1-W-T																								
12-3-W-D										17.0	18.0	5.714	2.0U	2.0U	NC									
12-3-W-T										26.0	28.0	7.407	2.0U	2.0U	NC									
13-2-W-D	16.28	15.58	4.40	3.0U	3.0U	NC	3.0U	3.0U	NC	16.0	15.0	6.452	2.0U	2.0U	NC	0.10U	0.10U	NC	1.0U	1.0U	NC	1.0U	1.0U	NC
13-2-W-T	220.2	216.8	1.556	3.0U	3.0U	NC	3.0U	3.0U	NC	17.0	17.0	0	2.0U	2.0U	NC	0.10U	0.10U	NC	1.0U	1.0U	NC	2.9U	2.2U	NC
14-3-W-D										17.0	16.0	6.061	2.0U	2.0U	NC									
14-3-W-T	442.7	419	5.50	3.0U	3.0U	NC				20.0	17.0	16.22	2.0U	2.0U	NC				1.0U	1.0U	NC	3.1U	1.8U	NC
15-3-W-D										16.0	16.0	0	2.0U	2.0U	NC									
15-3-W-T										21.0	22.0	4.651	2.0U	2.0U	NC									

Sample Number	Iron			Lead			Mercury			Nickel			Selenium			Silver			Thallium			Zinc		
	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD
1-1-W-D							0.11U	0.122	NC															
1-1-W-T							0.11U	0.11U	NC															
3-3-W-D										7.0	5.0U	NC										6.0	3.0U	NC
3-3-W-T	391	377	3.646							5.0U	5.0U	NC										6.0U	3.0U	NC
5-1-W-D				0.80U	0.80U	NC	0.11U	0.11U	NC				3.0U	3.0U	NC	1.0U	1.0U	NC	1.0	1.0	0			
5-1-W-T				0.80U	0.80U	NC							3.0U	3.0U	NC	3.7U	2.0U	NC	1.0U	1.24	NC			
8-1-W-D	75.0	73.0	2.70	0.80U	0.80U	NC	0.11U	0.11U	NC	5.0U	5.0U	NC	3.0U	3.0U	NC	1.0U	1.0U	NC	1.025	1.0U	NC	3.0U	3.0U	NC
8-1-W-T	353	349	1.14	0.80U	0.80U	NC	0.11U	0.11U	NC	5.0U	5.0U	NC	3.0U	3.0U	NC	4.99	4.965	0.50	1.0U	1.075	NC	3.0U	3.0U	NC
10-1-W-D							0.11U	0.11U	NC															
10-1-W-T							0.11U	0.11U	NC															
12-1-W-D							0.11U	0.11U	NC															
12-1-W-T							0.11U	0.11U	NC															
12-3-W-D	27.0	31.0	13.79							5.0U	5.0U	NC										3.0U	3.0U	NC
12-3-W-T	905	985	8.466							5.0U	5.0U	NC										22.0	37.0	50.85
13-2-W-D	7.0	5.0U	NC	0.80U	1.625	NC				5.0U	6.0	NC	3.0U	3.0U	NC	1.0U	1.0U	NC	1.0U	1.0U	NC	3.0U	3.0U	NC
13-2-W-T	239	230	3.838	1.00	0.80	21.73				5.0U	5.0U	NC	3.0U	3.0U	NC	33.38	1.0U	NC	1.0U	1.0U	NC	4.0	21.0	136
14-3-W-D	61.0	65.0	6.349							5.0U	5.0U	NC										3.0U	3.0U	NC
14-3-W-T	657	574	13.48							5.0U	5.0U	NC										13.0	6.0	73.68
15-3-W-D	9.0	8.0	11.76							5.0U	5.0U	NC										3.0U	3.0U	NC
15-3-W-T	468	465	0.643							5.0U	5.0U	NC										5.0	30.0	142.9

U = Undetected at the given detection limit

NC = Not calculated because of one or more non-detect values

TABLE 7. LABORATORY DUPLICATE ANALYSIS FOR METALS (Page 2 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum			Antimony			Arsenic			Barium			Beryllium			Cadmium			Chromium			Copper		
	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD
B. SEDIMENT																								
(mg/kg dry)																								
5-S	20333	19054	6.495				2.82	2.85	1.058	142	142	0	0.84	0.64	27.03	1.05	0.85	21.05	19.2	16.1	17.56			
9-1-S																								
14-S	16189	15563	3.943				1.74	2.19	22.9	138	137	0.727	0.63	0.64	1.575	1.86	1.82	2.174	17.7	19.3	8.649			
C. TISSUE																								
(mg/kg wet)																								
2-CF																								
6-CF				0.012	0.003	NC	0.036	0.009	NC										0.089	0.021	123.6			
9-CF				0.015	0.016	NC	0.046	0.047	NC	24.4	27.8	13.03				0.010	0.010	NC	0.095	0.087	8.791	3.69	5.57	40.6
13-2-CF				0.018	0.02	10.53	0.038	0.037	NC	32.3	28.3	13.2				0.009	0.008	NC	0.066	0.074	11.43	3.61	3.67	1.648
3-LS										0.64	0.71	10.37				0.008	0.008	NC				0.107	0.10	10.84
7-LS				0.012	0.003	NC	0.036	0.009	NC							0.017	0.004	123.8	0.153	0.038	120.4			
8-LS				0.012	0.012	NC	0.037	0.036	NC	1.4	1.3	3.745				0.041	0.04	2.469	0.08	0.067	17.69	0.733	0.80	8.616
13-1-LS				0.01U	0.008	NC	0.035	0.009	NC															

Sample Number	Iron			Lead			Mercury			Nickel			Selenium			Silver			Thallium			Zinc		
	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD	Result 1	Result 2	RPD
B. SEDIMENT																								
(mg/kg dry)																								
5-S	21070	20642	2.052	5.28	5.07	4.058				14.6	14.4	1.379	0.32U	0.32U	NC	0.11	0.11U	NC	0.11U	0.11U	NC	101	101	0
9-1-S							0.085	0.078	8.364															
14-S	18369	18203	0.908	0.274	0.28	2.166				14.7	14.9	1.351	0.31U	0.27U	NC	0.10U	2.21	NC	0.10U	0.09U	NC	155	158	1.917
C. TISSUE																								
(mg/kg wet)																								
2-CF							0.065	0.063	3.125															
6-CF				0.113	0.024	129.9	0.044	0.04	9.524				0.036	0.009	NC	0.028	0.007	120						
9-CF				0.206	0.114	57.5				0.13	0.10	21.46	0.046	0.047	NC	0.043	0.024	56.72				16.7	7.7	73.77
13-2-CF				0.142	0.123	14.34				0.1	0.020	NC	0.038	0.037	NC	0.035	0.019	59.26				4.92	5.1	3.593
3-LS										0.06	0.09	46.15										3.24	3.46	6.567
7-LS				0.077	0.02	117.5	0.10	0.10	0.976				0.054	0.009	NC	0.006	0.001	142.9						
8-LS				0.161	0.228	34.45				0.102	0.100	NC	0.04	0.036	NC	0.004	0.004	NC				20.0	20.6	2.956
13-1-LS				0.183	0.063	97.56	0.215	0.232	7.606				0.035	0.012	NC	0.004	0.001	NC						

U = Undetected at the given detection limit

NC = Not calculated because of one or more non-detect values

TABLE 8. FIELD TRIPLICATE ANALYSIS RESULTS FOR WATER (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Station/Fraction	Aluminum	RSD	Barium	RSD	Chromium	RSD	Copper	RSD	Iron	RSD	Lead	RSD	Zinc	RSD
Water (µg/L)														
1/dissolved	29.0		12.0		1.0 U		1.0 U		22.0		0.80 U		3.0 U	
	41.7		12.0		1.0 U		1.0 U		23.0		1.4 U/B		3.0 U	
	40.0	18.7	11.0	4.9	1.0 U	NC	1.0 U	NC	25.0	6.5	0.80 U	NC	3.0 U	NC
1/total	395		18.0		1.0 U		5.1		495		19.0		14.0	
	259		14.0		1.0 U		5.1		525		0.80 U		20.0	
	447	26.5	13.0	17.6	1.0 U	NC	3.5	20.2	576	7.7	0.80 U	NC	9.0	38.4
2/dissolved	45.0		12.0		1.0 U		1.0 U		22.0		0.80 U		3.0 U	
	36.3		12.0		1.0 U		1.0 U		21.0		0.80 U		3.0 U	
	40.5	10.7	11.0	4.9	1.0 U	NC	1.0 U	NC	34.0	28.2	0.80 U	NC	3.0 U	NC
2/total	376		16.0		1.0 U		2.6		459		0.80 U		15.0 U/B	
	428		14.0		1.0 U		2.2		475		0.80 U		16.0 E	
	323	14.0	14.0	7.9	1.0 U	NC	1.7	20.8	328	19.2	0.80 U	NC	8.0 E	NC
3/dissolved	19.7		11.0		1.0 U		1.0 U		25.0		0.80 U		3.0 U	
	22.0		14.0		1.0 U		1.0 U		38.0		0.80 U		3.0 U	
	24.0	9.8	14.0	13.3	1.0 U	NC	1.0 U	NC	20.0	33.6	0.80 U	NC	6.0	NC
3/total	428		17.0		1.0 U		2.3		5.0 U		0.80 U		3.0 U	
	408		13.0		1.0 U		2.0		167		0.80 U		3.0 U	
	447	4.6	15.0	13.3	1.0 U	NC	5.1	54.6	391	NC	0.80 U	NC	6.0 U/B	NC
4/dissolved	27.5 E		14.0		1.0 U		1.0 U		5.0 U		0.80 U		3.0 U	
	18.1 E		13.0		1.0 U		1.0 U		5.0		0.80 U		3.0 U	
	21.3 E	21.4	14.0	4.2	1.0 U	NC	1.0 U	NC	17.0	NC	0.80 U	NC	3.0 U	NC
4/total	297		17.0		1.0 U		1.6		29.0		0.80 U		3.0 U	
	343		17.0		1.0 U		2.4		389		0.80 U		4.0 U/B	
	523	30.8	18.0	3.3	1.0 U	NC	2.6	24.1	494	80.2	0.80 U	NC	3.0 U	NC
5/dissolved	41.9 E		12.0		1.0 U		1.0 U		21.0		0.80 U		3.0 U	
	16.6 E		14.0		1.0 U		1.0 U		12.0		0.80 U		10.0	
	19.5 E	53.3	13.0	7.7	1.0 U	NC	1.0 U	NC	19.0	27.3	0.80 U	NC	3.0 U	NC
5/total	642		20.0		1.0 U		1.9		718		0.80 U		3.0 U	
	838		24.0		1.3 U/B		2.6		1150		0.80 U		15.0	
	732	13.3	23.0	9.3	1.0 U	NC	3.1	23.8	858	24.3	0.80 U	NC	3.0 U	NC
6/dissolved	18.9		8.0		1.0 U		1.0 U		157		0.80 U		5.0	
	21.8		8.0		1.0 U		1.0 U		131		0.80 U		3.0 U	
	20.3	7.1	9.0	6.9	1.0 U	NC	1.0 U	NC	122	13.3	0.80 U	NC	3.0 U	NC
6/total	169		12.0		1.0 U		1.0 U		358		0.80 U		3.0 U	
	196		11.0		1.0 U		1.0		334		0.80 U		3.0 U	
	208	10.5	11.0	5.1	1.0 U	NC	1.1	NC	363	4.4	0.80 U	NC	3.0 U	NC
7/dissolved	24.9		15.0		1.0 U		1.0 U		42.0		0.80 U		3.0 U	
	24.9		14.0		1.0 U		1.0 U		45.0		0.80 U		3.0 U	
	24.5	0.9	14.0	4.0	1.0 U	NC	1.0 U	NC	38.0	8.4	0.80 U	NC	3.0 U	NC
7/total	361		18.0		1.0 U		1.8		336		0.80 U		5.0 U/B	
	345		18.0		1.0 U		1.5		341		0.80 U		3.0 U	
	456	15.5	17.0	3.3	1.0 U	NC	1.6	9.4	356	3.0	0.80 U	NC	3.0 U	NC
8/dissolved	7.7 E		14.0		1.0 U		1.0 U		75.0		0.80 U		3.0 U	
	5.4		14.0		1.0 U		1.0 U		63.0		0.80 U		3.0	
	13.0	44.8	14.0	0.0	1.0 U	NC	1.0 U	NC	71.0	8.8	0.80 U	NC	3.0 U	NC
8/total	387		16.0		1.0 U		1.7		353		0.80 U		3.0 U	
	287		17.0		1.0 U		1.4		362		0.80 U		3.0 U	
	291	17.6	17.0	3.5	1.0 U	NC	2.6	32.9	380	3.8	0.80 U	NC	12.0 U/B	NC
9/dissolved	10.8 U/B		15.0		1.0 U		1.0 U		76.0		0.80 U		6.0	
	14.9		16.0		1.0 U		1.0 U		82.0		0.80 U		3.0 U	
	9.1 U/B	NC	16.0	3.7	1.0 U	NC	1.0 U	NC	73.0	6.0	0.80 U	NC	3.0 U	NC
9/total	147		18.0		1.0 U		1.8		446		0.80 U		9.0	
	163		18.0		1.0 U		1.9		446		0.80 U		6.0	
	167	6.7	21.0	9.1	1.0 U	NC	1.7	5.6	522	9.3	0.80 U	NC	10.0	25.0
10/dissolved	60.5		13.0		1.0 U		1.0 U		439		0.80 U		3.0 U	
	73.2		13.0		1.0 U		1.0 U		462		0.84 U/B		3.0 U	
	60.7	11.2	12.0	4.6	1.0 U	NC	1.0 U	NC	426	4.1	0.80 U	NC	3.0 U	NC

TABLE 8. FIELD TRIPLICATE ANALYSIS RESULTS FOR WATER (Page 2 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Station/Fraction	Aluminum	RSD	Barium	RSD	Chromium	RSD	Copper	RSD	Iron	RSD	Lead	RSD	Zinc	RSD
10/total	967		25.0		1.6		2.8		2240		1.70 U/B		5.0	
	849		26.0		6.9		5.3		3380		1.6		18.0	
	712	15.1	22.0	8.6	1.3	96.4	3.1	36.6	1950	30.0	0.80 U	NC	27.0	66.4
11/dissolved	42.6		17.0		1.0 U		1.0 U		9.0		0.80 U		3.0 U	
	40.1		17.0		1.0 U		1.0 U		6.0		0.80 U		3.0 U	
	39.5	4.0	15.0	7.1	1.0 U	NC	1.0 U	NC	5.0 U	NC	1.10 U/B	NC	3.0 U	NC
11/total	417		21.0		1.0 U		2.1		447		0.80 U		5.0	
	440		20.0		1.0 U		2.3		413		1.1 U/B		3.0	
	339	13.3	20.0	2.8	1.0 U	NC	2.4	6.7	345	12.9	1.0 U/B	NC	4.0	25.0
12/dissolved	20.7		17.0		1.0 U		1.0 U		18.0		0.80 U		3.0 U	
	25.8		17.0		1.0 U		1.0 U		25.0		0.80 U		3.0 U/E	
	21.8	11.8	17.0	0.0	1.0 U	NC	1.0 U	NC	27.0	20.3	0.80 U	NC	3.0 U/E	NC
12/total	397		24.0		1.0 U		2.0		839		1.1 U/B		10.0 E	
	458		20.0		1.0 U		2.0		431		1.8 E		10.0 E	
	415	7.4	26.0	13.1	1.0 U	NC	2.1	2.8	905	35.4	2.0 E	NC	22.0 E	49.5
13/dissolved	14.6 U/B		16.0		1.0 U		1.0 U		5.0		0.80 E		3.0 U/E	
	16.3 U/B		16.0		1.0 U		1.0 U		7.0		0.80 U		3.0 U/E	
	10.9 U/B	NC	15.0	3.7	1.0 U	NC	1.0 U	NC	5.0 U	NC	0.80 U	NC	3.0 U/E	NC
13/total	205 E		17.0		1.0 U		1.9 U/B		229		1.2 E		9.0 E	
	220 E		17.0		1.0 U		2.9 U/B		239		1.0 E		4.0 E	
	217 E	3.7	18.0	3.3	1.0 U	NC	3.0 U/B	NC	236	2.2	0.80 U	NC	13.0 E	52.0
14/dissolved	14.8 U/B		18.0		1.0 U		1.0 U		60.0 E		0.80 U		3.0 U/E	
	12.0 U/B		19.0		1.0 U		1.0 U		68.0 E		0.80 U		4.0 E	
	10.5 U/B	NC	17.0	5.6	1.0 U	NC	1.0 U	NC	61.0 E	6.9	0.80 U	NC	3.0 U	NC
14/total	412 E		24.0		1.0 U		3.3 U/B		666		1.2 U/B		13.0 E	
	492 E		21.0		1.0 U		2.9 U/B		666		0.80 U		9.0 E	
	443 E	9.0	20.0	9.6	1.0 U	NC	3.1 U/B	NC	657	0.8	1.1	NC	13.0 E	19.8
15/dissolved	43.5		16.0		1.0 U		1.0 U		6.0 E		0.80 U		3.0 U	
	63.0		16.0		1.0 U		1.0 U		5.0 U		0.85		3.0 U	
	49.0	19.4	16.0	0.0	1.0 U	NC	1.0 U	NC	9.0 E	NC	0.80 U	NC	3.0 U	NC
15/total	460		21.0		1.0 U		2.2		573		2.0		6.0 E	
	433		26.0		1.0 U		3.0		936		2.4		13.0 E	
	445	3.0	21.0	12.7	1.0 U	NC	2.6	15.4	468	37.3	1.5	22.9	5.0 E	54.5

Note: Several metals analyzed were not included in this table because RSDs could not be calculated

U = Not detected

U/B = Not detected due to blank contamination

E = Estimated value due to evaluation of QC data

NC = Not calculated due to one or more non-detect value

TABLE 9. FIELD TRIPLICATE ANALYSIS RESULTS FOR SEDIMENT AND TISSUE
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Sediment (mg/kg dry)																
9-1-S	16900	0.32 U	4.0	129	0.64	1.1	20.1	25.5	19000	14.3 U/B	0.08	15.4	1.3 U	0.11 U	0.42 U	89.4
9-2-S	18500	0.28 U	4.6	152	0.85	1.1	20.0	29.2	21100	15.3	0.09	16.8	1.1 U	0.09 U	0.38 U	106
9-3-S	18700	0.31 U	4.8	152	0.73	0.73	19.9	28.2	21000	15.0	0.08	15.8	1.2 U	0.10 U	0.42 U	98.1
RSD	5.5	NC	9.3	9.2	14.2	21.9	0.5	6.9	5.8	NC	6.9	4.5	NC	NC	NC	8.5
Crayfish (mg/kg wet)																
13-1-CF		0.014	0.035 U	31.5		0.026	0.063	20.0		0.114 E	0.045	0.69	0.035 U	0.035		31.2
13-2-CF		0.018	0.038 U	32.3		0.030	0.066	18.1		0.141 E	0.050	0.40	0.038 U	0.035		24.6
13-3-CF		0.013	0.035 U	29.0		0.033	0.074	20.1		0.148 E	0.034	0.53	0.035 U	0.053		31.4
RSD		18.2	NC	5.6		11.6	9.0	5.8		13.4	18.3	26.9	NC	26.1		13.3
Fish (mg/kg wet)																
13-1-LS		0.012 U	0.035 U	3.20		0.066	0.314	1.16		0.183 E	0.215	0.10 U	0.035 U	0.004 U/E		20.7
13-2-LS		0.012 U	0.036 U	3.10		0.059	0.325	1.23		0.376 E	0.161	0.28	0.036 U	0.004 U/E		22.4
13-3-LS		0.011 U	0.034 U	3.50		0.053	0.527	1.18		0.296 E	0.119	2.26	0.034 U	0.004 U/E		137
RSD		NC	NC	6.4		11.3	30.9	3.0		34.0	29.2	NC	NC	NC		111.0

U = Not detected
U/B = Not detected due to blank contamination
E = Estimated value due to evaluation of QC data
NC = Not calculated due to one or more non-detect value

TABLE 10. STANDARD SEDIMENT REFERENCE MATERIAL ANALYSES (mg/kg dry)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum			Antimony			Arsenic			Barium			Beryllium			Cadmium			Chromium			Copper		
	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.
NIST 1646	**62500**	**16800**	26.88	**0.4**	0.3U	NC	**11.6**	6.7	57.76		NA		1.5	0.9	60	**0.4**	0.4	100	**76.0**	35.4	46.58	**18.0**	15.5	86.11
NIST 2704	**61100**	**17800**	29.13	**3.8**	1.5U	NC	**23.4**	20.4	87.18	**414.0**	92.00	22.22		NA		**3.4**	3.0	88.24	**135**	70.5	52.22	**98.6**	84.3	85.5

Sample Number	Iron			Lead			Mercury			Nickel			Selenium			Silver			Thallium			Zinc		
	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.	True	Found	% Accur.
NIST 1646	**33500**	**19500**	58.21	**28.2**	19.0	67.38	**0.1**	0.1	100	**32.0**	19.9	62.19	0.6	0.3U	NC		NA		0.5	0.1U	NC	138	87.0	63.04
NIST 2704	**41100**	**30850**	75.06	**161**	124	77.02	**1.4**	1.8	128.6	**44.1**	38.0	86.17	1.1	1.5U	NC		NA		1.2	0.5U	NC	438	339.5	77.51

Note: Values in bold have been certified by NIST
U = Undetected at the given detection limit
NA = Not analyzed
NC = Not calculated because of one or more non-detect values

TABLE 11. METALS DATA FOR WATER, SEDIMENT, AND TISSUE (Page 1 of 4)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Water (µg/L)																
1-1-W-D	29.0	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	22.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
1-1-W-T	395	3.0 U	3.0 U	18.0	2.0 U	0.10 U	1.0 U	5.1	495	1.9	0.11 U	5.0 U	3.0 U	1.0 U	1.1	14.0
1-2-W-D	41.7	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	23.0	1.4 U/B	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
1-2-W-T	259	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	5.1	525	0.80 U	0.11 U	7.0	3.0 U	1.0 U	1.0 U	20.0
1-3-W-D	40.0	3.0 U	3.0 U	11.0	2.0 U	0.10 U	1.0 U	1.0 U	25.0	0.80 U	0.11 U	5.0 U	3.2	1.0 U	1.0	3.0 U
1-3-W-T	447	3.0 U	3.0 U	13.0	2.0 U	0.10 U	1.0 U	3.5	576	0.80 U	0.11 U	6.0	3.0 U	1.0 U	1.0 U	9.0
2-1-W-D	45.0	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	22.0	0.80 U	0.11 U	7.0 E	3.0 U	1.0 U	1.1	3.0 U
2-1-W-T	376	3.0 U	3.0 U	16.0	2.0 U	0.10 U	1.0 U	2.6	459	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.1	15.0 U/B
2-2-W-D	36.3	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	21.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.1	3.0 U
2-2-W-T	428	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	2.2	475	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	16.0 E
2-3-W-D	40.5	3.0 U	3.0 U	11.0	2.0 U	0.10 U	1.0 U	1.0 U	34.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U
2-3-W-T	323	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.7	328	0.80 U	0.11 U	5.0 U	3.0 U	11.7	1.1	8.0 E
3-1-W-D	19.7	3.0 U	3.0 U	11.0	2.0 U	0.10 U	1.0 U	1.0 U	25.0	0.80 U	0.10 U/E	5.0 U/E	3.0 U	1.0 U	1.1 U/B	3.0 U
3-1-W-T	428	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	2.3	5.0 U	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
3-2-W-D	22.0	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	38.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.1	3.0 U
3-2-W-T	408	3.0 U	3.0 U	13.0	2.0 U	0.18 U/B	1.0 U	2.0	167	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0	3.0 U
3-3-W-D	24.0	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	20.0	0.80 U	0.11 U	7.0 E	3.0 U	1.0 U	1.3	6.0
3-3-W-T	447	3.0 U	3.0 U	15.0	2.0 U	0.10 U	1.0 U	5.1	391	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	6.0 U/B
4-1-W-D	27.5 E	3.0 U/E	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	5.0 U	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
4-1-W-T	297	3.0 U/E	3.0 U	17.0	2.0 U	0.10 U	1.0 U	1.6	29.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U/E	1.0 U	3.0 U
4-2-W-D	18.1 E	3.0 U/E	3.0 U	13.0	2.0 U	0.10 U	1.0 U	1.0 U	5.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.1 U/B	3.0 U
4-2-W-T	343	3.0 U/E	3.0 U	17.0	2.0 U	0.10 U	1.0 U	2.4	389	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U/E	1.0 U/B	4.0 U/B
4-3-W-D	21.3 E	3.0 U/E	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	17.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
4-3-W-T	523	3.0 U/E	3.0 U	18.0	2.0 U	0.10 U	1.0 U	2.6	494	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U/E	1.0 U/B	3.0 U
5-1-W-D	41.9 E	3.0 U/E	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	21.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U/B	3.0 U
5-1-W-T	642	3.0 U/E	3.0 U	20.0	2.0 U	0.10 U	1.0 U	1.9	718	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
5-2-W-D	16.6 E	3.0 U/E	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	12.0	0.80 U	0.10 U/E	5.0	3.0 U	1.0 U	1.0 E	10.0
5-2-W-T	838	3.0 U/E	3.0 U	24.0	2.0 U	0.10 U	1.3 U/B	2.6	1150	0.80 U	0.11 E	5.0 U	3.0 U	1.0 U/E	1.0 U	15.0
5-3-W-D	19.5 E	3.0 U/E	3.0 U	13.0	2.0 U	0.10 U	1.0 U	1.0 U	19.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 E	3.0 U
5-3-W-T	732	3.0 U/E	3.0 U	23.0	2.0 U	0.16 U/B	1.0 U	3.1	858	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U/E	1.0 U/B	3.0 U
6-1-W-D	18.9	3.0 U	3.0 U	8.0	2.0 U	0.35 U/B	1.0 U	1.0 U	157	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.0 U	5.0
6-1-W-T	169	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	358	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
6-2-W-D	21.8	3.0 U	3.0 U	8.0	2.0 U	0.10 U	1.0 U	1.0 U	131	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.0 U	3.0 U
6-2-W-T	196	3.0 U	3.0 U	11.0	2.0 U	0.10 U	1.0 U	1.0	334	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U/B	3.0 U
6-3-W-D	20.3	3.0 U	3.0 U	9.0	2.0 U	0.10 U	1.0 U	1.0 U	122	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.0 U	3.0 U
6-3-W-T	208	3.0 U	3.0 U	11.0	2.0 U	0.10 U	1.0 U	1.1	363	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
7-1-W-D	24.9	3.0 U	3.0 U	15.0	2.0 U	0.10 U	1.0 U	1.0 U	42.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U
7-1-W-T	361	3.0 U	3.0 U	18.0	2.0 U	0.10 U	1.0 U	1.8	336	0.80 U	0.11 U	5.0 U/B	3.0 U	1.0 U	1.0 U	5.0 U/B
7-2-W-D	24.9	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	45.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.1	3.0 U
7-2-W-T	345	3.0 U	3.0 U	18.0	2.0 U	0.32 U/B	1.0 U	1.5	341	0.80 U	0.11 U	9.0 U/B	3.0 U	1.0 U	1.0 U/B	3.0 U

TABLE 11. METALS DATA FOR WATER, SEDIMENT, AND TISSUE (Page 2 of 4)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
7-3-W-D	24.5	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	38.0	0.80 U	0.10 U/E	5.0 U/E	3.0 U	1.0 U/E	1.0 U/B	3.0 U
7-3-W-T	456	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	1.6	356	0.80 U	0.11 U	8.0 U/B	3.0 U	1.0 U	1.0 U	3.0 U
8-1-W-D	7.7 E	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	75.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.0 U	3.0 U
8-1-W-T	387	3.0 U	3.0 U	16.0	2.0 U	0.10 U	1.0 U	1.7	353	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
8-2-W-D	5.4	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	63.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.2	3.0
8-2-W-T	287	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	1.4	362	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
8-3-W-D	13.0	3.0 U	3.0 U	14.0	2.0 U	0.10 U	1.0 U	1.0 U	71.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U/E	1.0 U	3.0 U
8-3-W-T	291	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	2.6	380	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	12.0 U/B
9-1-W-D	10.8 U/B	3.0 U	3.0 U	15.0	2.0 U	0.10 U	1.0 U	1.0 U	76.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	6.0
9-1-W-T	147	3.0 U	3.0 U	18.0	2.0 U	0.10 U	1.0 U	1.8	446	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	9.0
9-2-W-D	14.9	3.0 U	3.0 U	16.0	2.0 U	0.10 U	1.0 U	1.0 U	82.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
9-2-W-T	163	3.0 U	3.0 U	18.0	2.0 U	0.10 U	1.0 U	1.9	446	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	6.0
9-3-W-D	9.1 U/B	3.0 U	3.0 U	16.0	2.0 U	0.10 U	1.0 U	1.0 U	73.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
9-3-W-T	167	3.0 U	3.0 U	21.0	2.0 U	0.10 U	1.0 U	1.7	522	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	10.0
10-1-W-D	60.5	3.0 U	3.0 U	13.0	2.0 U	0.10 U	1.0 U	1.0 U	439	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
10-1-W-T	967	3.0 U	3.0	25.0	2.0 U	0.10 U	1.6	2.8	2240	1.70	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	5.0
10-2-W-D	73.2	3.0 U	3.0 U	13.0	2.0 U	0.10 U	1.0 U	1.0 U	462	0.84	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
10-2-W-T	849	3.0 U	3.0 U	26.0	2.0 U	0.10 U	6.9	5.3	3380	1.6	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	18.0
10-3-W-D	60.7	3.0 U	3.0 U	12.0	2.0 U	0.10 U	1.0 U	1.0 U	426	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
10-3-W-T	712	3.0 U	3.0 U	22.0	2.0 U	0.10 U	1.3	3.1	1950	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	27.0
11-1-W-D	42.6	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	1.0 U	9.0	0.94	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
11-1-W-T	417	3.0 U	3.0 U	21.0	2.0 U	0.10 U	1.0 U	2.1	447	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.1	5.0
11-2-W-D	40.1	3.0 U	3.0 U	17.0	2.0 U	0.10 U	1.0 U	1.0 U	6.0	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
11-2-W-T	440	3.0 U	3.0 U	20.0	2.0 U	0.10 U	1.0 U	2.3	413	1.1 U/B	0.11 U	5.0	3.0 U	1.0 U	1.1	3.0
11-3-W-D	39.5	3.0 U	3.0 U	15.0	2.0 U	0.10 U	1.0 U	1.0 U	5.0 U	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
11-3-W-T	339	3.0 U	3.0 U	20.0	2.0 U	0.10 U	1.0 U	2.4	345	1.0 U/B	0.11 U	6.0	3.0 U	1.0 U	1.0 U	4.0
12-1-W-D	20.7	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	1.0 U	18.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U
12-1-W-T	397	3.0 U	3.0 U	24.0	2.0 U/E	0.10 U	1.0 U	2.0	839	1.1 U/B	0.11 U	5.0 U	3.0 U	1.0 U	1.0	10.0 E
12-2-W-D	25.8	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	1.0 U	25.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U/E
12-2-W-T	458	3.0 U	3.7	20.0	2.0 U/E	0.10 U	1.0 U	2.0	431	1.8 E	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	10.0 E
12-3-W-D	21.8	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	1.0 U	27.0	0.8 U	0.11 U	5.0 U/E	3.6	1.0 U	1.0 U	3.0 U/E
12-3-W-T	415	3.0 U	4.1	26.0	2.0 U/E	0.10 U	1.0 U	2.1	905	2.0 E	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	22.0 E
13-1-W-D	14.6 U/B	3.0 U	3.0 U	16.0	2.0 U/E	0.10 U	1.0 U	1.0 U	5.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U/E
13-1-W-T	205 E	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	1.9 U/B	229	1.2 E	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	9.0 E
13-2-W-D	16.3 U/B	3.0 U	3.0 U	16.0	2.0 U/E	0.10 U	1.0 U	1.0 U	7.0	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U/E
13-2-W-T	220 E	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	2.9 U/B	239	1.0 E	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	4.0 E
13-3-W-D	10.9 U/B	3.0 U	3.0 U	15.0	2.0 U/E	0.10 U	1.0 U	1.0 U	5.0 U	0.80 U	0.11 U	5.0 U/E	3.0 U	1.0 U	1.0 U	3.0 U/E
13-3-W-T	217 E	3.0 U	3.0 U	18.0	2.0 U/E	0.10 U	1.0 U	3.0 U/B	236	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	13.0 E
14-1-W-D	14.8 U/B	3.0 U	3.0 U	18.0	2.0 U/E	0.10 U	1.0 U	1.0 U	60.0 E	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U/E
14-1-W-T	412 E	3.0 U	3.0 U	24.0	2.0 U/E	0.10 U	1.0 U	3.3 U/B	666	1.2	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	13.0 E
14-2-W-D	12.0 U/B	3.0 U	3.0 U	19.0	2.0 U/E	0.10 U	1.0 U	1.0 U	68.0 E	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	4.0 E

TABLE 11. METALS DATA FOR WATER, SEDIMENT, AND TISSUE (Page 3 of 4)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
14-2-W-T	492 E	3.0 U	3.0 U	21.0	2.0 U/E	0.10 U	1.0 U	2.9 U/B	666	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	9.0 E
14-3-W-D	10.5 U/B	3.0 U	3.0 U	17.0	2.0 U/E	0.10 U	1.0 U	1.0 U	61.0 E	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
14-3-W-T	443 E	3.0 U	3.0 U	20.0	2.0 U/E	0.10 U	1.0 U	3.1 U/B	657	1.1	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	13.0 E
15-1-W-D	43.5	3.0 U	3.0 U	16.0	2.0 U/E	0.10 U	1.0 U	1.0 U	6.0 E	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
15-1-W-T	460	3.0 U	3.0 U	21.0	2.0 U/E	0.02 U/B	1.0 U	2.2	573	2.0	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	6.0 E
15-2-W-D	63.0	3.0 U	3.0 U	16.0	2.0 U/E	0.10 U	1.0 U	1.0 U	5.0 U	0.85	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
15-2-W-T	433	3.1	3.0 U	26.0	2.0 U/E	0.06 U/B	1.0 U	3.0	936	2.4	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	13.0 E
15-3-W-D	49.0	3.0 U	3.0 U	16.0	2.0 U/E	0.10 U	1.0 U	1.0 U	9.0 E	0.80 U	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	3.0 U
15-3-W-T	445	3.0	3.0 U	21.0	2.0 U/E	0.04 U/B	1.0 U	2.6	468	1.5	0.11 U	5.0 U	3.0 U	1.0 U	1.0 U	5.0 E
Sediment (mg/kg dry)																
1-S	21100	0.35 U	4.6	59.9	0.82	0.98	23.1	31.7	21500	16.1	0.08 E	15.3	1.4 U/E	0.12 U	0.47 U/E	93.2
2-S	17800	0.30 U	9.7	165	0.91	0.78	21.5	20.4	21800	12.7 U/B	0.09 E	16.5	1.2 U/E	0.10 U	0.40 U/E	79.8
3-S	16200	0.26 U	4.7	122	0.70	0.82	18.6	20.7	17500	12.0	0.08 E	14.5	1.1 U/E	0.09 U	0.35 U/E	77.3
4-S	17700	0.29 U	3.9	140	0.49	1.0	20.0	25.3	19000	14.6	0.06 E	14.7	1.2 U/E	0.11 U/B	0.39 U/E	95.9
5-S	20300	0.32 U	4.3	142	0.84 E	1.1 E	22.1	32.2	21100	15.6	0.06 E	14.6	1.3 U/E	0.11 U/B	0.42 U/E	101
6-S	33300	0.30 U	4.5	150	1.2	0.49	31.1	49.9	39000	9.5 U/B	0.08 E	24.8	1.2 U/E	3.10	0.40 U/E	91.8
7-S	14200	0.25 U	3.8	106	0.42	0.61	14.8	23.4	15500	11.8	0.18 E	14.0	1.0 U/E	0.20 U/B	0.33 U/E	68.3
8-S	19900	0.33 U	4.3	149	0.66	1.3	21.8	34.0	20600	16.4	0.10 E	17.4	1.3 U/E	0.49 U/B	0.44 U/E	136
9-1-S	16900	0.32 U	4.0	129	0.64	1.1	20.1	25.5	19000	14.3 U/B	0.08 E	15.4	1.3 U/E	0.11 U	0.42 U/E	89.4
9-2-S	18500	0.28 U	4.6	152	0.85	1.1	20.0	29.2	21100	15.3	0.09 E	16.8	1.1 U/E	0.09 U	0.38 U/E	106
9-3-S	18700	0.31 U	4.8	152	0.73	0.73	19.9	28.2	21000	15.0	0.08 E	15.8	1.2 U/E	0.10 U	0.42 U/E	98.1
10-S	26900	0.41 U	13.6	186	1.1	0.63	26.1	28.0	27700	18.1 U/B	0.14 E	18.2	1.6 U/E	0.14 U	0.55 U/E	94.4
11-S	15700	0.23 U	3.6	154	0.76	1.1	19.3	19.3	18300	12.7	0.13 E	15.0	0.9 U/E	0.08 U	0.30 U/E	97.3
12-S	21300	0.36 U	8.6	163	0.96	1.9	25.8	32.5	26900	26.3	0.14 E	19.4	1.4 U/E	0.12 U	0.48 U/E	148
13-S	19400	0.29 U	6.2	164	0.87	1.3	20.8	31.0	21100	23.6	0.08 E	18.3	1.2 U/E	0.10 U	0.39 U/E	128
14-S	16200	0.31 U	4.4 E	138	0.62	1.9	18.6	24.8	18400	17.6	0.08 E	14.7	1.2 U/E	0.10 U	0.42 U/E	155
15-S	16300	0.25 U	3.7	136	0.68	1.0	18.9	21.1	18900	17.4	0.07 E	14.6	1.0 U/E	0.11 U	0.34 U/E	117

TABLE 11. METALS DATA FOR WATER, SEDIMENT, AND TISSUE (Page 4 of 4)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Crayfish (mg/kg wet)																
2-CF		0.012	0.036 U/E	31.5		0.047	0.079 E	29.3		0.148 E	0.065	0.56	0.045 E	0.103		32.3 E
3-CF		0.012 U	0.036 U/E	31.0		0.043	0.055	31.1		0.108 E	0.049 U/B	0.83	0.036 U/E	0.057 E		28.5 E
4-CF		0.012 U	0.036 U	38.5		0.037	0.056	21.8		0.145 E	0.029	0.10 U	0.036 U/E	0.070		30.2 E
5-CF		0.011 U	0.033 U	8.5		0.029	0.035	20.9		0.174 E	0.048	0.24	0.033 U/E	0.062		31.4 E
6-CF		0.012 U	0.036 U	31.2		0.027	0.089	22.3		0.113 E	0.044	0.10 U	0.036 U	0.028 E		35.5 E
7-CF		0.012 U	0.036 U	47.2		0.038	0.089	24.2		0.096 E	0.045 U/B	1.33	0.036 U	0.018		33.9 E
8-CF		0.012 U	0.035 U	35.6		0.0004 U	0.088	14.9		0.174 E	0.081	0.29	0.035 U	0.004 U		31.9 E
9-CF		0.015 U	0.046 U	24.4		0.042	0.095	18.5		0.168 E	0.055	0.64 E	0.046 U	0.043 E		83.3 E
10-CF		0.015	0.036	36.9		0.027	0.093	15.9		0.124 E	0.039	0.36	0.047 E	0.057		33.6 E
11-CF		0.012 U	0.036 U/E	11.1		0.021	0.077	24.7		0.048 U/B	0.029	1.23	0.036 U/E	0.025		37.8 E
12-CF		0.012 U	0.036 U	33.5		0.053	0.090	21.8		0.163 E	0.032	0.68	0.036 U/E	0.091		35.2 E
13-1-CF		0.014	0.035 U/E	31.5		0.026	0.063	20.0		0.114 E	0.045	0.69	0.035 U/E	0.035		31.2 E
13-2-CF		0.018	0.038 U/E	32.3		0.030	0.066	18.1		0.141 E	0.050	0.40	0.038 U/E	0.035 E		24.6 E
13-3-CF		0.013	0.035 U/E	29.0		0.033	0.074	20.1		0.148 E	0.034	0.53	0.035 U/E	0.053		31.4 E
14-CF		0.017	0.036 U/E	27.6		0.051	0.063	21.8		0.444 E	0.052	0.46	0.044 E	0.054		55.7 E
Fish (mg/kg wet)																
1-LS		0.012 U	0.036 U	0.34		0.012	0.129	0.72		0.172 E	0.245	0.10 U	0.043 E	0.004 U/E		19.3 E
1-C		0.012 U	0.036 U	1.0		0.033	0.024 U/B	0.76		0.173 E	0.145	0.78	0.093 E	0.004 E		29.6 E
2-LS		0.011 U	0.034 U	1.4		0.028	0.050	0.71		0.060 U/B	0.264	0.09 U	0.034 U/E	0.004 U/E		18.9 E
3-LS		0.012 U	0.385	0.64		0.036	0.043	0.53		0.507 E	0.189	0.28 E	0.207 E	0.004 U/E		16.2 E
4-LS		0.012 U	0.037 U	0.66		0.020	0.032 U/B	0.39		0.010 U	0.117	0.10 U	0.037 U/E	0.004 U/E		12.3 E
5-LS		0.012 U	0.037 U	0.60		0.057	0.139	0.96		0.056 U/B	0.131	0.10 U	0.037 U/E	0.005 E		14.8 E
6-LS		0.012 U	0.037 U	1.7		0.023	0.071	0.86		0.038 U/B	0.100	0.10 U	0.037 U	0.004 U/E		15.2 E
7-LS		0.012 U	0.036 U	0.95		0.017 E	0.153 E	0.71		0.077 U/B	0.102	0.77	0.054 E	0.006 E		19.3 E
8-LS		0.012 U	0.037 U	1.4		0.046	0.080	0.73		0.161 E	0.222	0.10 U	0.040 E	0.004 U/E		20.0 E
9-LS		0.011 U	0.034 U	0.96		0.025	0.053	0.73		0.068 U/B	0.178	0.39	0.045 E	0.004 U/E		22.8 E
10-LS		0.011 U	0.034 U	2.2		0.010	0.092	0.74		0.106 E	0.213	0.09 U	0.034 U	0.004 U/E		15.6 E
11-LS		0.012 U	0.035 U	1.2		0.026	0.066	0.60		0.084 U/B	0.123	0.10 U	0.035 U	0.004 U/E		20.1 E
12-LS		0.011 U	0.034 U	1.7		0.042	0.170	0.79		0.204 E	0.111	0.09 U	0.072 E	0.004 U/E		17.5 E
13-1-LS		0.012 U	0.035 U	3.2		0.066	0.314	1.16		0.183 E	0.215	0.10 U	0.035 U	0.004 U/E		20.7 E
13-2-LS		0.012 U	0.036 U	3.1		0.059	0.325	1.23		0.376 E	0.161	0.28	0.036 U	0.004 U/E		22.4 E
13-3-LS		0.011 U	0.034 U	3.5		0.053	0.527	1.18		0.296 E	0.119	2.26	0.034 U	0.004 U/E		13.7 E
14-LS		0.011 U	0.034 U	3.5		0.062	0.450	1.21		0.009 U	0.196	0.13	0.034 U	0.004 U/E		23.7 E
15-C		0.012 U	0.035 U	1.2		0.039	0.078	1.26		0.116 E	0.001 U	0.10 U	0.035 U	0.005 E		92.1 E

Appendix A-6

Data Validation Report
Semivolatile Organics, Including Polynuclear Aromatic Hydrocarbons by SIMs

Site: Lower Columbia River

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Analytical Resources, Inc.

Data Reviewed by: Jennifer M. Baier and Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey and analyzed for semi-volatile organic compounds using U.S. EPA Method 8270 and for polynuclear aromatic hydrocarbons (PAHs) using U.S. EPA Method 8270 with selective ion monitoring system (SIMs) by Analytical Resources, Inc. (ARI) of Seattle, WA. The samples were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). In addition, a sample of Sequim Bay Reference Material (Sample SQ-1) was also analyzed. Of the 33 tissue samples, 15 were crayfish and 18 were fish, either largescale sucker or carp. Crayfish samples were collected at only 13 of the 15 stations (all except stations 1 and 15). Triplicate field samples were collected at station 13 (13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale sucker) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS). The data validation review was conducted according to guidelines presented in the U.S. EPA Contract Laboratory Program Statement of Work (SOW) for organics analyses (U.S. EPA 1991a), the Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses (U.S. EPA 1991b), and the sampling and QA/QC plan for the project (Tetra Tech 1993).

A. SEMIVOLATILES

A.1. HOLDING TIMES

Sediment and tissue samples were collected, placed on ice or dry ice (tissue) in a cooler, and transported to the laboratory within 9 days of collection. The maximum holding time for semivolatiles in sediment or tissue matrices has been established for this project as 14 days until extraction and an additional 26 days until analysis. Table 1 presents a summary of sample numbers, dates collected, extracted, and analyzed, and holding times. All samples were extracted and analyzed well within applicable holding times except for samples 10-CF and 12-CF, which were extracted 16 days after sample collection. This deviation was considered minor. Both of these crayfish samples were analyzed with the 40-day holding time. No data qualifiers were assigned to sample results for semivolatile organics based on holding times.

A.2. CALIBRATION AND INSTRUMENT PERFORMANCE

Sediment

GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis except for 6/25/93. On this date, mass 51 was 61.4 percent of mass 198. The laboratory has established in-house limits for this ion of 30-60 percent of mass 198, while EPA's criterion is 30-80 percent of mass 198. Because the ion abundance tuning for 6/25/93 satisfies EPA criteria, no data qualifiers were assigned.

An initial 6-point calibration was conducted on 6/25/93. Calibration standard concentrations were 2, 5,

10, 25, 40, and 60 ng/μL. All compounds had average relative response factors (RRF) greater than 0.05. The relative standard deviations (RSD) calculated from the initial calibration were all less than 30 percent, with the exception of 2,4-dinitrophenol (RSD=34.0). According to the National Functional Guidelines (U.S. EPA 1991b), 2,4-dinitrophenol has a historically poor response and therefore has no contractual maximum RSD criteria. The only required criterion (minimum RRF of 0.01) was met by the 2,4-dinitrophenol (RRF=0.128). The RRF and RSD results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for Contract Lab Program (CLP) analyses (i.e., before and within 12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The percent differences (%D) between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for benzyl alcohol and hexachlorocyclopentadiene on 7/15/93 and 7/16/93. These two compounds have a historically poor response and have no established %D criteria. The only required criterion is that the RRF value be greater than 0.010. Benzyl alcohol had a RRF of 0.454 (on 7/15/96) and 0.371 (on 7/16/93) and hexachlorocyclopentadiene had a RRF of 0.179 (on 7/15/93) and 0.237 (on 7/16/93). No data qualifiers were assigned due to continuing calibration.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. All internal standard area counts were within a factor of 2 of the 12-hour calibration area counts, except for internal standard 6 (perylene-d_{12}) for the spike blank duplicate and the reanalysis of method blank 3, which were below the lower limit. Target compounds and surrogates associated with the internal standard 6 were not found in the spike blank duplicate and no samples were associated with method blank 3 reanalysis. All retention times were within $\pm$ 30 seconds of the 12-hour calibration retention times.

Crayfish Tissue

GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis.

An initial 6-point calibration was conducted on 7/15/93. Calibration standard concentrations were 2, 5, 10, 25, 40, and 60 ng/μL. All compounds had RRFs greater than 0.05. The RSDs calculated from the initial calibration were all less than 30 percent, with the exception of 2,4-dinitrophenol (RSD=50.6) and 4-nitrophenol (RSD=31.9). According to the National Functional Guidelines (U.S. EPA 1991b), 2,4-dinitrophenol and 4-nitrophenol have historically poor responses and therefore have no contractual maximum RSD criteria. The only required criteria (minimum RRF of 0.01) was met by 2,4-dinitrophenol (RRF=0.137) and 4-nitrophenol (RRF=0.167). The RRF and RSD results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for CLP analyses (i.e., before and within 12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The %D between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for fluorene (84.8 %D) on 8/3/93. Up to four semivolatile target compounds may fail to meet QC guidelines, according to the National Functional Guidelines (U.S. EPA 1991b), but data qualification for fluorene is warranted since the percent difference for the compound was very high. The continuing calibration done on 8/9/93 had five compounds with %Ds greater than 25 percent (2,4-dinitrophenol at 27.2, pyrene at 30.1, butylbenzyl phthalate at 31.7, bis(2-ethylhexyl)phthalate at 27.1, and surrogate 2,4,6-tribromophenol at 28.7). Only pyrene has minimum %D criteria, the other compounds have historically poor response and typically are not considered in the evaluation of percent

difference in a continuing calibration analysis. These compounds with poor response did, however, meet the minimum RRF criteria of 0.010 (2,4-dinitrophenol at 0.174, butylbenzyl phthalate at 0.531, bis(2-ethylhexyl)phthalate at 0.708, and surrogate 2,4,6-tribromophenol at 0.323). Therefore, no data qualifiers were assigned based on the continuing calibration done on 8/9/93. It should be noted that fluorene (a PAH) was also analyzed by SIM (see section B). Because the fluorene results given in Table 15 are from the SIM analyses, the high %D noted for fluorene in the continuing calibration of 8/3/93 does not affect sample results.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. All internal standard area counts were within a factor of 2 of the 12-hour calibration area counts, except for internal standard 5 (chrysene-d_{12}) for sample 12-CF and the internal standard 6 (perylene-d_{12}) for the samples 3-CF and 12-CF, which were below the lower limit (Table 2). Compounds associated with internal standard 5 [butylbenzyl phthalate, 3,3'-dichlorobenzidine, and bis(2-ethylhexyl)phthalate] were qualified as estimates for sample 12-CF, while compounds associated with internal standard 6 (di-n-octyl phthalate) were qualified as estimates for both samples 3-CF and 12-CF. Several PAHs are associated with both internal standard 5 and 6, but were not qualified because the reported values for PAHs in Table 15 are from the SIM analyses. All retention times were within ± 30 seconds of the 12-hour calibration retention times.

Fish Tissue

GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis except for 6/25/93. On this date, mass 51 was 61.4 percent of mass 198. The laboratory has established in-house limits for this ion of 30-60 percent of mass 198, while EPA's criterion is 30-80 percent of mass 198. Because the ion abundance tuning for 6/25/93 satisfies EPA criteria, no data qualifiers were assigned.

Initial 6-point calibration was conducted on 6/25/93. Calibration standard concentrations were 2, 5, 10, 25, 40, and 60 ng/μL. All compounds had average RRFs greater than 0.05. The RSDs calculated from the initial calibration were all less than 30 percent, with the exception of 2,4-dinitrophenol (RSD=34) and 4,6-dinitro-2-methylphenol (RSD=40.6). According to the National Functional Guidelines (U.S. EPA 1991b), 2,4-dinitrophenol and 4,6-dinitro-2-methylphenol have historically poor responses and therefore have no contractual maximum RSD criteria. The only required criteria (minimum RRF of 0.01) was met by 2,4-dinitrophenol (RRF=0.128) and 4-nitrophenol (RRF=0.172). The RRF and RSD results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for CLP analyses (i.e., before and within 12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The %D between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for hexachlorocyclopentadiene (%D=26.8), pyrene (%D=25.9), and benzo(g,h,i)perylene (%D=26.1) on 8/19/93; 4,6-dinitro-2-methylphenol (%D=38.7) on 8/23/93; and benzoic acid (%D=43.5), 4,6-dinitro-2-methylphenol (%D=38.1), and pentachlorophenol (%D=53.6) on 8/24/93. Up to four semivolatile target compounds may fail to meet QC guidelines, according to the National Functional Guidelines (U.S. EPA 1991b) and no data qualifiers were assigned.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. All internal standard area counts and retention times were within ± 30 seconds of the 12-hour calibration.

A.3. SURROGATE RECOVERIES

All field, blank, and spike samples were spiked with four base/neutral surrogates (d5-nitrobenzene, 2-fluorobiphenyl, d14-p-terphenyl, and d4-1,2-dichlorobenzene) and four acid surrogates (d5-phenol, 2-fluorophenol, 2,4,6-tribromophenol, and d4-2-chlorophenol) before analysis.

Sediment
All surrogate recoveries were within the recovery limits, with the exception of 2-fluorophenol, which was recovered at 24.6 percent in one of the method blanks performed on 7/16/93, slightly less than the lower QC limit (25 percent). Two or more surrogate compounds must deviate from QC limits per method blank before data qualification is required (U.S. EPA 1991b); thus, qualification was not necessary in this case.

Crayfish Tissue
All surrogate recoveries were within the recovery limits, with the exception of d14-p-terphenyl in sample 10-CF (174 percent) and sample 12-CF (174 percent), well above the upper QC limit (137 percent). Two or more surrogate compounds must deviate from QC limits per sample before data qualification is required (U.S. EPA 1991b); thus, qualification was not necessary in this case.

Fish Tissue
All surrogate recoveries were within the recovery limits, with the exception of base/neutral surrogate 2-fluorophenol for sample 1-C (132 percent) and acid surrogate 2,4,6-tribromophenol for samples 1-C (210 percent), 3-LS (124 percent), 9-LS (129 percent), 11-LS (151 percent), 13-1-LS (123 percent), and the MSD (145 percent). Two or more surrogate compounds must deviate from QC limits per sample or matrix spike before data qualification is required (U.S. EPA 1991b); thus, data qualification was not necessary in this case.

A.4. METHOD BLANKS

Sediment
Method blanks were extracted on 7/7/93, 7/8/93, 7/9/93. Bis(2-ethylhexyl)phthalate was detected in the first method blank done on 7/7/93 at 160 μg/kg. Because the reported concentration from sample 8-S concentration was less than 10X the average amount detected in the blanks (i.e., 1600 μg/kg), the value was qualified as undetected due to blank contamination (qualifier code "U/B"). No other compound was detected in any of the samples, so no additional data qualifiers were assigned to sample results for semivolatile organics based on method blank results.

Crayfish Tissue
Method blanks were extracted on 7/28/93 and 8/5/93. No compound was detected in any of the blanks, so no data qualifiers were assigned to sample results for semivolatile organics based on method blank results.

Fish Tissue
The method blank was extracted on 8/16/93. Benzo(k)fluoranthene was detected in the method blank at 520 μg/kg. Normally benzo(k) fluoranthene values from all samples associated with this blank would be qualified as undetected unless the concentration was greater than 5200 μg/kg, but this compound was also analyzed by SIM (see section B). The benzo(k)fluoranthene data reported in Table 16 are from the SIM analyses, so the blank contamination noted for this compound is not relevant to this project. No other compound was detected in any of the samples, so no data qualifiers were assigned to sample results for

semivolatile organics based on method blank results.

A.5. MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSIS

Sediment

MS/MSD analyses were performed on sample 13-S and reported in Table 3. Spike compounds were added to samples to produce concentrations ranging from 44.4 to 601 µg/kg. Pentachlorophenol had a MS percent recovery of 12.4 which is slightly lower than the QC limit of 17 percent. Acenaphthene had a RPD of 20 percent which is slightly higher than the QC limit of 19 percent. Both of these were considered minor deviations and no qualifiers were assigned. Percent recoveries and the RPD for both the MS and the MSD were within QC limits established by U.S. EPA (1991a) for all other compounds. No data qualifiers were assigned to sample results based on MS/MSD results.

Crayfish Tissue

MS/MSD analyses were performed on sample 11-CF and reported in Table 3. Spike compounds were added to samples to produce concentrations ranging from 859 to 1,980 µg/kg. Percent recoveries and the RPD's for both the MS and the MSD were within QC limits established by U.S. EPA (1991a) for all compounds. No data qualifiers were assigned to sample results based on MS/MSD results.

Fish Tissue

MS/MSD analyses were performed on sample 10-LS and reported in Table 3. Spike compounds were added to samples to produce concentrations ranging from 832 to 1,980 µg/kg. Acenaphthene had a RPD of 25.5 percent which is slightly higher than the QC limit of 19 percent. Pyrene had a RPD of 40.3 percent which is slightly higher than the QC limit of 36 percent. No data qualifiers were assigned to these compounds because the PAH concentrations from these analyses are not relevant to this project. Percent recoveries and the RPDs for both the MS and the MSD were within QC limits established by U.S. EPA (1991a) for all other compounds. No data qualifiers were assigned to sample results based on MS/MSD results.

A.6. SPIKED BLANK ANALYSIS

Sediment

Two spiked blanks were analyzed in conjunction with the four method blanks. Eleven compounds were added to produce concentrations ranging from 166 to 401 µg/kg on 7/16/93 and from 172 to 362 µg/kg on 7/16/93. The percent recoveries for each of the spiked blanks are reported in Table 4. N-nitroso-di-n-propylamine had a percent recovery of 39.8, which is slightly less than the QC limit of 41. This was considered a minor deviation and no qualifiers were assigned. Percent recoveries for all other compounds were within QC limits established by U.S. EPA (1991a). No data qualifiers were assigned to sample results based on spiked blank data.

Crayfish Tissue

Two spiked blanks were analyzed in conjunction with the two method blanks. Eleven compounds were added to produce concentrations ranging from 654 to 1,340 µg/kg on 8/2/93 and from 902 to 1,560 µg/kg on 8/9/93. The percent recoveries for each of the spiked blanks are reported in Table 4. Percent recoveries for all compounds were within QC limits established by U.S. EPA (1991a). No data qualifiers were assigned to sample results based on spiked blank data.

Fish Tissue
One spiked blank was analyzed in conjunction with the method blank. Eleven compounds were added to produce concentrations ranging from 612 to 1,029 µg/kg. The percent recoveries for each of the spiked blanks are reported in Table 4. Percent recoveries for all compounds were within QC limits established by U.S. EPA (1991a). No data qualifiers were assigned to sample results based on spiked blank data.

A.7. REFERENCE MATERIALS

Sediment
Sequim Bay reference material (Sample SQ-1) was analyzed for semivolatile organic compounds. The results are presented in Table 5, along with the 95 percent confidence interval for reference concentrations obtained from U.S. EPA, Region X, Office of Puget Sound. Fifteen of the compounds listed in Table 5 were detected at concentrations below the lower limit of the confidence interval. Because organic concentrations in the Sequim Bay reference material have not been certified, no data qualifiers were assigned to the results based on the reference material analysis.

A.8. LABORATORY DUPLICATES

Sediment
One pair of analyses from this project, the non-spiked compounds in the MS/MSD analyses for sample 13-S, were considered as analytical duplicates. The concentrations for compounds that were detected in either member of the duplicate are listed in Table 6. Guidelines presented in the sampling and QA/QC plan for the project (Tetra Tech 1993) specify action limits for laboratory duplicates at 50 percent RPD. Two compounds exceeded 50 percent, fluoranthene (53.8) and bis(2-ethylhexyl)phthalate (56.4). The RPDs from the associated MS/MSD are within QC limits and indicate acceptable laboratory precision. Therefore, the exceedances from the laboratory duplicates are considered minor deviations. No data qualifiers were assigned based on laboratory duplicate results.

Crayfish Tissue
One pair of analyses from this project, the non-spiked compounds in the MS/MSD analyses for sample 11-CF, were considered as analytical duplicates. There were no compounds detected in either the matrix spike or the matrix spike duplicate; therefore, evaluation of laboratory duplicates for laboratory precision was not possible.

Fish Tissue
One pair of analyses from this project, the non-spiked compounds in the MS/MSD analyses for sample 10-CF, were considered as analytical duplicates. There were no compounds detected in either the matrix spike or the matrix spike duplicate; therefore, evaluation of laboratory duplicates for laboratory precision was not possible.

A.9. FIELD REPLICATES

Sediment
One set of field triplicate samples (samples 9-1-S, 9-2-S, and 9-3-S) were analyzed for semivolatile organics and reported in Table 7. For those analytes that were detected in all three samples, the RSDs were below 30 percent, with the exception of benzo(a)anthracene (37.89) and chrysene (46.88). The qualification of results based on field replicates is not appropriate.

Crayfish Tissue
One set of field triplicate samples (samples 13-1-CF, 13-2-CF, and 13-3-CF) were analyzed for semivolatile organics. There were no compounds detected in the samples; therefore, it was not possible to analyze field variability.

Fish Tissue
One set of field triplicate samples (samples 13-1-LS, 13-2-LS, and 13-3-LS) were analyzed for semivolatile organics. There were no compounds detected in the samples; therefore, it was not possible to analyze field variability.

B. POLYNUCLEAR AROMATIC HYDROCARBONS

B.1. HOLDING TIMES

Sediment and tissue samples were collected, placed on ice or dry ice (tissue) in a cooler, and transported to the laboratory within 9 days of collection. The maximum holding time for polynuclear aromatic hydrocarbons (PAHs) in sediment or tissue matrices has been established for this project as 14 days until extraction and an additional 26 days until analysis. Table 8 presents a summary of sample numbers, dates collected, extracted, and analyzed, and holding times. All samples were extracted and analyzed well within applicable holding times except for samples 10-CF and 12-CF, which were extracted 16 days after sample collection. This deviation was considered minor. Both of these crayfish samples were analyzed with the 40-day holding time. No data qualifiers were assigned to sample results for PAHs based on holding times.

B.2. CALIBRATION AND INSTRUMENT PERFORMANCE

Sediment
GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis.

An initial 6-point calibration was conducted on 7/14/93. Calibration standard concentrations were 0.1, 0.2, 0.4, 1, 5, and 10 ng/μL. All compounds had RRFs greater than 0.05. The RSDs calculated from the initial calibration were all less than 30 percent, with the exception of dibenzo(a,h)anthracene (RSD=33.2). In accordance with guidance provided in the National Functional Guidelines (U.S. EPA 1991b), the RSD was reduced to 25.87 percent by removing the lowest response factor (RF) from the calculations. The RRF and RSD (using the recalculated RSD for dibenzo(a,h)anthracene) results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for CLP analyses (i.e., before and within 12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The %D between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for indeno(1,2,3-cd)pyrene (%D=33.9) and dibenzo(a,h)anthracene (%D=37.6). Up to four semivolatile target compounds may fail to meet QC guidelines, according to the National Functional Guidelines (U.S. EPA 1991b) and no data qualifiers were assigned.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. The EPA criterion for internal standard

areas (factor of 2 of 12-hour calibration standard areas) is not applicable to SIM analyses (Harris, M., 23 September 1993, personal communication). Because of the variability inherent to the SIM method, the acceptable criterion was widened to a factor of 4 for this project. All internal standard area counts were within a factor of 4 of the 12-hour calibration counts and the retention times were within ± 30 seconds of the 12-hour calibration retention times.

Crayfish Tissue

GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis.

An initial 6-point calibration was conducted on 7/14/93. Calibration standard concentrations were 0.1, 0.2, 0.4, 1, 5, and 10 ng/μL. All compounds had RRFs greater than 0.05. The RSDs calculated from the initial calibration were all less than 30 percent, with the exception of dibenzo(a,h)anthracene (RSD=33.2). In accordance with guidance provided in the National Functional Guidelines (U.S. EPA 1991b), the RSD was reduced to 25.87 percent by removing the lowest response factor (RF) from the calculations. The RRF and RSD (using the recalculated RSD for dibenzo(a,h)anthracene) results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for CLP analyses (i.e., before and within 12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The %D between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene in both continuing calibrations (8/10/93 and 8/11/93). Up to four semivolatile target compounds may fail to meet QC guidelines, according to the National Functional Guidelines (U.S. EPA 1991b) and no data qualifiers were assigned.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. All internal standard area counts were within a factor of 4 of the 12-hour calibration area counts, except for internal standard 4 (acenaphthalene-d_{10}) for samples 8-CF and 13-2-CF, which were above the upper bounds of the QC guidelines (Table 9). Compounds associated with internal standard 4 [acenaphthalene, acenaphthene, dibenzofuran, and fluorene] were qualified as estimates for samples 8-CF and 13-2-CF (Harris, M., 23 September 1993, personal communication). All retention times were within ± 30 seconds of the 12-hour calibration retention times.

Fish Tissue

GC/MS tuning was conducted at the beginning of each day on which samples were analyzed. All of the ion abundance criteria were satisfied for each analysis.

An initial 6-point calibration was conducted on 7/14/93. Calibration standard concentrations were 0.1, 0.2, 0.4, 1, 5, and 10 ng/μL. All compounds had RRF greater than 0.05. The RSDs calculated from the initial calibration were all less than 30 percent, with the exception of dibenzo(a,h)anthracene (RSD=33.2). In accordance with guidance provided in the National Functional Guidelines (U.S. EPA 1991b), the RSD was reduced to 25.87 percent by removing the lowest response factor (RF) from the calculations. The RRF and RSD (using the recalculated RSD for dibenzo(a,h)anthracene) results indicate that the initial calibration was valid.

Continuing calibration was conducted at the required frequency for CLP analyses (i.e., before and within

12 h of sample analyses). All compound RRFs were greater than 0.05 in the continuing calibrations. The %D between the initial calibration RRF and the continuing calibration RRFs were all less than 25 percent, except for pyrene (%D=40.4) on 9/8/93; pyrene (%D=38.3) on 9/9/93; and pyrene (%D=36.4), benzo(g,h,i)perylene (%D=27.0), and diphenyl-d_{10} (%D=69.8) on 9/10/93. Up to four semivolatile target compounds may fail to meet QC guidelines, according to the National Functional Guidelines (U.S. EPA 1991b) and no data qualifiers were assigned.

Internal standard area counts and retention times were evaluated to determine instrument performance and as a check on continuing calibration for compound quantitation. All internal standard area counts were within a factor of 4 of the 12-hour calibration counts and the retention times were within $\pm$ 30 seconds of the 12-hour calibration retention times.

B.3. SURROGATE RECOVERIES

Sediment
All surrogate recoveries were within the recovery limits and no data qualifiers were assigned based on surrogate recovery.

Crayfish Tissue
All surrogate recoveries were within the recovery limits and no data qualifiers were assigned based on surrogate recovery.

Fish Tissue
All surrogate recoveries were within the recovery limits and no data qualifiers were assigned based on surrogate recovery.

B.4. METHOD BLANKS

Sediment
Two method blanks were extracted on 7/8/93 and 7/9/93. Indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene were detected in both method blanks. In accordance with U.S. EPA guidelines (U.S. EPA 1991b), all indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene values from samples 9-1-S, 9-2-S, 9-3-S, 11-S, 13-S, and 15-S were qualified as undetected because the sample concentration was less than 5X the 7/8/93 method blank concentration of 1.6 μg/kg for both compounds. Benzo(g,h,i)perylene values for samples 2-S, 6-S, and 7-S were qualified because the sample concentration was less than 5X the concentration of benzo(g,h,i)perylene (1.6 μg/kg) in the 7/8/93 method blank. No other compound was detected in any of the samples, so no additional data qualifiers were assigned to sample results for PAHs based on method blank results.

Crayfish Tissue
Two method blanks were extracted on 7/28/93 and 8/5/93. Naphthalene was detected at 2.5 μg/kg and 2-methylnaphthalene was detected at 1.4 μg/kg in the 7/28/93 method blank. Samples 6-CF, 7-CF, 8-CF, 9-CF, 11-CF, 13-1-CF, 13-2-CF, 13-3-CF, and 14-CF are associated with the 7/28/93 method blank. In accordance with U.S. EPA guidelines (U.S. EPA 1991b), naphthalene values for samples 7-CF, 8-CF, 11-CF, 13-1-CF, 13-2-CF, and 13-3-CF and 2-methylnaphthalene values for samples 8-CF and 11-CF were qualified as undetected because the sample concentration was less than 5X the blank concentration. Naphthalene was also detected in the 8/5/93 method blank and samples 2-CF and 3-CF were qualified because their concentrations were less than 5X the blank concentration. No other compound was detected

in any of the samples, so no additional data qualifiers were assigned to sample results for PAHs based on method blank results.

Fish Tissue
Two method blanks were extracted on 8/16/93 and 8/18/93. Benzo(k)fluoranthene was detected at 710 μg/kg in the 8/16/93 method blank. All samples except 8-LS and 13-2-LS are associated with the 8/16/93 method blank. Naphthalene (52 μg/kg), 2-methylnaphthalene (5.0 μg/kg), and pyrene (79 μg/kg) were detected in the 8/18/93 method blank. Because none of the above compounds were detected in any of the samples, no data qualifiers were assigned to sample results for PAHs based on method blank results.

B.5. MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSIS

Sediment
MS/MSD analyses were performed on sample 13-S and are reported in Table 10. Spike compounds were added to samples to produce concentrations ranging from 36.8 to 49.7 μg/kg. QC limits for MS and MSD have not been established for the spiked PAHs by the U.S. EPA. However, the reported percent recoveries for the three compounds were within QC guidelines for other similar organic compounds.

Crayfish Tissue
MS/MSD analyses were performed on sample 13-CF and are reported in Table 10. Spike compounds were added to samples to produce concentrations ranging from 140 to 940 μg/kg. QC limits for MS and MSD have not been established by the U.S. EPA, except for acenaphthene and pyrene. The percent recoveries and RPDs for the two compounds were within QC limits. Although QC guidelines do not exist for the other sixteen compounds, percent recoveries were within QC guidelines for other similar organic compounds. No data qualifiers were assigned to the samples based on MS/MSD results.

Fish Tissue
MS/MSD analyses were performed on sample 10-LS and are reported in Table 10. Spike compounds were added to samples to produce concentrations ranging from 59.8 to 630 μg/kg. QC limits for MS and MSD have not been established for the spiked PAHs by the U.S. EPA. However, the reported percent recoveries for the five compounds were within QC guidelines for other similar organic compounds.

B.6. SPIKED BLANK ANALYSIS

Sediment
Spiked blanks were not analyzed for the sediment samples.

Crayfish Tissue
Spike blanks were not analyzed for the crayfish tissue samples.

Fish Tissue
A spiked blank was analyzed in conjunction with the two method blanks. Five compounds were added at final concentrations of 100 to 719 μg/kg. The percent recoveries for the spiked blank are reported in Table 11. Percent recoveries for all compounds were within QC limits established by U.S. EPA (1991a). No data qualifiers were assigned to sample results based on spiked blank data.

B.7. LABORATORY DUPLICATES

Sediment

One pair of analyses from this project, the non-spiked compounds in the MS/MSD analyses for sample 13-S, were considered as analytical duplicates. The concentrations for compounds that were detected in either member of the duplicate are listed in Table 12. Guidelines presented in the sampling and QA/QC plan for the project (Tetra Tech 1993) specify action limits for laboratory duplicates at 50 percent RPD. Two compounds exceeded 50 percent, dibenzofuran (51.4) and benzo(a)pyrene (52.6). The RPDs from the associated MS/MSD are below QC limits and indicate acceptable laboratory precision. Therefore, the exceedances from the laboratory duplicates are considered minor deviations. No data qualifiers were assigned based on laboratory duplicate results.

Crayfish Tissue

There were no non-spiked compounds in the MS/MSD analyses for sample 11-CF, so an evaluation of laboratory duplicates could not be made.

Fish Tissue

One pair of analyses from this project, the non-spiked compounds in the MS/MSD analyses for sample 10-LS, were considered as analytical duplicates. The concentrations for compounds that were detected in either member of the duplicate are listed in Table 12. Guidelines presented in the sampling and QA/QC plan for the project (Tetra Tech 1993) specify action limits for laboratory duplicates at 50 percent RPD. No data qualifiers were assigned based on laboratory duplicate results.

B.8. FIELD REPLICATES

Sediment

One set of field replicate samples (samples 9-1-S, 9-2-S, and 9-3-S) were analyzed for PAHs and reported in Table 13. For those analytes that were detected in all three samples, the RSD ranged from 2.31 to 46.87 percent. With the exception of anthracene (35.12), benzo(a)anthrancene (42.43), and chrysene (46.87), the RSDs were all below 30 percent. The qualification of results based on field replicates is not appropriate.

Crayfish Tissue

One set of field triplicate samples (samples 13-1-CF, 13-2-CF, and 13-3-CF) were analyzed for semivolatile organics. There were no compounds detected in the samples; therefore, it was not possible to analyze field variability.

Fish Tissue

One pair of field replicate samples (samples 13-1-LS, 13-2-LS, and 13-3-LS) were analyzed for PAHs and reported in Table 13. For those analytes that were detected in all three samples, the RSD could not be calculated because the analytes were undetected in some of the samples. Therefore, it was not possible to analyze field variability.

SUMMARY

Sediment

All sample data were reported by the laboratory in µg/kg dry weight and are presented in Table 14. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (13-180 µg/kg for semivolatile organics and 0.65 µg/kg for PAHs) met the specified detection limits set in the sampling and QA/QC plan (Tetra Tech 1993).

Sample results for several compounds were qualified as undetected based on evaluation of QA/QC data. Bis(2-ethylhexyl)phthalate was found in an BNA method blank and the values for samples 10-S and 15-S were qualified as undetected due to blank contamination. Also, several sample results for benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene were qualified as undetected due to blank contamination.

The precision, accuracy, and completeness of the semivolatile organics and PAH analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Crayfish Tissue

All sample data were reported by the laboratory in µg/kg wet weight and are presented in Table 15. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (94-3100 µg/kg) for semivolatile organics, were up to an order of magnitude higher than those specified in the sampling and QA/QC plan (Tetra Tech 1993). The laboratory was not able to achieve its target detection limits because of matrix interferences with the phthalate compounds. The detection limits reported by the laboratory (9.3-9.9 µg/kg) for PAHs met the specified detection limits set in the sampling and QA/QC plan (Tetra Tech 1993).

Sample results for several compounds were qualified as estimated and undetected based on evaluation of QA/QC data. Internal standard results for several compounds exceeded applicable criteria (Tables 2 and 9) (U.S. EPA 1991a) for both semivolatile organic analyses and PAH analyses. For each of the exceedances, the results for the compound were qualified as estimated for the samples associated with the continuing calibration run on that day. Naphthalene was detected in both method blanks run for the PAH analyses and values for several samples (2-CF, 3-CF, 7-CF, 8-CF, 11-CF, 13-1-CF, 13-2-CF, and 13-2-CF) were qualified as undetected due to blank contamination. Also, 2-methyl naphthalene was detected in one of the method blanks run for the PAH analyses and the values for samples 8-CF and 11-CF were qualified as undetected due to blank contamination.

The precision, accuracy, and completeness of the semivolatile organics and PAH analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Fish Tissue

All sample data were reported by the laboratory in µg/kg wet weight and are presented in Table 16. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported

by the laboratory (96-12000 μg/kg) for semivolatile organics were an order of magnitude higher than those specified in the sampling and QA/QC plan (Tetra Tech 1993). The laboratory was not able to achieve its target detection limits because the fats and lipids present in the tissue samples tied up the active sites in the column and the column's efficiency was greatly reduced (Harris, M., 16 September 1993, personal communication). The detection limits reported by the laboratory (8.5-10 μg/kg) for PAHs met the specified detection limits set in the sampling and QA/QC plan (Tetra Tech 1993).

No data qualifiers, other than U, were added to any of the results for the fish samples.

The precision, accuracy, and completeness of the semivolatile organics and PAH analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

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U.S. Environmental Protection Agency. 1991b. National functional guidelines for organic data review. Multi-media, multi-concentration (OLM01.0) and Low concentration water (OLC01.0). Draft December, 1990, Revised June, 1991. U.S. Environmental Protection Agency/Hazardous Site Evaluation Division, Washington, DC.

TABLE 1. SEMI-VOLATILE ORGANICS ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Analytical Resources, Inc Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Sediment							
1-S	X046A	6/28/93	6/29/93	7/9/93	7/15/93	11	17
2-S	X046B	6/27/93	6/29/93	7/8/93	7/14/93	11	17
3-S	X046C	6/27/93	6/29/93	7/8/93	7/14/93	11	17
4-S	X046D	6/26/93	6/29/93	7/8/93	7/15/93	12	19
5-S	X046E	6/26/93	6/29/93	7/8/93	7/15/93	12	19
6-S	X046F	6/25/93	6/29/93	7/8/93	7/15/93	13	20
7-S	X046G	6/25/93	6/29/93	7/8/93	7/15/93	13	20
8-S	X046H	6/24/93	6/29/93	7/7/93	7/16/93	13	22
9-1-S	X046I	6/29/93	7/2/93	7/8/93	7/15/93	9	16
9-2-S	X046J	6/29/93	7/2/93	7/8/93	7/15/93	9	16
9-3-S	X046K	6/29/93	7/2/93	7/8/93	7/15/93	9	16
10-S	X046L	6/28/93	6/29/93	7/9/93	7/16/93	11	18
11-S	X046M	6/29/93	7/2/93	7/8/93	7/15/93	9	16
12-S	X046N	6/30/93	7/2/93	7/8/93	7/15/93	8	15
13-S	X046O	7/1/93	7/2/93	7/8/93	7/15/93	7	14
14-S	X046P	7/1/93	7/2/93	7/8/93	7/15/93	7	14
15-S	X046Q	6/30/93	7/2/93	7/8/93	7/16/93	8	16
Crayfish							
2-CF	X047J2	7/22/93	7/29/93	8/5/93	8/9/93	14	18
3-CF	X047K2	7/22/93	7/29/93	8/5/93	8/9/93	14	18
3-CF reanalysis	X047K2RE	7/22/93	7/29/93	8/5/93	8/9/93	14	18
4-CF	X047L2	7/24/93	7/29/93	8/5/93	8/9/93	12	16
5-CF	X047M2	7/23/93	7/29/93	8/5/93	8/9/93	13	17
6-CF	X047A	7/16/93	7/23/93	7/28/93	8/2/93	12	17
7-CF	X047B	7/16/93	7/23/93	7/28/93	8/2/93	12	17
8-CF	X047C	7/16/93	7/23/93	7/28/93	8/2/93	12	17
9-CF	X048D	7/16/93	7/23/93	7/28/93	8/2/93	12	17
10-CF reanalysis	X047N2RE	7/20/93	7/29/93	8/5/93	8/10/93	16	21
11-CF	X047E	7/18/93	7/23/93	7/28/93	8/2/93	10	15
12-CF	X047O2	7/20/93	7/29/93	8/5/93	8/9/93	16	20
12-CF reanalysis	X047O2RE	7/20/93	7/29/93	8/5/93	8/10/93	16	21
13-1-CF	X047F	7/18/93	7/23/93	7/28/93	8/2/93	10	15
13-2-CF	X047G	7/18/93	7/23/93	7/28/93	8/3/93	10	16
13-3-CF	X047H	7/18/93	7/23/93	7/28/93	8/3/93	10	16
14-CF	X047I	7/18/93	7/23/93	7/28/93	8/3/93	10	16
Fish							
1-LS	X047P	8/6/93	8/13/93	8/16/93	8/23/93	10	17
1-C	X047Q	8/6/93	8/13/93	8/16/93	8/19/93	10	13
2-LS	X047R	8/6/93	8/13/93	8/16/93	8/24/93	10	18
3-LS	X047S	8/5/93	8/13/93	8/16/93	8/19/93	11	14
4-LS	X047T	8/5/93	8/13/93	8/16/93	8/19/93	11	14
5-LS	X047U	8/5/93	8/13/93	8/16/93	8/24/93	11	19
6-LS	X047V	8/5/93	8/13/93	8/16/93	8/19/93	11	14
6-LS Re	X047V2	8/5/93	8/13/93	8/16/93	8/23/93	11	18
7-LS	X047W	8/5/93	8/13/93	8/16/93	8/19/93	11	14
7-LS Re	X047W2	8/5/93	8/13/93	8/16/93	8/23/93	11	18
8-LS	X047X	8/5/93	8/13/93	8/16/93	8/24/93	11	19
9-LS	X047Y	8/5/93	8/13/93	8/16/93	8/23/93	11	18
10-LS	X047Z	8/4/93	8/13/93	8/16/93	8/23/93	12	19
10-LS dil	X047Zdl	8/4/93	8/13/93	8/16/93	8/24/93	12	20
11-LS	X047AA	8/4/93	8/13/93	8/16/93	8/23/93	12	19
12-LS	X047AB	8/4/93	8/13/93	8/16/93	8/23/93	12	19
13-1-LS	X047AC	8/3/93	8/13/93	8/16/93	8/23/93	13	20
13-2-LS	X047AD	8/3/93	8/13/93	8/16/93	8/24/93	13	21
13-3-LS	X047AE	8/3/93	8/13/93	8/16/93	8/23/93	13	20
14-LS	X047AF	8/3/93	8/13/93	8/16/93	8/24/93	13	21
15-C	X047AG	8/3/93	8/13/93	8/16/93	8/24/93	13	21

TABLE 2. SEMIVOLATILE ORGANIC INTERNAL STANDARD AREAS EXCEEDING QC LIMITS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Internal Standard [1]	Sample Internal Standard Area	QC Limits
3-CF	Perylene-d12	40,406	41,381-165,524
12-CF	Chrysene-d12	48,828	50,240-200,960
	Perylene-d12	30,348	35,615.5-142,462

[1] Target compounds are associated with each internal standard as follows:

Chrysene-d12: Butylbenzyl phthalate, 3,3'-Dichlorobenzidine, bis(2-Ethylhexyl)phthalate

Perylene-d12: Di-n-octyl phthalate

TABLE 3. SEMIVOLATILE ORGANICS MS/MSD RESULTS (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample 13-S
Analyzed 7/15/93

	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Phenol	49.7	62.6	23.0	26-90	35
2-Chlorophenol	50.0	62.6	22.4	25-102	50
1,4-Dichlorobenzene	45.1	55.8	21.2	28-104	27
N-Nitroso-di-n-propylamine	49.3	62.7	23.9	41-126	38
1,2,4-Trichlorobenzene	65.8	57.9	12.8	38-107	23
4-Chloro-3-methylphenol	63.0	72.0	13.3	26-103	33
Acenaphthene	56.3	68.8	20.0	31-137	19
4-Nitrophenol	69.4	97.8	34.0	11-114	50
2,4-Dinitrotoluene	59.4	73	20.5	28-89	47
Pentachlorophenol	12.4	17.9	36.3	17-109	47
Pyrene	55.3	72.0	26.2	35-142	36
Phenanthrene	65.8	106.0	46.8	NA	NA
Chrysene	63.0	87.7	32.8	NA	NA
Benzo(k)fluoranthene	56.3	91.7	47.8	NA	NA

Sample 11-CF
Analyzed 8/3/93

	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Phenol	77.3	82.8	6.9	26-90	35
2-Chlorophenol	80.5	85.0	5.4	25-102	50
1,4-Dichlorobenzene	70.5	74.3	5.2	28-104	27
N-Nitroso-di-n-propylamine	78.0	88.3	12.4	41-126	38
1,2,4-Trichlorobenzene	78.2	82.8	5.7	38-107	23
4-Chloro-3-methylphenol	78.4	82.8	5.5	26-103	33
Acenaphthene	90.5	95.1	5.0	31-137	19
4-Nitrophenol	105.0	110.0	4.7	11-114	50
2,4-Dinitrotoluene	69.9	71.6	2.4	28-89	47
Pentachlorophenol	90.3	96.7	6.8	17-109	47
Pyrene	98.0	108.0	9.7	35-142	36

TABLE 3. SEMIVOLATILE ORGANICS MS/MSD RESULTS (Page 2 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample 10-LS Analyzed 8/23/93					
	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Phenol	71.7	70.6	1.5	26-90	35
2-Chlorophenol	80.2	77.0	4.1	25-102	50
1,4-Dichlorobenzene	69.7	71.3	2.3	28-104	27
N-Nitroso-di-n-propylamine	76.6	76.0	0.8	41-126	38
1,2,4-Trichlorobenzene	82.3	76.2	7.7	38-107	23
4-Chloro-3-methylphenol	81.8	73.3	11.0	26-103	33
Acenaphthene	79.7	103.0	25.5	31-137	19
4-Nitrophenol	70.1	85.0	19.2	11-114	50
2,4-Dinitrotoluene	93.5	94.4	1.0	28-89	47
Pentachlorophenol	97.3	106	8.6	17-109	47
Pyrene	67.1	101.0	40.3	35-142	36

TABLE 4. SEMIVOLATILE ORGANICS BLANK MATRIX SPIKE RESULTS (Page 1 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sediment Spike Blank 1
Analyzed 7/16/93

	SPIKE ADDED (µg/kg)	SB CONC. (µg/kg)	SB % Rec.	QC LIMITS % Rec.
Phenol	625	317	50.7	26-90
2-Chlorophenol	625	341	54.6	25-102
1,4-Dichlorobenzene	417	266	63.8	28-104
N-Nitroso-di-n-propylamine	417	166	39.8	41-126
1,2,4-Trichlorobenzene	417	253	60.7	38-107
4-Chloro-3-methylphenol	625	368	58.9	26-103
Acenaphthene	417	257	61.6	31-137
4-Nitrophenol	625	364	58.2	11-114
2,4-Dinitrotoluene	417	304	72.9	28-89
Pentachlorophenol	625	401	64.2	17-109
Pyrene	417	353	84.7	35-142

Sediment Spike Blank 2
Analyzed 7/16/93

	SPIKE ADDED (µg/kg)	SB CONC. (µg/kg)	SB % Rec.	QC LIMITS % Rec.
Phenol	625	294	47.0	26-90
2-Chlorophenol	625	321	51.4	25-102
1,4-Dichlorobenzene	417	253	60.7	28-104
N-Nitroso-di-n-propylamine	417	172	41.2	41-126
1,2,4-Trichlorobenzene	417	243	58.3	38-107
4-Chloro-3-methylphenol	625	329	52.6	26-103
Acenaphthene	417	252	60.4	31-137
4-Nitrophenol	625	244	39.0	11-114
2,4-Dinitrotoluene	417	302	72.4	28-89
Pentachlorophenol	625	362	57.9	17-109
Pyrene	417	347	83.2	35-142

TABLE 4. SEMIVOLATILE ORGANICS BLANK MATRIX SPIKE RESULTS (Page 2 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Crayfish Tissue Spike Blank 1
Analyzed 8/2/93

	SPIKE ADDED (ug/kg)	SB CONC. (ug/kg)	SB % Rec.	QC LIMITS % Rec.
Phenol	1880	955	50.8	26-90
2-Chlorophenol	1880	1110	59.0	25-102
1,4-Dichlorobenzene	1250	710	56.8	28-104
N-Nitroso-di-n-propylamine	1250	654	52.3	41-126
1,2,4-Trichlorobenzene	1250	734	58.7	38-107
4-Chloro-3-methylphenol	1880	1340	71.3	26-103
Acenapthene	1500	956	63.7	31-137
4-Nitrophenol	1880	1100	58.5	11-114
2,4-Dinitrotoluene	1250	863	69.0	28-89
Pentachlorophenol	1880	697	37.1	17-109
Pyrene	1500	1110	74.0	35-142

Crayfish Tissue Spike Blank 2
Analyzed 8/9/93

	SPIKE ADDED (ug/kg)	SB CONC. (ug/kg)	SB % Rec.	QC LIMITS % Rec.
Phenol	1880	1360	72.3	26-90
2-Chlorophenol	1880	1430	76.1	25-102
1,4-Dichlorobenzene	1250	975	78.0	28-104
N-Nitroso-di-n-propylamine	1250	902	72.2	41-126
1,2,4-Trichlorobenzene	1250	973	77.8	38-107
4-Chloro-3-methylphenol	1880	1450	77.1	26-103
Acenapthene	1500	1040	69.3	31-137
4-Nitrophenol	1880	1560	83.0	11-114
2,4-Dinitrotoluene	1250	966	77.3	28-89
Pentachlorophenol	1880	907	48.2	17-109
Pyrene	1500	1510	100.7	35-142

TABLE 4. SEMIVOLATILE ORGANICS BLANK MATRIX SPIKE RESULTS (Page 3 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Fish Tissue Spike Blank Analyzed 8/19/93				
	SPIKE ADDED (ug/kg)	SB CONC. (ug/kg)	SB % Rec.	QC LIMITS % Rec.
Phenol	1880	933	49.6	26-90
2-Chlorophenol	1880	1029	54.7	25-102
1,4-Dichlorobenzene	1250	678	54.2	28-104
N-Nitroso-di-n-propylamine	1250	612	49.0	41-126
1,2,4-Trichlorobenzene	1250	716	57.3	38-107
4-Chloro-3-methylphenol	1880	1020	54.3	26-103
Acenaphthene	1250	693	55.4	31-137
4-Nitrophenol	1880	950	50.5	11-114
2,4-Dinitrotoluene	1250	685	54.8	28-89
Pentachlorophenol	1880	872	46.4	17-109
Pyrene	1250	910	72.8	35-142

TABLE 5. SEMIVOLATILE ORGANIC COMPOUND REFERENCE MATERIAL RESULTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Compound	Sample SQ-1 (µg/kg)	Reference Concentration (µg/kg)
Phenol	**21 J**	224-356
1,3-Dichlorobenzene	**22 J**	23-41
1,4-Dichlorobenzene	67 U	9-17
1,2-Dichlorobenzene	**16 J**	17-27
4-Methylphenol	**30 J**	220-296
Isophorone	**73**	76-92
Benzoic Acid	330 U	69-337
Naphthalene	**62**	70-88
Hexachlorobutadiene	67 U	0-12
2-Methylnaphthalene	82	78-104
Acenaphthylene	**36**	61-77
Acenaphthene	89	89-105
4-Chlorophenyl-phenylether	**92**	99-119
Fluorene	**90**	96-114
4-Bromophenyl-phenylether	**210**	213-257
Hexachlorobenzene	33 U	1
Pentachlorophenol	**63 J**	291-635
Phenanthrene	170	139-175
Anthracene	**100**	109-133
Fluoranthene	120	113-139
Pyrene	110	110-142
Butylbenzyl phthalate	33 U	0-312
Benzo(a)anthracene	110	102-128
bis(2-Ethylhexyl) phthalate	180 U/B	137-367
Chrysene	110	106-128
Benzo(b, k)fluoranthene	110	99-127
Benzo(a)pyrene	110	104-138
Indeno(1,2,3-cd)pyrene	33 U	6-88
Dibenzo(a,h)anthracene	**75**	89-115
Benzo(g,h,i)perylene	**73**	89-117

Note: Compounds not detected in SQ-1 and for which no reference concentration exists are not listed

Values in bold are outside the 95% confidence interval calculated for the reference material

Data qualifiers: U = Compound undetected at given method detection limit.
B = Blank contaminated
J = Compound detected below specified detection limit.

TABLE 6. LABORATORY DUPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Compound	Sample 13-S Matrix Spike (µg/kg)	Sample 13-S Matrix Spike Duplicate (µg/kg)	RPD
4-Methylphenol	140	190	30.3
Benzoic Acid	75 E	65 E	14.3
Fluoranthene	19	33	53.8
bis(2-Ethylhexyl)phthalate	56	100	56.4

Data Qualifiers: E = Estimated value

TABLE 7. SEMIVOLATILE ORGANIC COMPOUND FIELD REPLICATE RESULTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Compound	Sample 9-1-S (µg/kg)	Sample 9-2-S (µg/kg)	Sample 9-3-S (µg/kg)	RSD
Benzoic acid	66 J	38 J	48 J	27.29
Phenanthrene	24	37	30	21.33
Fluoranthene	45	50	58	13.81
Pyrene	35	34	45	17.63
Benzo(a)anthracene	13 J	28	17	37.89
bis(2-Ethylhexyl) phthalate	49	15 U	15 U	--
Chrysene	20	51	25	46.88
Benzo(b)fluoranthene	*	*	*	*
Benzo(k)fluoranthene	26	38	31	18.84
Benzo(a)pyrene	12 J	17	13 J	18.25

* Compound cannot be reliably distinguished from benzo(k)fluoranthene

Data qualifiers: U = Compound undetected. Value given in method detection limit.
E = Estimated value based on QA/QC data evaluation
J = Compound detected below specified detection limit.

TABLE 8. POLYNUCLEAR AROMATIC HYDROCARBON ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Analytical Resources, Inc Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Sediment							
1-S	X046A	6/28/93	6/29/93	7/9/93	7/16/93	11	18
2-S	X046B	6/27/93	6/29/93	7/8/93	7/16/93	11	19
3-S	X046C	6/27/93	6/29/93	7/8/93	7/16/93	11	19
4-S	X046D	6/26/93	6/29/93	7/8/93	7/16/93	12	20
5-S	X046E	6/26/93	6/29/93	7/8/93	7/16/93	12	20
6-S	X046F	6/25/93	6/29/93	7/8/93	7/16/93	13	21
7-S	X046G	6/25/93	6/29/93	7/8/93	7/16/93	13	21
8-S	X046H	6/24/93	6/29/93	7/7/93	7/16/93	13	22
9-1-S	X046I	6/29/93	7/2/93	7/8/93	7/16/93	9	17
9-2-S	X046J	6/29/93	7/2/93	7/8/93	7/16/93	9	17
9-3-S	X046K	6/29/93	7/2/93	7/8/93	7/17/93	9	18
10-S	X046L	6/28/93	6/29/93	7/9/93	7/17/93	11	19
11-S	X046M	6/29/93	7/2/93	7/8/93	7/17/93	9	18
12-S	X046N	6/30/93	7/2/93	7/8/93	7/17/93	8	17
13-S	X046O	7/1/93	7/2/93	7/8/93	7/17/93	7	16
14-S	X046P	7/1/93	7/2/93	7/8/93	7/17/93	7	16
15-S	X046Q	6/30/93	7/2/93	7/8/93	7/17/93	8	17
Crayfish							
2-CF	X047JDL	7/22/93	7/29/93	8/5/93	8/11/93	14	20
3-CF	X047KDL	7/22/93	7/29/93	8/5/93	8/11/93	14	20
4-CF	X047LDL	7/24/93	7/29/93	8/5/93	8/11/93	12	18
5-CF	X047MDL	7/23/93	7/29/93	8/5/93	8/11/93	13	19
6-CF	X047DL	7/16/93	7/23/93	7/28/93	8/10/93	12	25
7-CF	X047BDL	7/16/93	7/23/93	7/28/93	8/10/93	12	25
8-CF	X047CDL	7/16/93	7/23/93	7/28/93	8/10/93	12	25
9-CF	X048DDL	7/16/93	7/23/93	7/28/93	8/10/93	12	25
10-CF	X047NDL	7/20/93	7/29/93	8/5/93	8/11/93	16	22
11-CF	X047EDL	7/18/93	7/23/93	7/28/93	8/10/93	10	23
12-CF	X047ODL	7/20/93	7/29/93	8/5/93	8/11/93	16	22
13-1-CF	X047FDL	7/18/93	7/23/93	7/28/93	8/10/93	10	23
13-2-CF	X047GDL	7/18/93	7/23/93	7/28/93	8/10/93	10	23
13-3-CF	X047HDL	7/18/93	7/23/93	7/28/93	8/10/93	10	23
14-CF	X047IDLR	7/18/93	7/23/93	7/28/93	8/10/93	10	23
Fish							
1-LS	X047P	8/6/93	8/13/93	8/16/93	9/9/93	10	34
1-C	X047Q	8/6/93	8/13/93	8/16/93	9/9/93	10	34
2-LS	X047R	8/6/93	8/13/93	8/16/93	9/9/93	10	34
3-LS	X047S	8/5/93	8/13/93	8/16/93	9/9/93	11	35
4-LS	X047T	8/5/93	8/13/93	8/16/93	9/9/93	11	35
5-LS	X047U	8/5/93	8/13/93	8/16/93	9/9/93	11	35
6-LS	X047V	8/5/93	8/13/93	8/16/93	9/9/93	11	35
7-LS	X047W	8/5/93	8/13/93	8/16/93	9/9/93	11	35
8-LS	X047X	8/5/93	8/13/93	8/16/93	9/10/93	11	36
9-LS	X047Y	8/5/93	8/13/93	8/16/93	9/9/93	11	35
10-LS	X047Z	8/4/93	8/13/93	8/16/93	9/8/93	12	35
11-LS	X047AA	8/4/93	8/13/93	8/16/93	9/9/93	12	36
12-LS	X047AB	8/4/93	8/13/93	8/16/93	9/9/93	12	36
13-1-LS	X047AC	8/3/93	8/13/93	8/16/93	9/9/93	13	37
13-2-LS	X047AD	8/3/93	8/13/93	8/16/93	9/9/93	13	37
13-3-LS	X047AE	8/3/93	8/13/93	8/16/93	9/9/93	13	37
14-LS	X047AF	8/3/93	8/13/93	8/16/93	9/9/93	13	37
15-C	X047AG	8/3/93	8/13/93	8/16/93	9/9/93	13	37

TABLE 9. POLYNUCLEAR AROMATIC HYDROCARBON INTERNAL STANDARD AREAS EXCEEDING QC LIMITS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample Number	Date Analyzed	Internal Standard[1]	Sample Internal Standard Area	QC Guidelines
8-CF	8/10/93	d10-Acenaphthalene	686,006	83,752-670,016
13-2-CF	8/10/93	d10-Acenaphthalene	688,334	83,752-670,016
MSD	8/10/93	d10-Acenaphthalene	738,128	83,752-670,016

[1] Target compounds are associated with each internal standard as follows:

d10-Acenaphthalene: Acenaphthylene, Acenaphthene, Dibenzofuran, Fluorene

TABLE 10. POLYNUCLEAR AROMATIC HYDROCARBONS
MATRIX SPIKE/MATRIX SPIKE DUPLICATE RESULTS (Page 1 of 2)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Sample 13-S
Analyzed 7/17/93

	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Phenanthrene	51.3	75.8	38.6	*	**
Chrysene	49.1	48.0	2.3	*	**
Benzo(k)fluoranthene	70.4	87.6	21.8	*	**

Sample 11-CF
Analyzed 8/10/93

	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Naphthalene	63.4	63.2	0.3	*	**
2-Methylnaphthalene	62.3	56.0	10.7	*	**
Acenaphthylene	66.6	74.2	10.8	*	**
Acenaphthene	61.3	65.3	6.3	31-137	19
Dibenzofuran	76.2	80.6	5.6	*	**
Fluorene	85.9	84.8	1.3	*	**
Phenanthrene	68.4	73.0	6.5	*	**
Anthracene	76.6	83.3	8.4	*	**
Fluoranthene	170	198.0	15.2	*	**
Pyrene	69.9	61.8	12.3	35-142	36
Benzo(a)anthracene	97.8	100.0	2.2	*	**
Chrysene	70.9	70.2	1.0	*	**
Benzo(b)fluoranthene	101.0	113.0	11.2	*	**
Benzo(k)fluoranthene	76.5	66.3	14.3	*	**
Benzo(a)pyrene	89.9	87.3	2.9	*	**
Indeno(1,2,3-cd)pyrene	102.0	84.1	19.2	*	**
Dibenzo(a, h)anthracene	113.0	93.2	19.2	*	**
Benzo(ghi)perylene	60.5	50.0	19.0	*	**

TABLE 10. POLYNUCLEAR AROMATIC HYDROCARBONS MATRIX SPIKE/MATRIX SPIKE DUPLICATE RESULTS (Page 2 of 2) LOWER COLUMBIA RIVER RECONNAISSANCE SURVEY

Sample 10-LS Analyzed 9/8/93					
	Percent Recovery			QC LIMITS	
	MS	MSD	RPD	% Rec.	RPD
Acenapthene	40.3	38.2	5.4	31-137	19
Phenanthrene	54.5	49.6	9.4	*	**
Pyrene	50.8	46.4	9.1	17-109	47
Chrysene	42.9	40.0	7.0	*	**
Benzo(k)fluoranthene	41.7	45.1	7.8	*	**

* The QC limits for percent received have not been established.

** The QC limits for relative percent difference have not been established.

TABLE 11. POLYNUCLEAR AROMATIC HYDROCARBON BLANK MATRIX SPIKE RESULTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Fish Tissue Spike Blank Analyzed 8/23/93				
	SPIKE ADDED (µg/kg)	SB CONC. (µg/kg)	SB % Rec.	QC LIMITS % Rec.
Acenaphthene	1250	719	57.5	31-137
Phenanthrene	150	116	77.3	*
Pyrene	1250	640	51.2	35-142
Chrysene	150	100	66.7	*
Benzo(k)fluoranthene	150	125	83.3	*

* No QC limits established.

TABLE 12. LABORATORY DUPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Compound	Sample 13-S Matrix Spike (µg/kg)	Sample 13-S Matrix Spike Duplicate (µg/kg)	RPD
Naphthalene	3.1	4.0	25.4
Acenaphthylene	0.9	1.2	28.6
Dibenzofuran	1.3	2.2	51.4
Fluorene	1.9	2.8	38.3
Anthracene	2.1	3.3	44.4
Fluoranthene	14.0	22.0	44.4
Benzo(a)anthracene	8.0	9.1	12.9
Benzo(b)fluoranthene	11.0	16.0	37.0
Benzo(a)pyrene	7.0	12.0	52.6
Indeno(1,2,3-cd)pyrene	4.5 B	6.9 B	42.1
Dibenzo(a,h)anthracene	1.9	2.3	19.0
Benzo(ghi)perylene	4.0 B	6.4 B	46.2

Compound	Sample 10-LS Matrix Spike (µg/kg)	Sample 10-LS Matrix Spike Duplicate (µg/kg)	RPD
Naphthalene	13	14	7.4
2-Methylnaphthalene	22	17	25.6

Data Qualifiers: B = Estimated due to blank contamination

TABLE 13. POLYNUCLEAR AROMATIC HYDROCARBON FIELD REPLICATE RESULTS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Compound	Sample 9-1-S (µg/kg)	Sample 9-2-S (µg/kg)	Sample 9-3-S (µg/kg)	RSD
Naphthalene	2.5	2.5	2.6	2.31
2-Methylnaphthalene	1.7	1.9	2	8.49
Acenaphthylene	1.2	1.5	1.5	12.83
Acenaphthene	3.4	4.3	3.3	14.31
Dibenzofuran	4.3	4.7	4.2	5.88
Fluorene	6	8.1	6.1	16.80
Phenanthrene	22	31	27	17.02
Anthracene	4.9	7.9	3.5	35.12
Fluoranthene	43	37	45	10.41
Pyrene	90	95	120	17.38
Benzo(a)anthracene	20	44	21	42.43
Chrysene	40	100	47	46.87
Benzo(b)fluoranthene	*	*	*	*
Benzo(k)fluoranthene	22	33	26	20.25
Benzo(a)pyrene	8.6	15	10	28.51
Indeno(1,2,3-cd)pyrene	4.8 U/B	7.1 U/B	5.3 U/B	**
Dibenzo(a,h)anthracene	2.1 M	3.3 M	2.2 M	24.66
Benzo(ghi)perylene	4.4 U/B	6.1 U/B	4.6 U/B	**

Compound	Sample 13-1-LS (µg/kg)	Sample 13-2-LS (µg/kg)	Sample 13-3-LS (µg/kg)	RSD
Naphthalene	9.6 U	8.5 U	6.6 J	**
2-Methylnaphthalene	9.6 U	8.5 U	10	**

* Compound cannot be reliably distinguished from benzo(k)fluoranthene

** Cannot be calculated.

Data qualifiers: U = Compound undetected. Value given in method detection limit.
E = Estimated value based on QA/QC data evaluation
J = Compound detected below specified detection limit.
M = Estimated value with low spectral match parameters
B = Blank contaminated

TABLE 14. SEMI-VOLATILE ORGANIC COMPOUNDS IN SEDIMENT (µg/kg dry)(Page 1 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Phenols

	Phenol	2-Methylphenol	4-Methylphenol	2,4-Dimethylphenol	Pentachlorophenol	2-Chlorophenol	2,4-Dichlorophenol	4-Chloro-3-methylphenol	2,4-Dinitrophenol	2-Nitrophenol	4-Nitrophenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	4, 6-Dinitro-2-methylphenol
1-S	37 U	18 U	18 U	37 U	92 U	18 U	37 U	37 U	180 U	92 U	92 U	92 U	92 U	180 U
2-S	30 U	15 U	15 U	30 U	75 U	15 U	30 U	30 U	150 U	75 U	75 U	75 U	75 U	150 U
3-S	31 U	16 U	16 U	31 U	78 U	16 U	31 U	31 U	160 U	78 U	78 U	78 U	78 U	160 U
4-S	30 U	15 U	15 U	30 U	74 U	15 U	30 U	30 U	150 U	74 U	74 U	74 U	74 U	150 U
5-S	32 U	16 U	16 U	32 U	81 U	16 U	32 U	32 U	160 U	81 U	81 U	81 U	81 U	160 U
6-S	33 U	16 U	16 U	33 U	81 U	16 U	33 U	33 U	160 U	81 U	81 U	81 U	81 U	160 U
7-S	26 U	13 U	13 U	26 U	64 U	13 U	26 U	26 U	120 U	64 U	64 U	64 U	64 U	120 U
8-S	33 U	17 U	17 U	33 U	83 U	17 U	33 U	33 U	170 U	83 U	83 U	83 U	83 U	170 U
9-1-S	31 U	15 U	15 U	31 U	77 U	15 U	31 U	31 U	150 U	77 U	77 U	77 U	77 U	150 U
9-2-S	30 U	15 U	15 U	30 U	75 U	15 U	30 U	30 U	150 U	75 U	75 U	75 U	75 U	150 U
9-3-S	30 U	15 U	15 U	30 U	74 U	15 U	30 U	30 U	150 U	74 U	74 U	74 U	74 U	150 U
10-S	40 U	20 U	20 U	40 U	100 U	20 U	40 U	40 U	200 U	100 U	100 U	100 U	100 U	200 U
11-S	25 U	13 U	13 U	25 U	63 U	13 U	25 U	25 U	130 U	63 U	63 U	63 U	63 U	130 U
12-S	36 U	18 U	18 U	36 U	89 U	18 U	36 U	36 U	180 U	89 U	89 U	89 U	89 U	180 U
13-S	33 U	16 U	150	33 U	82 U	16 U	33 U	33 U	160 U	82 U	82 U	82 U	82 U	160 U
14-S	33 U	17 U	17 U	33 U	83 U	17 U	33 U	33 U	170 U	83 U	83 U	83 U	83 U	170 U
15-S	26 U	13 U	13 U	26 U	70 U	13 U	26 U	26 U	130 U	70 U	70 U	70 U	70 U	130 U

Halogenated Ethers

	bis(2-Chloroethyl)ether	bis(2-Chloroethoxy)methane	4-Bromophenyl-phenylether	4-Chlorophenyl-phenylether	2,2'-Oxybis(1-chloropropane)
1-S	18 U	18 U	18 U	18 U	18 U
2-S	15 U	15 U	15 U	15 U	15 U
3-S	16 U	16 U	16 U	16 U	16 U
4-S	15 U	15 U	15 U	15 U	15 U
5-S	16 U	16 U	16 U	16 U	16 U
6-S	16 U	16 U	16 U	16 U	16 U
7-S	13 U	13 U	13 U	13 U	13 U
8-S	17 U	17 U	17 U	17 U	17 U
9-1-S	15 U	15 U	15 U	15 U	15 U
9-2-S	15 U	15 U	15 U	15 U	15 U
9-3-S	15 U	15 U	15 U	15 U	15 U
10-S	20 U	20 U	20 U	20 U	20 U
11-S	13 U	13 U	13 U	13 U	13 U
12-S	18 U	18 U	18 U	18 U	18 U
13-S	16 U	16 U	16 U	16 U	16 U
14-S	17 U	17 U	17 U	17 U	17 U
15-S	13 U	13 U	13 U	13 U	13 U

Data Qualifier:
U = Undetected value

Nitroaromatics

	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Nitrobenzene	2-Nitroaniline	3-Nitroaniline	4-Nitroaniline
1-S	92 U	92 U	18 U	92 U	92 U	92 U
2-S	75 U	75 U	15 U	75 U	75 U	75 U
3-S	78 U	78 U	16 U	78 U	78 U	78 U
4-S	74 U	74 U	15 U	74 U	74 U	74 U
5-S	81 U	81 U	16 U	81 U	81 U	81 U
6-S	81 U	81 U	16 U	81 U	81 U	81 U
7-S	64 U	64 U	13 U	64 U	64 U	64 U
8-S	83 U	83 U	17 U	83 U	83 U	83 U
9-1-S	77 U	77 U	15 U	77 U	77 U	77 U
9-2-S	75 U	75 U	15 U	75 U	75 U	75 U
9-3-S	74 U	74 U	15 U	74 U	74 U	74 U
10-S	100 U	100 U	20 U	100 U	100 U	100 U
11-S	63 U	63 U	13 U	63 U	63 U	63 U
12-S	89 U	89 U	18 U	89 U	89 U	89 U
13-S	82 U	82 U	16 U	82 U	82 U	82 U
14-S	83 U	83 U	17 U	83 U	83 U	83 U
15-S	70 U	70 U	13 U	70 U	70 U	70 U

TABLE 14. SEMI-VOLATILE ORGANIC COMPOUNDS IN SEDIMENT (µg/kg dry)(Page 2 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Polynuclear Aromatic Hydrocarbons

	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(b,k)fluoranthene	Benzo(a)pyrene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene
1-S	2.2	2.2	4.9	20	50	26	18	29	4.9	47	2.7	33
2-S	0.78 J	0.72 J	1.9	5.6	16	8.8	7.4 U/B	9.1	1.7 J	13	0.78	9.0
3-S	1.2	0.67 J	1.2	8.7	21	11	8.4	13	2.7 J	16	0.74 J	8.1
4-S	1.6	1.1	1.9	13	32	16	11	19	3.1 J	24	1.5	22
5-S	1.8	1.3	2.6	16	38	19	13	24	3.7	28	2.2	27
6-S	0.67 J	0.26 J	0.46 J	3.6 J	13	4.2	3.8 U/B	8.1	1.6 J	8.1	0.85	15
7-S	1.3	1.7	3.2	12	29	12	6.7 U/B	22	2.5	30	1.8	13
8-S	2.7	3.3	5.6	23	44	19	15	39	3.7	66	4.7	14
9-1-S	3.4	1.2	4.9	20	22	8.6	4.4 U/B	40	2.1 J	43	6	4.8 U/B
9-2-S	4.3	1.5	7.9	44	33	15	6.1 U/B	100	3.3 J	37	8.1	7.1 U/B
9-3-S	3.3	1.5	3.5	21	26	10	4.6 U/B	47	2.2 J	45	6.1	5.3 U/B
10-S	4.1	5.4	12	40	110	61	40	55	8.5	76	5.9	41
11-S	1.3	1	2.3	9.1	20	8.8	5 U/B	15	1.8 J	16	1.5	5.5 U/B
12-S	1.7	2.5	3.1	20	52	29	21	28	4.8	38	3	20
13-S	1.7	0.67 J	2.1	9	21	9.3	6 U/B	13	2.8	15	2.2	6.8 U/B
14-S	3	0.38 J	2.7	37	83	35	22	50	9.7 J	39	2.5	24
15-S	0.72	0.65 U	1.2	5.3	12	4.8	3.3 U/B	6.5	1.5	8.5	0.86	4.5 U/B

Naphthalenes

	Naphthalene	Phenanthrene	Pyrene	2-Methylnaphthalene	Dibenzofuran	2-Chloronaphthalene
1-S	3.9	16	46	2.2	1.9	18 U
2-S	1.3	5.6	14	0.95	0.45 J	15 U
3-S	1.3	6.7	13	0.7	0.39 J	16 U
4-S	1.9	10	20	1.1	0.81	15 U
5-S	2.8	14	25	1.6	1.3	16 U
6-S	1.5	6.6	7	1.3	0.72 J	16 U
7-S	3.6	14	24	1.5	1.1	13 U
8-S	9.7	26	67	3.2	3.7	17 U
9-1-S	2.5	22	90	1.7	4.3	15 U
9-2-S	2.5	31	95	1.9	4.7	15 U
9-3-S	2.6	27	120	2.0	4.2	15 U
10-S	9.8	34	93	4.2	4.9	20 U
11-S	2.2	8.8	18	1.2	0.86	13 U
12-S	4.9	17	43	2.7	1.5	18 U
13-S	3.1	12	18	2.2	1.7	16 U
14-S	2.2	19	47	1.9	1.5	17 U
15-S	1.0	6.8	8.7	0.76	0.62 J	13 U

Data Qualifiers:
U = Undetected value
B = Blank contaminated
J = estimated value because the value is less than the detection limit

TABLE 14. SEMI-VOLATILE ORGANIC COMPOUNDS IN SEDIMENT (µg/kg dry)(Page 3 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Chlorinated Benzenes

	1,3-Dichlorobenzene	1,2-Dichlorobenzene	1,4-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	Hexachlorobutadiene	Hexachloroethane	Hexachlorocyclopentadiene
1-S	18 U	18 U	37 U	18 U	18 U	37 U	92 U	92 U
2-S	15 U	15 U	30 U	15 U	15 U	30 U	75 U	75 U
3-S	16 U	16 U	31 U	16 U	16 U	31 U	78 U	78 U
4-S	15 U	15 U	30 U	15 U	15 U	30 U	74 U	74 U
5-S	16 U	16 U	32 U	16 U	16 U	32 U	81 U	81 U
6-S	16 U	16 U	33 U	16 U	16 U	33 U	81 U	81 U
7-S	13 U	13 U	26 U	13 U	13 U	26 U	64 U	64 U
8-S	17 U	17 U	33 U	17 U	17 U	33 U	83 U	83 U
9-1-S	15 U	15 U	31 U	15 U	15 U	31 U	77 U	77 U
9-2-S	15 U	15 U	30 U	15 U	15 U	30 U	75 U	75 U
9-3-S	15 U	15 U	30 U	15 U	15 U	30 U	74 U	74 U
10-S	20 U	20 U	40 U	20 U	20 U	40 U	100 U	100 U
11-S	13 U	13 U	25 U	13 U	13 U	25 U	63 U	63 U
12-S	18 U	18 U	36 U	18 U	18 U	36 U	89 U	89 U
13-S	16 U	16 U	33 U	16 U	16 U	33 U	82 U	82 U
14-S	17 U	17 U	33 U	17 U	17 U	33 U	83 U	83 U
15-S	13 U	13 U	26 U	13 U	13 U	26 U	70 U	70 U

Data Qualifiers:
U = undetected value
B = blank contaminated
J = estimated value because the value is less than the detection limit

Benzidines

	3,3'-Dichlorobenzidine
1-S	92 U
2-S	75 U
3-S	78 U
4-S	74 U
5-S	81 U
6-S	81 U
7-S	64 U
8-S	83 U
9-1-S	77 U
9-2-S	75 U
9-3-S	74 U
10-S	100 U
11-S	63 U
12-S	89 U
13-S	82 U
14-S	83 U
15-S	70 U

Phthalate Esters

	Dimethyl phthalate	Diethyl phthalate	Di-n-butyl phthalate	Benzyl butyl phthalate	bis(2-Ethylhexyl)phthalate	Di-n-octyl phthalate
1-S	18 U	18 U	18 U	18 U	**24**	18 U
2-S	15 U	15 U	15 U	15 U	**13 J**	15 U
3-S	16 U	16 U	16 U	16 U	**13 J**	16 U
4-S	15 U	15 U	15 U	15 U	**25**	15 U
5-S	16 U	16 U	16 U	16 U	**40**	16 U
6-S	16 U	16 U	16 U	16 U	**18**	16 U
7-S	13 U	13 U	13 U	13 U	**17**	13 U
8-S	17 U	17 U	17 U	17 U	25 U/B	17 U
9-1-S	15 U	15 U	15 U	15 U	**49**	15 U
9-2-S	15 U	15 U	15 U	15 U	15 U	15 U
9-3-S	15 U	15 U	15 U	15 U	15 U	15 U
10-S	20 U	20 U	20 U	20 U	**51**	20 U
11-S	13 U	13 U	13 U	13 U	**18**	13 U
12-S	18 U	18 U	18 U	18 U	**18**	18 U
13-S	16 U	16 U	16 U	16 U	**50**	16 U
14-S	17 U	17 U	17 U	17 U	**26**	17 U
15-S	13 U	13 U	13 U	13 U	11 U	13 U

Miscellaneous

	Carbazole	Benzyl Alcohol	Benzoic Acid	Isophorone	4-Chloroaniline
1-S	18 U	92 U	**55 J**	18 U	55 U
2-S	15 U	75 U	**40 J**	15 U	45 U
3-S	16 U	78 U	160 U	16 U	47 U
4-S	15 U	74 U	**45 J**	15 U	44 U
5-S	16 U	81 U	**37 J**	16 U	48 U
6-S	16 U	81 U	**43 J**	16 U	49 U
7-S	13 U	64 U	**32 J**	13 U	39 U
8-S	17 U	83 U	**49 J**	17 U	50 U
9-1-S	15 U	77 U	**66 J**	15 U	46 U
9-2-S	15 U	75 U	**38 J.**	15 U	45 U
9-3-S	15 U	74 U	**48 J**	15 U	44 U
10-S	20 U	100 U	**68 J**	20 U	60 U
11-S	13 U	63 U	**32 J**	13 U	38 U
12-S	18 U	89 U	**38 J**	18 U	54 U
13-S	16 U	82 U	**42 J**	16 U	49 U
14-S	17 U	83 U	**63 J**	17 U	50 U
15-S	13 U	70 U	**20 J**	13 U	39 U

TABLE 15. SEMI-VOLATILE ORGANIC COMPOUNDS IN CRAYFISH (µg/kg wet)(Page 1 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Phenols

	Phenol	2-Methylphenol	4-Methylphenol	2,4-Dimethylphenol	Pentachlorophenol	2-Chlorophenol	2,4-Dichlorophenol	4-Chloro-3-methylphenol	2,4-Dinitrophenol	2-Nitrophenol	4-Nitrophenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	4, 6-Dinitro-2-methylphenol
2-CF	94 U	94 U	94 U	94 U	470 U	94 U	280 U	190 U	470 U	470 U	470 U	470 U	470 U	940 U
3-CF	94 U	94 U	94 U	94 U	470 U	94 U	280 U	190 U	470 U	470 U	470 U	470 U	470 U	940 U
4-CF	94 U	94 U	94 U	94 U	470 U	94 U	280 U	190 U	470 U	470 U	470 U	470 U	470 U	940 U
5-CF	**530**	94 U	94 U	94 U	470 U	94 U	280 U	190 U	470 U	470 U	470 U	470 U	470 U	940 U
6-CF	**690**	96 U	96 U	96 U	480 U	96 U	290 U	190 U	480 U	480 U	480 U	480 U	480 U	960 U
7-CF	**240**	99 U	99 U	99 U	500 U	99 U	300 U	200 U	500 U	500 U	500 U	500 U	500 U	990 U
8-CF	99 U	99 U	99 U	99 U	500 U	99 U	300 U	200 U	500 U	500 U	500 U	500 U	500 U	990 U
9-CF	**130**	96 U	**56 J/M**	96 U	480 U	96 U	290 U	190 U	480 U	480 U	480 U	480 U	480 U	960 U
10-CF	**100**	93 U	93 U	93 U	460 U	93 U	280 U	190 U	460 U	460 U	460 U	460 U	460 U	930 U
11-CF	98 U	98 U	98 U	98 U	490 U	98 U	290 U	200 U	490 U	490 U	490 U	490 U	490 U	980 U
12-CF	95 U	95 U	95 U	95 U	470 U	95 U	280 U	190 U	470 U	470 U	470 U	470 U	470 U	950 U
13-1-CF	99 U	99 U	99 U	99 U	490 U	99 U	300 U	200 U	490 U	490 U	490 U	490 U	490 U	990 U
13-2-CF	98 U	98 U	98 U	98 U	490 U	98 U	290 U	200 U	490 U	490 U	490 U	490 U	490 U	980 U
13-3-CF	98 U	98 U	98 U	98 U	490 U	98 U	290 U	200 U	490 U	490 U	490 U	490 U	490 U	980 U
14-CF	99 U	99 U	99 U	99 U	500 U	99 U	300 U	200 U	500 U	500 U	500 U	500 U	500 U	990 U

Halogenated Ethers

	bis(2-Chloroethyl)ether	bis(2-Chloroethoxy)methane	4-Bromophenyl-phenylether	4-Chlorophenyl-phenylether	2,2'-Oxybis(1-chloropropane)
2-CF	94 U	94 U	94 U	94 U	94 U
3-CF	94 U	94 U	94 U	94 U	94 U
4-CF	94 U	94 U	94 U	94 U	94 U
5-CF	94 U	94 U	94 U	94 U	94 U
6-CF	96 U	96 U	96 U	96 U	96 U
7-CF	99 U	99 U	99 U	99 U	99 U
8-CF	99 U	99 U	99 U	99 U	99 U
9-CF	96 U	96 U	96 U	96 U	96 U
10-CF	93 U	93 U	93 U	93 U	93 U
11-CF	98 U	98 U	98 U	98 U	98 U
12-CF	95 U	95 U	95 U	95 U	95 U
13-1-CF	99 U	99 U	99 U	99 U	99 U
13-2-CF	98 U	98 U	98 U	98 U	98 U
13-3-CF	98 U	98 U	98 U	98 U	98 U
14-CF	99 U	99 U	99 U	99 U	99 U

Data Qualifiers:
U = Undetected value
J = Value detected below specified detection limit
M = Value detected with low spectral match parameters

Nitroaromatics

	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Nitrobenzene	2-Nitroaniline	3-Nitroaniline	4-Nitroaniline
2-CF	470 U	470 U	94 U	470 U	470 U	470 U
3-CF	470 U	470 U	94 U	470 U	470 U	470 U
4-CF	470 U	470 U	94 U	470 U	470 U	470 U
5-CF	470 U	470 U	94 U	470 U	470 U	470 U
6-CF	480 U	480 U	96 U	480 U	480 U	480 U
7-CF	500 U	500 U	99 U	500 U	500 U	500 U
8-CF	500 U	500 U	99 U	500 U	500 U	500 U
9-CF	480 U	480 U	96 U	480 U	480 U	480 U
10-CF	460 U	460 U	93 U	460 U	460 U	460 U
11-CF	490 U	490 U	98 U	490 U	490 U	490 U
12-CF	470 U	470 U	95 U	470 U	470 U	470 U
13-1-CF	490 U	490 U	99 U	490 U	490 U	490 U
13-2-CF	490 U	490 U	98 U	490 U	490 U	490 U
13-3-CF	490 U	490 U	98 U	490 U	490 U	490 U
14-CF	500 U	500 U	99 U	500 U	500 U	500 U

TABLE 15. SEMI-VOLATILE ORGANIC COMPOUNDS IN CRAYFISH (µg/kg wet)(Page 2 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Polynuclear Aromatic Hydrocarbons

	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(b,k)fluoranthene	Benzo(a)pyrene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene
2-CF	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U
3-CF	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	11.0 U	9.4 U	9.4 U
4-CF	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U
5-CF	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U	9.4 U
6-CF	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U
7-CF	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
8-CF	**7.3 E**	9.9 U/E	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	**5.3 E**	9.9 U
9-CF	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U
10-CF	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U	9.3 U
11-CF	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
12-CF	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U	9.5 U
13-1-CF	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
13-2-CF	9.8 U/E	9.8 U/E	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	10.0 U	9.8 U/E	9.8 U
13-3-CF	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
14-CF	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U

	Naphthalene	Phenanthrene	Pyrene	2-Methylnaphthalene	Dibenzofuran
2-CF	4.7 U/B	9.4 U	9.4 U	**5.5 M**	9.4 U
3-CF	7.5 U/B	9.4 U	9.4 U	**7.4 M**	9.4 U
4-CF	**15.0**	9.4 U	9.4 U	**14.0**	9.4 U
5-CF	**17.0**	9.4 U	9.4 U	**20.0**	9.4 U
6-CF	**13.0**	9.6 U	9.6 U	**12.0**	9.6 U
7-CF	6.9 U/B	9.9 U	9.9 U	**7.7**	9.9 U
8-CF	6.4 U/B	**7.7 J**	9.9 U	5.6 U/B	**3.6 E**
9-CF	**57.0**	9.6 U	9.6 U	**16.0**	9.6 U
10-CF	**12.0**	9.3 U	9.3 U	**14.0**	9.3 U
11-CF	4.4 U/B	9.8 U	9.8 U	5.7 U/B	9.8 U
12-CF	**9.5**	9.5 U	9.5 U	**5.3 M**	9.5 U
13-1-CF	9.9 U/B	9.9 U	9.9 U	**9.9**	9.9 U
13-2-CF	9.8 U/B	9.8 U	9.8 U	**9.8**	9.8 U/E
13-3-CF	9.8 U/B	9.8 U	9.8 U	**9.8**	9.8 U
14-CF	**20.0**	9.9 U	9.9 U	**17.0**	9.9 U

Data Qualifiers:
U = Undetected value
B = Blank contaminated
J = Value detected below specified detection limit
M = Value detected with low spectral match parameters
E = Estimated value

Naphthalenes

	2-Chloronaphthalene
2-CF	94 U
3-CF	94 U
4-CF	94 U
5-CF	94 U
6-CF	96 U
7-CF	99 U
8-CF	99 U
9-CF	96 U
10-CF	93 U
11-CF	98 U
12-CF	95 U
13-1-CF	99 U
13-2-CF	98 U
13-3-CF	98 U
14-CF	99 U

TABLE 15. SEMI-VOLATILE ORGANIC COMPOUNDS IN CRAYFISH (µg/kg wet)(Page 3 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Chlorinated Benzenes

	1,3-Dichlorobenzene	1,2-Dichlorobenzene	1,4-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	Hexachlorobutadiene	Hexachloroethane	Hexachlorocyclopentadiene
2-CF	94 U	94 U	94 U	94 U	94 U	94 U	94 U	470 U
3-CF	94 U	94 U	94 U	94 U	94 U	94 U	94 U	470 U
4-CF	94 U	94 U	94 U	94 U	94 U	94 U	94 U	470 U
5-CF	94 U	94 U	94 U	94 U	94 U	94 U	94 U	470 U
6-CF	96 U	96 U	96 U	96 U	96 U	96 U	96 U	480 U
7-CF	99 U	99 U	99 U	99 U	99 U	99 U	99 U	500 U
8-CF	99 U	99 U	99 U	99 U	99 U	99 U	99 U	500 U
9-CF	96 U	96 U	96 U	96 U	96 U	96 U	96 U	480 U
10-CF	93 U	93 U	93 U	93 U	93 U	93 U	93 U	460 U
11-CF	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
12-CF	95 U	95 U	95 U	95 U	95 U	95 U	95 U	470 U
13-1-CF	99 U	99 U	99 U	99 U	99 U	99 U	99 U	490 U
13-2-CF	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
13-3-CF	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
14-CF	99 U	99 U	99 U	99 U	99 U	99 U	99 U	500 U

Data Qualifiers:
U = undetected value
E = estimated value
J = estimated value because the value is less than the detection limit
M = Value detected with low spectral match parameters

Benzidines

	3,3'-Dichlorobenzidine
2-CF	470 U
3-CF	470 U
4-CF	470 U
5-CF	470 U
6-CF	480 U
7-CF	500 U
8-CF	500 U
9-CF	480 U
10-CF	460 U
11-CF	490 U
12-CF	470 U/E
13-1-CF	490 U
13-2-CF	490 U
13-3-CF	490 U
14-CF	500 U

Phthalate Esters

	Dimethyl phthalate	Diethyl phthalate	Di-n-butyl phthalate	Benzyl butyl phthalate	bis(2-Ethylhexyl)phthalate	Di-n-octyl phthalate
2-CF	94 U	94 U	2200 U	4700 U	1000 U	94 U
3-CF	94 U	94 U	2000 U	7400 U	970 U	94 U/E
4-CF	94 U	94 U	840 U	4100 U	330 U	94 U
5-CF	94 U	94 U	**240**	5200 U	320 U	94 U
6-CF	96 U	96 U	660 U	4600 U	820 U	96 U
7-CF	99 U	99 U	830 U	2500 U	760 U	99 U
8-CF	99 U	99 U	910 U	2300 U	660 U	99 U
9-CF	96 U	96 U	260 U	3000 U	640 U	96 U
10-CF	93 U	93 U	1400 U	5200 U	320 U	93 U
11-CF	98 U	98 U	960 U	2200 U	290 U	98 U
12-CF	95 U	95 U	3100 U	7100 U/E	1100 U/E	95 U/E
13-1-CF	99 U	99 U	730 U	1900 U	110 U	99 U
13-2-CF	98 U	98 U	1100 U	2700 U	480 U	98 U
13-3-CF	98 U	98 U	690 U	2100 U	98 U	98 U
14-CF	99 U	99 U	1400 U	2600 U	99 U	99 U

Miscellaneous

	Carbazole	Benzyl Alcohol	Benzoic Acid	Isophorone	4-Chloroaniline
2-CF	94 U	94 U	94 U	94 U	280 U
3-CF	94 U	94 U	94 U	94 U	280 U
4-CF	94 U	94 U	94 U	94 U	280 U
5-CF	94 U	94 U	94 U	94 U	280 U
6-CF	96 U	96 U	96 U	96 U	290 U
7-CF	99 U	99 U	99 U	99 U	300 U
8-CF	99 U	99 U	99 U	99 U	300 U
9-CF	96 U	**59 J/M**	96 U	96 U	290 U
10-CF	93 U	93 U	93 U	93 U	280 U
11-CF	98 U	**68 J/M**	98 U	98 U	290 U
12-CF	95 U	95 U	95 U	95 U	280 U
13-1-CF	99 U	99 U	99 U	99 U	300 U
13-2-CF	98 U	98 U	98 U	98 U	290 U
13-3-CF	98 U	98 U	98 U	98 U	290 U
14-CF	99 U	99 U	99 U	99 U	300 U

TABLE 16. SEMI-VOLATILE ORGANIC COMPOUNDS IN FISH (µg/kg wet)(Page 1 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Phenols

	Phenol	2-Methylphenol	4-Methylphenol	2,4-Dimethylphenol	Pentachlorophenol	2-Chlorophenol	2,4-Dichlorophenol	4-Chloro-3-methylphenol	2,4-Dinitrophenol	2-Nitrophenol	4-Nitrophenol	2,4,5-Trichlorophenol	2,4,6-Trichlorophenol	4, 6-Dinitro-2-methylphenol
1-LS	99 U	99 U	99 U	99 U	2500 U/J	99 U	300 U	200 U	990 U	490 U	490 U	490 U	490 U	990 U
1-C	96 U	96 U	96 U	96 U	2400 U/J	96 U	290 U	190 U	960 U	480 U	480 U	480 U	480 U	960 U
2-LS	500 U	500 U	500 U	500 U	12000 U/J	500 U	1500 U	1000 U	5000 U	2500 U	2500 U	2500 U	2500 U	5000 U
3-LS	100 U	100 U	100 U	100 U	2500 U/J	100 U	299 U	200 U	1000 U	500 U	500 U	500 U	500 U	1000 U
4-LS	97 U	97 U	97 U	97 U	2400 U/J	97 U	290 U	190 U	970 U	480 U	480 U	480 U	480 U	970 U
5-LS	490 U	490 U	490 U	490 U	12000 U/J	490 U	1500 U	980 U	4900 U	2400 U	2400 U	2400 U	2400 U	4900 U
6-LS	98 U	98 U	98 U	98 U	2400 U/J	98 U	290 U	200 U	980 U	490 U	490 U	490 U	490 U	980 U
7-LS	98 U	98 U	98 U	98 U	2400 U/J	98 U	290 U	200 U	980 U	490 U	490 U	490 U	490 U	980 U
8-LS	490 U	490 U	490 U	490 U	12000 U/J	490 U	1500 U	990 U	4900 U	2500 U	2500 U	2500 U	2500 U	4900 U
9-LS	99 U	99 U	99 U	99 U	2500 U/J	99 U	300 U	200 U	990 U	490 U	490 U	490 U	490 U	990 U
10-LS	490 U	490 U	490 U	490 U	12000 U/J	490 U	1500 U	990 U	4900 U	2500 U	2500 U	2500 U	2500 U	4900 U
11-LS	98 U	98 U	98 U	98 U	2400 U/J	98 U	290 U	200 U	980 U	490 U	490 U	490 U	490 U	980 U
12-LS	99 U	99 U	99 U	99 U	2500 U/J	99 U	300 U	200 U	990 U	490 U	490 U	490 U	490 U	990 U
13-1-LS	96 U	96 U	96 U	96 U	2400 U/J	96 U	290 U	190 U	960 U	480 U	480 U	480 U	480 U	960 U
13-2-LS	480 U	480 U	480 U	480 U	12000 U/J	480 U	1400 U	960 U	4800 U	2400 U	2400 U	2400 U	2400 U	4800 U
13-3-LS	98 U	98 U	98 U	98 U	2500 U/J	98 U	290 U	200 U	980 U	490 U	490 U	490 U	490 U	980 U
14-LS	500 U	500 U	500 U	500 U	12000 U/J	500 U	1500 U	990 U	5000 U	2500 U	2500 U	2500 U	2500 U	5000 U
15-C	500 U	500 U	500 U	500 U	12000 U/J	500 U	1500 U	1000 U	5000 U	2500 U	2500 U	2500 U	2500 U	5000 U

Halogenated Ethers

	bis(2-Chloroethyl)ether	bis(2-Chloroethoxy)methane	4-Bromophenyl-phenylether	4-Chlorophenyl-phenylether	2,2'-Oxybis(1-chloropropane)
1-LS	99 U	99 U	99 U	99 U	99 U
1-C	96 U	96 U	96 U	96 U	96 U
2-LS	500 U	500 U	500 U	500 U	500 U
3-LS	100 U	100 U	100 U	100 U	100 U
4-LS	97 U	97 U	97 U	97 U	97 U
5-LS	490 U	490 U	490 U	490 U	490 U
6-LS	98 U	98 U	98 U	98 U	98 U
7-LS	98 U	98 U	98 U	98 U	98 U
8-LS	490 U	490 U	490 U	490 U	490 U
9-LS	99 U	99 U	99 U	99 U	99 U
10-LS	490 U	490 U	490 U	490 U	490 U
11-LS	98 U	98 U	98 U	98 U	98 U
12-LS	99 U	99 U	99 U	99 U	99 U
13-1-LS	96 U	96 U	96 U	96 U	96 U
13-2-LS	480 U	480 U	480 U	480 U	480 U
13-3-LS	98 U	98 U	98 U	98 U	98 U
14-LS	500 U	500 U	500 U	500 U	500 U
15-C	500 U	500 U	500 U	500 U	500 U

Qualifier:
U = Undetected value

Nitroaromatics

	2,4-Dinitrotoluene	2,6-Dinitrotoluene	Nitrobenzene	2-Nitroaniline	3-Nitroaniline	4-Nitroaniline
1-LS	490 U	490 U	99 U	490 U	490 U	490 U
1-C	480 U	480 U	96 U	480 U	480 U	480 U
2-LS	2500 U	2500 U	500 U	2500 U	2500 U	2500 U
3-LS	500 U	500 U	100 U	500 U	500 U	500 U
4-LS	480 U	480 U	97 U	480 U	480 U	480 U
5-LS	2400 U	2400 U	490 U	2400 U	2400 U	2400 U
6-LS	490 U	490 U	98 U	490 U	490 U	490 U
7-LS	490 U	490 U	98 U	490 U	490 U	490 U
8-LS	2500 U	2500 U	490 U	2500 U	2500 U	2500 U
9-LS	490 U	490 U	99 U	490 U	490 U	490 U
10-LS	2500 U	2500 U	490 U	2500 U	2500 U	2500 U
11-LS	490 U	490 U	98 U	490 U	490 U	490 U
12-LS	490 U	490 U	99 U	490 U	490 U	490 U
13-1-LS	480 U	480 U	96 U	480 U	480 U	480 U
13-2-LS	2400 U	2400 U	480 U	2400 U	2400 U	2400 U
13-3-LS	490 U	490 U	98 U	490 U	490 U	490 U
14-LS	2500 U	2500 U	500 U	2500 U	2500 U	2500 U
15-C	2500 U	2500 U	500 U	2500 U	2500 U	2500 U

TABLE 16. SEMI-VOLATILE ORGANIC COMPOUNDS IN FISH (µg/kg wet)(Page 2 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Polynuclear Aromatic Hydrocarbons

	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(b,k)fluoranthene	Benzo(a)pyrene	Benzo(ghi)perylene	Chrysene	Dibenzo(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene
1-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
1-C	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U
2-LS	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
3-LS	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-LS	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U
5-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
6-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
7-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
8-LS	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U
9-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
10-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
11-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
12-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
13-1-LS	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U
13-2-LS	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U
13-3-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U
14-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U
15-C	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U

Naphthalenes

	Naphthalene	Phenanthrene	Pyrene	2-Methylnaphthalene	Dibenzofuran	2-Chloronaphthalene
1-LS	**11**	9.9 U	9.9 U	**10**	9.9 U	99 U
1-C	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	96 U
2-LS	10 U	10 U	10 U	10 U	10 U	500 U
3-LS	10 U	10 U	10 U	10 U	10 U	100 U
4-LS	9.7 U	9.7 U	9.7 U	9.7 U	9.7 U	97 U
5-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	490 U
6-LS	**8.3 J**	9.8 U	9.8 U	**8.8 J**	9.8 U	98 U
7-LS	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	98 U
8-LS	7.8 U	7.8 U	7.8 U	7.8 U	7.8 U	490 U
9-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	99 U
10-LS	**13**	9.9 U	9.9 U	**23**	9.9 U	490 U
11-LS	**10**	9.8 U	9.8 U	**22**	9.8 U	98 U
12-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	99 U
13-1-LS	9.6 U	9.6 U	9.6 U	9.6 U	9.6 U	96 U
13-2-LS	8.5 U	8.5 U	8.5 U	8.5 U	8.5 U	480 U
13-3-LS	**6.6 J**	9.8 U	9.8 U	**10**	9.8 U	98 U
14-LS	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	500 U
15-C	10 U	10 U	10 U	10 U	10 U	500 U

Data Qualifier:
U = Undetected value

TABLE 16. SEMI-VOLATILE ORGANIC COMPOUNDS IN FISH (µg/kg wet)(Page 3 of 3)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Chlorinated Benzenes

	1,3-Dichlorobenzene	1,2-Dichlorobenzene	1,4-Dichlorobenzene	1,2,4-Trichlorobenzene	Hexachlorobenzene	Hexachlorobutadiene	Hexachloroethane	Hexachlorocyclopentadiene
1-LS	99 U	99 U	99 U	99 U	99 U	99 U	99 U	490 U
1-C	96 U	96 U	96 U	96 U	96 U	96 U	96 U	480 U
2-LS	500 U	500 U	500 U	500 U	500 U	500 U	500 U	2500 U
3-LS	100 U	100 U	100 U	100 U	100 U	100 U	100 U	500 U
4-LS	97 U	97 U	97 U	97 U	97 U	97 U	97 U	480 U
5-LS	490 U	490 U	490 U	490 U	490 U	490 U	490 U	2400 U
6-LS	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
7-LS	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
8-LS	490 U	490 U	490 U	490 U	490 U	490 U	490 U	2500 U
9-LS	99 U	99 U	99 U	99 U	99 U	99 U	99 U	490 U
10-LS	490 U	490 U	490 U	490 U	490 U	490 U	490 U	2500 U
11-LS	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
12-LS	99 U	99 U	99 U	99 U	99 U	99 U	99 U	490 U
13-1-LS	96 U	96 U	96 U	96 U	96 U	96 U	96 U	480 U
13-2-LS	480 U	480 U	480 U	480 U	480 U	480 U	480 U	2400 U
13-3-LS	98 U	98 U	98 U	98 U	98 U	98 U	98 U	490 U
14-LS	500 U	500 U	500 U	500 U	500 U	500 U	500 U	2500 U
15-C	500 U	500 U	500 U	500 U	500 U	500 U	500 U	2500 U

Data Qualifier:
U = Undetected value

Benzidines

	3,3'-Dichlorobenzidine
1-LS	490 U
1-C	480 U
2-LS	2500 U
3-LS	500 U
4-LS	480 U
5-LS	2400 U
6-LS	490 U
7-LS	490 U
8-LS	2500 U
9-LS	490 U
10-LS	2500 U
11-LS	490 U
12-LS	490 U
13-1-LS	480 U
13-2-LS	2400 U
13-3-LS	490 U
14-LS	2500 U
15-C	2500 U

Phthalate Esters

	Dimethyl phthalate	Diethyl phthalate	Di-n-butyl phthalate	Benzyl butyl phthalate	bis(2-Ethylhexyl)phthalate	Di-n-octyl phthalate
1-LS	99 U	99 U	99 U	99 U	99 U	99 U
1-C	96 U	96 U	96 U	96 U	96 U	96 U
2-LS	500 U	500 U	500 U	500 U	500 U	500 U
3-LS	100 U	100 U	**430**	100 U	100 U	100 U
4-LS	97 U	97 U	97 U	97 U	**760**	97 U
5-LS	490 U	490 U	490 U	490 U	490 U	490 U
6-LS	98 U	98 U	98 U	98 U	**400**	98 U
7-LS	98 U	98 U	98 U	98 U	98 U	98 U
8-LS	490 U	490 U	490 U	490 U	490 U	490 U
9-LS	99 U	99 U	99 U	99 U	99 U	99 U
10-LS	490 U	490 U	490 U	490 U	490 U	490 U
11-LS	98 U	98 U	98 U	98 U	98 U	98 U
12-LS	99 U	99 U	99 U	99 U	99 U	99 U
13-1-LS	96 U	96 U	96 U	96 U	96 U	96 U
13-2-LS	480 U	480 U	480 U	480 U	480 U	480 U
13-3-LS	98 U	98 U	98 U	98 U	98 U	98 U
14-LS	500 U	500 U	500 U	500 U	500 U	500 U
15-C	500 U	500 U	500 U	500 U	500 U	500 U

Miscellaneous

	Carbazole	Benzyl Alcohol	Benzoic Acid	Isophorone	4-Chloroaniline
1-LS	99 U	99 U	990 U	99 U	300 U
1-C	96 U	96 U	960 U	96 U	290 U
2-LS	500 U	500 U	5000 U	500 U	1500 U
3-LS	100 U	100 U	1000 U	100 U	299 U
4-LS	97 U	97 U	970 U	97 U	290 U
5-LS	490 U	490 U	4900 U	490 U	1500 U
6-LS	98 U	98 U	980 U	98 U	290 U
7-LS	98 U	98 U	980 U	98 U	290 U
8-LS	490 U	490 U	4900 U	490 U	1500 U
9-LS	99 U	99 U	990 U	99 U	300 U
10-LS	490 U	490 U	4900 U	490 U	1500 U
11-LS	98 U	98 U	980 U	98 U	290 U
12-LS	99 U	99 U	990 U	99 U	300 U
13-1-LS	96 U	96 U	960 U	96 U	290 U
13-2-LS	480 U	480 U	4800 U	480 U	1400 U
13-3-LS	98 U	98 U	980 U	98 U	290 U
14-LS	500 U	500 U	5000 U	500 U	990 U
15-C	500 U	500 U	5000 U	500 U	500 U

Appendix A-7

Data Validation Report
Pesticide and PCB Analyses

Site: Lower Columbia River

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Analytical Resources, Inc.

Data Reviewed by: Jennifer M. Baier and Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey and analyzed for pesticides and PCBs using U.S. EPA Method 8080 by Analytical Resources, Inc. (ARI) of Seattle, WA. The samples were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Of the 33 tissue samples, 15 were crayfish and 18 were fish, either largescale sucker or carp. Crayfish samples were collected at only 13 of the 15 stations (all except stations 1 and 15). Triplicate field samples were collected at station 13 (13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale sucker) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS). In addition, a sample of Sequim Bay Reference Material (Sample SQ-1) was also analyzed. The data validation review was conducted according to guidelines presented in the U.S. EPA Contract Laboratory Program Statement of Work (SOW) for organics analyses (U.S. EPA 1991), the Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses (U.S. EPA 1988), and the sampling and QA/QC plan for the project (Tetra Tech 1993a).

Five compounds not normally included in method 8080 (o,p'-DDD, o,p'-DDE, o,p'-DDT, methyl parathion, and dicofol) were added to the list of target compounds for this project. This was done to ensure consistency with the results from the 1991 Lower Columbia River Reconnaissance Survey (Tetra Tech 1993b).

A. HOLDING TIMES

Samples were collected, placed on ice or frozen (tissue) in a cooler, and transported to the laboratory within 4 days of collection. The maximum holding time established for this project for pesticides and PCBs in sediment and tissue matrices is 14 days until extraction and an additional 26 days until analysis (Tetra Tech 1993). Table 1 presents a summary of sample numbers, dates collected, extracted, and analyzed, and holding times. All samples were extracted and analyzed well within applicable holding times, with the exception of crayfish samples 10-CF and 12-CF, which were extracted 16 days after sample collection. This deviation was considered minor. Due to the late arrival of standards, the laboratory performed the sediment analyses for the five additional target compounds (o,p'-DDD, o,p'-DDE, o,p'-DDT, methyl parathion, and dicofol) approximately two weeks after the initial analyses. All samples, however, were analyzed within the 40 day holding time. No data qualifiers were assigned to sample results for pesticides and PCBs based on holding times.

B. CALIBRATION AND INSTRUMENT PERFORMANCE

Sediment

Dual megabore columns of dissimilar phases (DB-5 and DB-608) were used for quantitation and

confirmation of sediment pesticide and PCB concentrations. Initial three-point calibrations were conducted for both individual standard mixtures A and B for both columns on 7/13-7/14/93 and 7/19-7/20/93. The percent relative standard deviations (%RSD) of the calibration factors for the low, mid, and high standards were less than 20 percent for all compounds except heptachlor and endrin aldehyde on the DB-608 column on 7/13-7/14/93; alpha-BHC and gamma-BHC on the DB-5 column on 7/19-7/20/93; and heptachlor on DB-608 column on 7/19-7/20/93. QA/QC guidelines established by U.S. EPA (1991) allow for up to two target compounds having a %RSD of greater than or equal to 20 percent, but less than or equal to 30 percent. Three peaks were reported for the initial calibration of multicomponent analytes. The results of the initial calibration indicate that linearity criteria were met and the initial calibration was valid.

Continuing calibration analyses were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of instrument blanks, Performance Evaluation Mixtures (PEM), and the mid-point concentrations of individual standard mixtures A and B. Calculated amounts for each compound in the PEMs and mid-point standard mixtures had RPDs less than or equal to 25 percent from the nominal amount. The absolute retention times for each compound were within the retention time windows established from the initial calibration except for Aroclor 1248 on the DB-5 column on 7/19/93; and delta-BHC, endosulfan sulfate, endrin ketone on both columns on 7/21/93. The breakdown of two target compounds in the PEM, endrin and p,p'-DDT, was within QC guidelines for all analyses of the PEM (U.S. EPA 1991). No evidence of contamination was noted for any of the instrument blanks associated with the continuing calibration. The results of the continuing calibration indicate that the initial calibration remained valid, except for the compounds noted above, through the analysis of all field samples.

The compounds detected in the column outside the established retention time window during the continuing calibration were qualified as estimated ("E") for pesticide and PCB samples performed on the same day. Thus, Aroclor 1248 results were qualified as estimates for samples 9-1-S and 14-S (analyzed 7/19/93) and delta-BHC, endosulfan sulfate, and endrin ketone results were qualified as estimates for samples 1-S and 10-S (analyzed 7/21/93).

Crayfish Tissue

Dual megabore columns of dissimilar phases (DB-5 and DB-608) were used for quantitation and confirmation of crayfish pesticide and PCB concentrations. An initial three-point calibration was conducted for both individual standard mixtures A and B for both columns on 8/14/93. The %RSD of the calibration factors for the low, mid, and high standards were less than 20 percent for all compounds except for delta-BHC on the DB-5 column on 8/14/93 and beta-BHC and heptachlor epoxide on the DB-608 column on 8/14/93. QA/QC guidelines established by U.S. EPA (1991) allow for up to two target compounds having a %RSD of greater than or equal to 20 percent, but less than or equal to 30 percent. Three peaks were reported for the initial calibration of multicomponent analytes. The results of the initial calibration indicate that linearity criteria were met and the initial calibration was valid.

Continuing calibration analyses were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of instrument blanks, Performance Evaluation Mixtures (PEM), and the mid-point concentrations of individual standard mixtures A and B. Calculated amounts for each compound in the PEMs and mid-point standard mixtures had RPDs less than or equal to 25 percent from the nominal amount. The absolute retention times for each compound were within the retention time windows established from the initial calibration except for delta-BHC, endosulfan sulfate, and endrin ketone on both columns on 8/15/93 and 8/16/93. The breakdown of two target compounds in the PEM, endrin and p,p'-DDT, was within QC guidelines for

all analyses of the PEM (U.S. EPA 1991). No evidence of contamination was noted for any of the instrument blanks associated with the continuing calibration. The results of the continuing calibration indicate that the initial calibration remained valid, except for the compounds noted above, through the analysis of all field samples.

The compounds detected in the column outside the established retention time window during the continuing calibration were qualified as estimated ("E") for pesticide samples performed on the same day. Thus, delta-BHC, endosulfan sulfate, and endrin ketone results were qualified as estimates for samples 6-CF, 7-CF, 8-CF, 9-CF, and 11-CF (analyzed 8/15/93) and for samples 2-CF, 3-CF, 4-CF, 5-CF, 10-CF, 12-CF, 13-1-CF, 13-2-CF, 13-3-CF and 14-CF (analyzed 8/16/93).

Fish Tissue

Dual megabore columns of dissimilar phases (DB-5 and DB-608) were used for quantitation and confirmation of fish pesticide and PCB concentrations. Initial three-point calibrations were conducted for both individual standard mixtures A and B for both columns on 8/25/93 for the pesticides, 9/4/93 for the PCBs and a few pesticides, and 9/9/93 for the diluted samples. The %RSD of the calibration factors for the low, mid, and high standards were less than 20 percent for all compounds, with the exception of lindane (%RSD=21.2) and alpha-chlordane (%RSD=24.3) for the DB-5 column and endosulfan sulfate (%RSD=20.9) for the DB-608 column on 8/25/93, p,p'-DDT (%RSD=22.1) for DB-1701 column on 9/4/93, and alpha-chlordane (%RSD=24.8) for DB-608 on 9/9/93. QA/QC guidelines established by U.S. EPA (1991) allow for up to two target compounds having a %RSD of greater than or equal to 20 percent, but less than or equal to 30 percent. Three peaks were reported for the initial calibration of multicomponent analytes. The results of the initial calibration indicate that linearity criteria were met and the initial calibration was valid.

Continuing calibration were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of instrument blanks, Performance Evaluation Mixtures (PEM), and the mid-point concentrations of individual standard mixtures A and B. Calculated amounts for each compound in the PEMs and mid-point standard mixtures had RPDs less than or equal to 25 percent from the nominal amount, with the exception of the compounds found in Table 2. The samples associated with those continuing calibrations were qualified as estimates for the compounds listed in Table 2. The absolute retention times for each compound were within the retention time window established from the initial calibration. The breakdown of two target compounds in the PEM, endrin and p,p'-DDT, were within QC guidelines for all analyses of the PEM (U.S. EPA 1991), with the exception of the endrin breakdown (25 percent) for the 8/27/93 continuing calibration that is associated with the 8/25/93 initial calibration. The endrin values for the samples associated with the 8/27/93 continuing calibration were qualified as estimates. No other evidence of contamination was noted for any of the instrument blanks associated with the continuing calibration. The results of the continuing calibration indicate that the initial calibration remained valid, except for the above mentioned compounds, through the analysis of all field samples.

C. SURROGATE RECOVERIES

Sediment

All field, blank, and spike samples were spiked with the surrogate compounds TCMX and DCBP before analysis. Advisory QC limits for percent recovery have been established by U.S. EPA (1991) as 60-150 percent for both compounds. In addition, the laboratory has established in-house advisory limits of 40-131

percent for TCMX and 54-131 percent for DCBP. The percent recovery of surrogates for all sediment samples is given in Table 3A. For the Method 8080 target compound analyses performed on 7/18-7/21/93, surrogate recoveries were slightly below the laboratory QC guidelines for approximately 10 samples. These deviations were considered minor and no data qualifiers were added. For the additional target compound analyses performed on 7/31/93, surrogate recoveries were consistently below laboratory QC guidelines for both TCMX (5-15 percent below) and DCBP (10-25 percent below). The laboratory hypothesized that a portion of the surrogates may have been lost during the sample concentration procedure, which was performed under nitrogen gas. Because matrix spike data did not provide an independent confirmation of the accuracy of the analytical methodology, all sample data for these compounds (o,p'-DDD, o,p'-DDE, o,p'-DDT, methyl parathion, and dicofol) were qualified as estimates.

Crayfish Tissue

All field, blank, and spike samples were spiked with the surrogate compounds TCMX and DCBP before analysis. Advisory QC limits for percent recovery have been established by the U.S. EPA (1991) as 60-150 percent for both compounds. In addition, the laboratory has established in-house advisory limits of 40-131 percent for TCMX and 54-131 percent for DCBP. The percent recovery of surrogates for all crayfish samples is given in Table 3B. Surrogate recoveries were within the laboratory's advisory QC limits for all samples, with the exception of samples 4-CF, 7-CF, and 13-1-CF, for which the percent recovery of TCMX was slightly below the advisory range. These deviations were considered minor. No data qualifiers were assigned to crayfish results based on surrogate recoveries.

Fish Tissue

All field, blank, and spike samples were spiked with the surrogate compounds TCMX and DCBP before analysis. Advisory QC limits for percent recovery have been established by the U.S. EPA (1991) as 60-150 percent for both compounds. In addition, the laboratory has established in-house advisory limits of 40-131 percent for TCMX and 54-131 percent for DCBP. The percent recovery of surrogates for all fish samples is given in Table 3C. Surrogate recoveries were within the laboratory's advisory QC limits for all samples, with the exception of sample 2-C, for which the percent recovery of TCMX was slightly below the advisory range in the initial analyses of the samples, and samples 1-LS, 12-LS, 13-2-LS, and 13-3-LS, for which the percent recovery of DCBP was slightly above the advisory range for the dilution analyses of the samples. These deviations were considered minor. No data qualifiers were assigned based on surrogate recoveries.

D. METHOD BLANKS

Sediment

For the sediment sample data, three method blanks were extracted on 7/7/93, 7/8/93, and 7/9/93. For the analyses of the five additional target compounds (o,p'-DDD, o,p'-DDE, o,p'-DDT, methyl parathion, and dicofol) three method blanks were extracted on 7/7/93, 7/8/93, and 7/9/93. Raw data for all method blanks were examined, and no indication of PCB or pesticide contamination at concentrations exceeding practical quantitation limits was found. No data qualifiers were assigned to sediment sample results for pesticides and PCBs based on method blank results.

Crayfish Tissue

For the crayfish sample data, one method blank was extracted on 7/28/93 and the other method blank was extracted on 8/5/93. Raw data for all method blanks were examined, and no indication of PCB or

pesticide contamination at concentrations exceeding practical quantitation limits was found. No data qualifiers were assigned to crayfish sample results for pesticides and PCBs based on method blank results.

Fish Tissue

For the fish sample data, two method blanks were performed on 8/27/93 and 8/28/93 for the initial analyses and two method blanks were preformed on 9/4/93 and 9/5/93 for the PCB analyses. Raw data for all method blanks were examined, and no indication of PCB or pesticide contamination at concentrations exceeding practical quantitation limits was found. No data qualifiers were assigned to sample results for pesticides and PCBs based on method blank results.

E. MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSIS

Sediment

MS/MSD analyses were performed on sample 13-S and are reported in Table 4. Lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were added to the sample at concentrations of 8.2 to 16.4 μg/kg. Percent recoveries and the RPDs between the MS and the MSD were all within U.S. EPA (1991) QC guidelines. An additional MS/MSD analysis was attempted for Sample 13-S using p,p'-DDT to represent the five additional target compounds. No percent recovery for this compound could be calculated because the instrument response was saturated due to the concentration of the sample extract. No data qualifiers were assigned to sample results based on matrix spike data.

Crayfish Tissue

MS/MSD analyses were performed on sample 11-CF and are reported in Table 4. Lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were added to the sample at concentrations of 24.6 to 49.3 μg/kg. Percent recoveries and the RPDs between the MS and the MSD were all within U.S. EPA (1991) QC guidelines. No data qualifiers were assigned to crayfish sample results based on matrix spike data.

Fish Tissue

MS/MSD analyses were performed on sample 10-LS and are reported in Table 4. Lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were added to the sample at concentrations of 24.7 to 49.5 μg/kg. Percent recoveries and the RPDs between the MS and the MSD were all within U.S. EPA (1991) QC guidelines, with the exception of aldrin and dieldrin. The MS (%R=179) and MSD (%R=167) for endrin are higher than the QC limit of 132 percent because of interference due to the presence of aroclor 1254 in the 10-LS sample. Dieldrin (%RPD=141) was slightly higher than the MS limit of 134 percent, but no data qualifiers were assigned since all other precision data indicated no consistent bias. No data qualifiers were assigned to sample results based on matrix spike data.

F. SPIKED BLANK ANALYSIS

Sediment

Two blank spikes were analyzed on 7/18/93 and are reported in Table 5A. Percent recoveries for lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were all within U.S. EPA (1991) QC limits. No data qualifiers were assigned to sediment sample results based on spiked blank data.

Crayfish Tissue

Two blank spikes were analyzed on 8/16/93 and are reported in Table 5B. Percent recoveries for lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were all within QC limits, except for spike blank 1 which had a percent recovery of 37.5 percent for lindane. This deviation was considered minor. No data qualifiers were assigned to crayfish sample results based on spiked blank data.

Fish Tissue

One blank spike was analyzed on 8/27/93 and are reported in Table 5C. Percent recoveries for lindane, heptachlor, aldrin, dieldrin, endrin, and p,p'-DDT were all within QC limits. No data qualifiers were assigned to fish sample results based on spiked blank data.

G. REFERENCE MATERIALS

Sediment

Sequim Bay reference material (sample SQ-1) was analyzed for pesticides and PCBs. The five compounds detected in sample SQ-1 for the first set of sediment sample data are reported in Table 6, along with the 95 percent confidence interval for the "true" concentration. All three compounds (alpha-BHC, lindane, and Aroclor 1254) for which confidence intervals could be calculated were outside their respective confidence intervals. Sequim Bay reference material was also analyzed in conjunction with the additional target compounds on 7/31/93. None of the additional target compounds were detected in the reference material; however, none of these compounds are known to be present in the reference material. Because contaminant concentrations for the reference material from Sequim Bay have not been certified, no data qualifiers were added to sample results based on reference material analysis.

H. LABORATORY REPLICATES

Sediment

One pair of analyses from this project, the non-spiked compounds in the MS/MSD analysis of sample 13-S, were considered to be laboratory replicates. The results from these analyses are given in Table 7A. Only p,p'-DDD was detected in both the matrix spike and the matrix spike duplicate for both the 7/18/93 and the 7/31/93 MD/MSD analyses. The RPD between both pairs of analyses for p,p'-DDE satisfies the data quality objective for precision (RPD $\leq$ 50 percent) specified in the sampling and QA/QC plan (Tetra Tech 1993a). The paucity of positive results, however, makes it difficult to assess laboratory precision. No data qualifiers were assigned based on laboratory replicate results.

Crayfish Tissue

One pair of analyses from this project, the non-spiked compounds in the MS/MSD analysis of sample 11-CF, were considered to be analytical replicates. The results from these analyses are given in Table 7B. Only p,p'-DDE was found in both the MS and MSD. The RPD for the analyses satisfied project QC criteria (Tetra Tech 1993a), although the paucity of positive results makes it difficult to assess laboratory precision. No data qualifiers were assigned based on laboratory replicate results.

Fish Tissue

One pair of analyses from this project, the non-spiked compounds in the MS/MSD analysis of sample 11-LS, were considered to be analytical replicates. The results from these analyses are given in Table 7C. Only p,p'-DDE and p,p'-DDD were found in the MS/MSD for the initial analyses and only aroclor 1254

was found in the MS/MSD for the PCB analyses. The paucity of positive results makes it difficult to assess laboratory precision. No data qualifiers were assigned based on laboratory replicate results.

I. FIELD TRIPLICATES

Sediment

One set of field triplicate samples (samples 9-1-S, 9-2-S, and 9-3-S) were analyzed for PCBs and pesticides. The detected values are given in Table 8A. Only p,p'-DDD was detected in all three samples for the 7/18 analyses and only p,p'-DDD and p,p'-DDE were detected in the 7/31/93 analyses. The RSDs for these compounds were all less than 10 percent, indicating relatively low field variability.

Crayfish Tissue

One set of field triplicate samples (samples 13-1-CF, 13-2-CF, 13-3-CF) were analyzed for PCBs and pesticides. The detected values are given in Table 8B. Only p,p'-DDE was detected in all three samples. The RSD between the samples for p,p'-DDE was 13.1 percent. Given the paucity of positive values, an estimate of field variability is difficult to make.

Fish Tissue

One set of field triplicate samples (samples 13-1-LS, 13-2-LS, 13-3-LS) were analyzed for PCBs and pesticides. The detected values are given in Table 8C. Aroclor 1254, p,p'-DDE, p,p'-DDD, p,p'-DDT were detected in all three replicate samples. Aroclor 1260 was detected in samples 13-1-LS and 13-3-LS, but not in sample 13-2-LS. The RSDs for most of these compounds were relatively high (> 45 percent). No other RSDs could be calculated.

SUMMARY

Sediment

All sample data were reported by the laboratory in µg/kg dry weight and are presented in Table 9 (pesticides) and Table 10 (PCBs). The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (0.2-50 µg/kg for pesticides and 20 µg/kg for PCBs) were up to an order of magnitude higher than those specified in the sampling and QA/QC plan (Tetra Tech 1993a). The laboratory was not able to achieve its target detection limits because of matrix interference.

Sample results for several compounds were qualified as estimated based on evaluation of QA/QC data. Aroclor 1248 in samples 9-1-S and 14-S and delta-BHC, endosulfan sulfate, and endrin ketone in samples 1-S and 10-S were qualified based on exceedance of retention time windows. The pesticide p,p'-DDD was qualified for sample by the laboratory due to matrix interference in the laboratory duplicate results. All five of the additional target compounds (o,p'-DDD, o,p'-DDE, o,p'-DDT, methyl parathion, and dicofol) were qualified because of consistently low surrogate recoveries.

The precision, accuracy, and completeness of the pesticide and PCB analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Crayfish Tissue

All sample data were reported by the laboratory in µg/kg wet weight and are presented in Table 11 (pesticides) and Table 12 (PCBs). The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (2.5-250 µg/kg for pesticides and 50-100 µg/kg for PCBs) were up to an order of magnitude higher than those specified in the sampling and QA/QC plan (Tetra Tech 1993a). The laboratory was not able to achieve its target detection limits because of matrix interference.

Sample results for several compounds were qualified as estimated based on evaluation of QA/QC data. Delta-BHC, endosulfan sulfate, and endrin ketone in all crayfish samples were qualified based on exceedance of retention time windows.

The precision, accuracy, and completeness of the pesticide and PCB analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Fish Tissue

All sample data were reported by the laboratory in µg/kg wet weight and are presented in Table 13 (pesticides) and Table 14 (PCBs). The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (2.5-260 µg/kg for pesticides and 50-100 µg/kg for PCBs) were up to an order of magnitude higher than those specified in the sampling and QA/QC plan

(Tetra Tech 1993a). The laboratory was not able to achieve its target detection limits because of matrix interference.

Sample results for several compounds were qualified as estimates based on QA/QC data. Alpha-BHC, delta-BHC, lindane, endrin, endosulfan II, endosulfan sulfate, p,p'-DDT, and endrin ketone were qualified based on exceedance of continuing calibration %D limits.

The precision, accuracy, and completeness of the pesticide and PCB analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

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TABLE 1. PESTICIDES/PCBs ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(page 1 of 2)

Tetra Tech Sample Number	Analytical Resources, Inc Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Sediment							
1-S	X046A	6/28/93	6/29/93	7/9/93	7/21, 7/31	11	34
2-S	X046B	6/27/93	6/29/93	7/8/93	7/18, 7/31	11	35
3-S	X046C	6/27/93	6/29/93	7/8/93	7/18, 7/31	11	35
4-S	X046D	6/26/93	6/29/93	7/8/93	7/18, 7/31	12	36
5-S	X046E	6/26/93	6/29/93	7/8/93	7/18, 7/31	12	36
6-S	X046F	6/25/93	6/29/93	7/8/93	7/18, 7/31	13	37
7-S	X046G	6/25/93	6/29/93	7/8/93	7/18, 7/31	13	37
8-S	X046H	6/24/93	6/29/93	7/7/93	7/18, 7/31	13	38
9-1-S	X046I	6/29/93	7/2/93	7/8/93	7/19, 7/31	9	33
9-2-S	X046J	6/29/93	7/2/93	7/8/93	7/18, 7/31	9	33
9-3-S	X046K	6/29/93	7/2/93	7/8/93	7/18, 7/31	9	33
10-S	X046L	6/28/93	6/29/93	7/9/93	7/21, 7/31	11	34
11-S	X046M	6/29/93	7/2/93	7/8/93	7/18, 7/31	9	33
12-S	X046N	6/30/93	7/2/93	7/8/93	7/18, 7/31	8	32
13-S	X046O	7/1/93	7/2/93	7/8/93	7/18, 7/31	7	31
14-S	X046P	7/1/93	7/2/93	7/8/93	7/19, 7/31	7	31
15-S	X046Q	6/30/93	7/2/93	7/8/93	7/18, 7/31	8	32
Crayfish							
2-CF	X047J	7/22/93	7/29/93	8/5/93	8/16/93	14	25
3-CF	X047K	7/22/93	7/29/93	8/5/93	8/16/93	14	25
4-CF	X047L	7/24/93	7/29/93	8/5/93	8/16/93	12	23
5-CF	X047M	7/23/93	7/29/93	8/5/93	8/16/93	13	24
6-CF	X047A	7/16/93	7/23/93	7/28/93	8/15/93	12	30
7-CF	X047B	7/16/93	7/23/93	7/28/93	8/15/93	12	30
8-CF	X047C	7/16/93	7/23/93	7/28/93	8/15/93	12	30
9-CF	X048D	7/16/93	7/23/93	7/28/93	8/15/93	12	30
10-CF	X047N	7/20/93	7/29/93	8/5/93	8/16/93	16	27
11-CF	X047E	7/18/93	7/23/93	7/28/93	8/15/93	10	28
12-CF	X047O	7/20/93	7/29/93	8/5/93	8/16/93	16	27
13-1-CF	X047F	7/18/93	7/23/93	7/28/93	8/16/93	10	29
13-2-CF	X047G	7/18/93	7/23/93	7/28/93	8/16/93	10	29
13-3-CF	X047H	7/18/93	7/23/93	7/28/93	8/16/93	10	29
14-CF	X047I	7/18/93	7/23/93	7/28/93	8/16/93	10	29

TABLE 1. PESTICIDES/PCBs ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY
(page 2 of 2)

Tetra Tech Sample Number	Analytical Resources, Inc Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Fish							
1-LS	X047P	8/6/93	8/13/93	8/16/93	8/27, 9/5	10	21
1-LS dil	X047P	8/6/93	8/13/93	8/16/93	9/9/93	10	34
1-C	X047Q	8/6/93	8/13/93	8/16/93	8/27, 9/5	10	21
2-LS	X047R	8/6/93	8/13/93	8/16/93	8/27, 9/5	10	21
2-LS dil	X047R	8/6/93	8/13/93	8/16/93	9/9/93	10	34
3-LS	X047S	8/5/93	8/13/93	8/16/93	8/27, 9/5	11	22
3-LS dil	X047S	8/5/93	8/13/93	8/16/93	9/10/93	11	36
4-LS	X047T	8/5/93	8/13/93	8/16/93	8/27, 9/5	11	22
5-LS	X047U	8/5/93	8/13/93	8/16/93	8/27, 9/5	11	22
5-LS dil	X047U	8/5/93	8/13/93	8/16/93	9/9/93	11	35
6-LS	X047V	8/5/93	8/13/93	8/16/93	8/27, 9/5	11	22
7-LS	X047W	8/5/93	8/13/93	8/16/93	8/27, 9/5	11	22
8-LS	X047X	8/5/93	8/13/93	8/16/93	8/28, 9/5	11	23
8-LS dil	X047X	8/5/93	8/13/93	8/16/93	9/10/93	11	36
9-LS	X047Y	8/5/93	8/13/93	8/16/93	8/28, 9/5	11	23
10-LS	X047Z	8/4/93	8/13/93	8/16/93	8/28, 9/5	12	24
10-LS dil	X047Zdl	8/4/93	8/13/93	8/16/93	9/9/93	12	36
11-LS	X047AA	8/4/93	8/13/93	8/16/93	8/28, 9/5	12	24
11-LS dil	X047AA	8/4/93	8/13/93	8/16/93	9/9/93	12	36
12-LS	X047AB	8/4/93	8/13/93	8/16/93	8/28, 9/5	12	24
12-LS dil	X047AB	8/4/93	8/13/93	8/16/93	9/10/93	12	37
13-1-LS	X047AC	8/3/93	8/13/93	8/16/93	9/10/93	13	38
13-1-LS dil	X047AC	8/3/93	8/13/93	8/16/93	9/10/93	13	38
13-2-LS	X047AD	8/3/93	8/13/93	8/16/93	8/28, 9/5	13	25
13-2-LS dil	X047AD	8/3/93	8/13/93	8/16/93	9/10/93	13	38
13-3-LS	X047AE	8/3/93	8/13/93	8/16/93	8/28, 9/5	13	25
13-3-LS dil	X047AE	8/3/93	8/13/93	8/16/93	9/10/93	13	38
14-LS	X047AF	8/3/93	8/13/93	8/16/93	8/28, 9/5	13	25
14-LS dil	X047AF	8/3/93	8/13/93	8/16/93	9/10/93	13	38
15-C	X047AG	8/3/93	8/13/93	8/16/93	8/28, 9/5	13	25
15-C dil	X047AG	8/3/93	8/13/93	8/16/93	9/10/93	13	38

TABLE 2. CONTINUING CALIBRATION EXCEEDANCES *
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Continuing Calibration (8/25/93 initial calibration for fish samples)		
	8/27/93 11:38 AM	8/27/93 10:32 PM	8/28/93 9:24 AM
Compounds	(%RPD)	(%RPD)	(%RPD)
delta-BHC	81		327
endosulfan sulfate	93		580
endrin ketone	97		787.5
endrin % breakdown		25	
alpha-BHC		40	51.5
gamma-BHC (Lindane)		50	47.5
p,p'-DDT		32	
endosulfan II			30.5
Associated Samples	1-LS, 1-C, 2-LS, 3-LS, 4-LS, 5-LS, 6-LS	7-LS, 9-LS, 10-LS, 11-LS, 12-LS, 13-1-LS	8-LS, 13-2-LS, 13-3-LS, 14-LS, 15-C

* The QC limits are %RPD less than or equal to 25 percent

TABLE 3. PERCENT RECOVERIES FOR PESTICIDE/PCB SURROGATE COMPOUNDS LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. Sediment

Sample Number	Part 1 [1] DCBP	Part 1 [1] TCMX	Part 2 [2] DCBP	Part 2 [2] TCMX
SQ1	54.1	45.8	**38.7**	**36.4**
MS	**41.8**	43.2	**29.8**	**29.6**
MSD	60.0	55.1	**39.3**	**40.1**
MB 1	56.0	**32.2**	**38.0**	**21.9**
MB 2	71.7	58.2	**45.1**	**42.0**
MB 3	80.6	70.1	**46.2**	**45.4**
1-S	61.7	54.3	**41.8**	**41.7**
2-S	65.2	56.7	**38.2**	**38.3**
3-S	**53.6**	48.9	**36.5**	**36.8**
4-S	61.5	53.9	**35.1**	**34.6**
5-S	**49.7**	**44.6**	**35.7**	**36.3**
6-S	**51.9**	**45.1**	**32.7**	**30.1**
7-S	55.8	50.0	**35.4**	**35.4**
8-S	67.3	58.9	**41.6**	**42.4**
9-1-S	**43.0**	**40.4**	**30.3**	**30.3**
9-2-S	**49.5**	**43.8**	**34.5**	**33.8**
9-3-S	**52.5**	48.5	**33.4**	**33.3**
10-S	59.3	68.2	**40.5**	**37.0**
11-S	**53.0**	50.4	**37.7**	**37.8**
12-S	**49.9**	**41.6**	**38.4**	**38.8**
13-S	**53.9**	48.9	**36.3**	**36.4**
14-S	**49.9**	**42.6**	**30.8**	**31.0**
15-S	58.8	51.4	**37.4**	**38.5**

B. Crayfish

Sample Number	DCBP	TCMX
MS	101.0	50.0
MSD	106.0	77.8
MB 1	102.0	59.7
MB 2	87.1	62.7
2-CF	111.0	52.5
3-CF	106.0	80.3
4-CF	102.0	**45.3**
5-CF	98.5	77.3
6-CF	114.0	79.3
7-CF	100.0	**43.6**
8-CF	95.8	76.1
9-CF	103.0	46.0
10-CF	104.0	47.6
11-CF	101.0	73.4
12-CF	95.3	67.7
13-1-CF	87.6	**37.0**
13-2-CF	101.0	76.7
13-3-CF	109.0	50.3
14-CF	90.4	70.7

C. Fish

Sample Number	Initial Analyses DCBP	Initial Analyses TCMX	PCB Analyses DCBP	PCB Analyses TCMX	Dilution Analyses DCBP	Dilution Analyses TCMX
MS	59.1	87.6	95.5	73.6		
MSD	76.8	81.5	83.4	69.8		
MB 1	87.3	67.1	89.1	69.7		
MB 2	58.8	58.1	79.5	60.8		
SB	**49.2**	85.9				
1-LS	127.0	79.8	115.0	84.7	**166.0**	103.0
1-C	83.0	**44.3**	75.7	69.7		
2-LS	95.4	49.5	86.5	70.0	134.0	77.9
3-LS	90.7	75.2	85.7	73.6	150.0	88.0
4-LS	86.8	51.8	82.0	75.4		
5-LS	85.7	73.6	75.6	70.7	141.0	79.5
6-LS	76.1	47.1	64.2	63.0		
7-LS	73.5	70.2	64.6	63.9		
8-LS	65.9	81.1	71.6	71.0	149.0	95.9
9-LS	84.8	56.2	74.1	69.1		
10-LS	80.8	73.9	75.3	67.9	115.0	77.2
11-LS	82.5	66.3	80.0	77.7	108.0	86.2
12-LS	69.0	72.6	62.7	65.2	**162.0**	84.3
13-1-LS	72.0	58.4	69.9	67.7	125.0	89.9
13-2-LS	67.0	61.7	77.5	68.5	**159.0**	91.3
13-3-LS	70.8	75.6	76.5	68.9	**152.0**	88.1
14-LS	70.1	67.9	66.6	70.0	149.0	86.5
15-C	67.0	72.4	68.4	66.0	149.0	85.7

TCMX = Tetrachloro-m-xylene, DCBP = Decachlorobiphenyl

[1] Target compounds from Method 8080 analyzed 7/18-7/21/93

[2] Additional target compounds analyzed 7/31/93

U.S. EPA (1991) advisory limits for percent recovery are 60-150 for both compounds

Laboratory in-house limits for percent recovery are 46-131 percent for TCMX and 54-138 percent for DCBP

Values in bold exceed both U.S. EPA and laboratory QC guidelines

TABLE 4. PESTICIDE/PCB MATRIX SPIKE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

MS/MSD - Sample 13-S
Analyzed 7/18/93

	MS % Rec.	MSD % Rec	% RPD	QC LIMITS %RPD	QC LIMITS %REC
Lindane	73.9	77.6	4.9	50.0	46-127
Heptachlor	102	88.9	13.7	31.0	35-130
Aldrin	79.2	78.9	0.4	43.0	34-132
Dieldrin	84.3	81.8	3.0	38.0	31-134
Endrin	69.3	68.6	1.0	45.0	42-139
4,4'-DDT	93.8	87.2	7.3	50.0	23-134

MS/MSD- Sample 11-CF
Analyzed 8/15/93

	MS % Rec.	MS % Rec	% RPD	QC LIMITS %RPD	QC LIMITS %REC
Lindane	69.9	112	46.3	50.0	46-127
Heptachlor	67.9	72.5	6.6	31.0	35-130
Aldrin	92.7	89.6	3.4	43.0	34-132
Dieldrin	79.1	82.5	4.2	38.0	31-134
Endrin	92.5	100	7.8	45.0	42-139
4,4'-DDT	94.7	97.7	3.1	50.0	23-134

MS/MSD - Sample 10-LS
Analyzed 8/28/93

	MS % Rec.	MSD % Rec	% RPD	QC LIMITS %RPD	QC LIMITS %REC
Lindane	121	123	1.6	50.0	46-127
Heptachlor	90.3	90.3	0.0	31.0	35-130
Aldrin	**179**	**167**	6.9	43.0	34-132
Dieldrin	**141**	131	7.4	38.0	31-134
Endrin	132	121	8.7	45.0	42-139
4,4'-DDT	121	105	14.2	50.0	23-134

TABLE 5A. PESTICIDE SPIKE BLANK RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Spike Blank 1 (1st set sediment)
Analyzed 7/18/93

	SPIKE ADDED (µg/kg)	SAMPLE CONC. (µg/kg)	% Rec.	QC LIMITS
Lindane	8.33	0	73.5	46-127
Heptachlor.	8.33	0	71.8	35-130
Aldrin	8.33	0	65.2	34-132
Dieldrin	16.7	0	67.7	31-134
Endrin	16.7	0	74.3	42-139
4,4'-DDT	16.7	0	69.5	23-134

Spike Blank 2 (2nd set sediment)
Analyzed 7/18/93

	SPIKE ADDED (µg/kg)	SAMPLE CONC. (µg/kg)	% Rec.	QC LIMITS
Lindane	8.33	0	79.2	46-127
Heptachlor	8.33	0	81.6	35-130
Aldrin	8.33	0	70.5	34-132
Dieldrin	16.7	0	71.9	31-134
Endrin	16.7	0	79.0	42-139
4,4'-DDT	16.7	0	76.0	23-134

TABLE 5B. PESTICIDE SPIKE BLANK RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Spike Blank 1 (Crayfish)
Analyzed 8/16/93

	SPIKE ADDED (µg/kg)	SAMPLE CONC. (µg/kg)	% Rec.	QC LIMITS
Lindane	24.8	0	37.5	46-127
Heptachlor	24.8	0	55.6	35-130
Aldrin	24.8	0	46.4	34-132
Dieldrin	49.5	0	60.8	31-134
Endrin	49.5	0	68.1	42-139
4,4'-DDT	49.5	0	68.1	23-134

Spike Blank 2 (Crayfish)
Analyzed 8/16/93

	SPIKE ADDED (µg/kg)	SAMPLE CONC. (µg/kg)	% Rec.	QC LIMITS
Lindane	24.8	0	46.8	46-127
Heptachlor	24.8	0	64.1	35-130
Aldrin	24.8	0	59.3	34-132
Dieldrin	49.5	0	66.9	31-134
Endrin	49.5	0	77.4	42-139
4,4'-DDT	49.5	0	75.6	23-134

TABLE 5C. PESTICIDE SPIKE BLANK RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Spike Blank (Fish) Analyzed 8/27/93				
	SPIKE ADDED (µg/kg)	SAMPLE CONC. (µg/kg)	% Rec.	QC LIMITS
Lindane	25.0	0	109	46-127
Heptachlor	25.0	0	87.2	35-130
Aldrin	25.0	0	84.4	34-132
Dieldrin	50.0	0	87.6	31-134
Endrin	50.0	0	107	42-139
4,4'-DDT	50.0	0	109	23-134

TABLE 6. PESTICIDE/PCB ANALYSIS OF SEQUIM BAY REFERENCE MATERIAL LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Chemical	Concentration (μg/kg)	95 Percent Confidence Interval
Alpha-BHC	**0.6 E**	2 - 6
Lindane	0.6	NA
Endosulfan I	11	NA
Endosulfan II	**4.5**	6 - 36
Aroclor 1254	**34**	106 - 158

NA = not available
E = estimated value due to matrix interference

Values in bold are outside the 95 percent confidence interval

TABLE 7. LABORATORY DUPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. SEDIMENT	7/18/93 Sample 13-S MS	Sample 13-S MSD	
Compound	(µg/kg)	(µg/kg)	RPD
p,p'-DDD	0.7 E	0.8 E	13.3
	7/31/93 Sample 13-S MS	Sample 13-S MSD	
Compound	(µg/kg)	(µg/kg)	RPD
p,p'-DDE	0.42	ND	--
p,p'-DDD	0.30	0.45	40.0

B. CRAYFISH	Sample 11-CF MS	Sample 11-CF MSD	
Compound	(µg/kg)	(µg/kg)	RPD
p,p'-DDE	9.9	10.0	1.0

C. FISH	Sample 11-LS MS	Sample 11-LS MSD	
Compound	(µg/kg)	(µg/kg)	RPD
p,p'-DDE	98 C	95 C	3.1
p,p'-DDD	33.0	32.0	3.1
	Sample 11-LS MS	Sample 11-LS MSD	
Compound	(µg/kg)	(µg/kg)	RPD
Aroclor 1254	1400 X	1300 X	7.4

ND = Not Detected
E = Estimated value
C = Probable concentration, but unable to confirm due to matrix interference.
X = Value greater than linear range of the detector.

TABLE 8. FIELD TRIPLICATE RESULTS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. SEDIMENT	7/18/93 Sample 9-1-S	Sample 9-2-S	Sample 9-3-S	
Compound	(µg/kg)	(µg/kg)	(µg/kg)	RSD
p,p'-DDD	0.7	0.8	0.8	7.5
Aroclor 1248	ND	7	ND	--
p,p'-DDT	ND	ND	1	--
	7/31/93 Sample 9-1-S	Sample 9-2-S	Sample 9-3-S	
Compound	(µg/kg)	(µg/kg)	(µg/kg)	RSD
p,p'-DDD	0.26	0.26	0.30	8.4
p,p'-DDE	0.30	0.26	0.27	7.5
p,p'-DDT	ND	ND	0.51	--

B. CRAYFISH	Sample 13-1-CF	Sample 13-2-CF	Sample 13-3-CF	
Compound	(µg/kg)	(µg/kg)	(µg/kg)	RSD
p,p'-DDE	10.0	13.0	12.0	13.1

C. FISH	Sample 13-1-LS	Sample 13-2-LS	Sample 13-3-LS	
Compound	(µg/kg)	(µg/kg)	(µg/kg)	RSD
p,p'-DDE	180.0	98.0	78.0	45.5
p,p'-DDD	31	21	27	19.1
p,p'-DDT	27	7.5	9.6	72.8
Aroclor 1254	68	26 J	170.0	84.2
Aroclor 1260	56	ND	37 J	--

ND = Not Detected

TABLE 9. PESTICIDES FOR SEDIMENT SAMPLES (µg/kg dry)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	p,p'-DDE	Endrin	Endosulfan II	p,p'-DDD
1-S	0.5 U	0.5 U	0.5 U/E	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
2-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
3-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
4-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
5-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
6-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
7-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	1 U
8-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	**1.2 C**	1 U	1 U	**1.6**
9-1-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	**0.7 J**
9-2-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	**0.8 J**
9-3-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	**0.8 J**
10-S	0.5 U	0.5 U	0.5 U/E	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	**0.9 J**	1 U	1 U	**2.0**
11-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	**0.6 J**
12-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	**0.8 J**	1 U	1 U	**1.3**
13-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	1 U	1 U	1 U	**0.7 J**
14-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	**0.8 J**	1 U	1 U	**0.8 J**
15-S	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1 U	**0.5 J**	1 U	1 U	**0.9 J**

	Endosulfan Sulfate	p,p'-DDT	Methoxychlor	Endrin Ketone	Endrin Aldehyde	Gamma-Chlordane	Alpha-Chlordane	Toxaphene	o,p'-DDE	o,p'-DDD	o,p'-DDT	Dicofol	Methyl Parathion
1-S	1 U/E	1 U	5 U	1 U/E	1 U	0.5 U	0.5 U	50 U	0.22 U/E	0.30 U/E	0.22 U/E	15 U/E	15 U/E
2-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
3-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
4-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
5-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
6-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
7-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.16 U/E	0.16 U/E	0.16 U/E	11 U/E	11 U/E
8-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.50 U/E	0.20 U/E	14 U/E	14 U/E
9-1-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.35 U/E	0.20 U/E	14 U/E	14 U/E
9-2-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
9-3-S	1 U	**1.2**	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.30 U/E	0.20 U/E	14 U/E	14 U/E
10-S	1 U/E	1 U	5 U	1 U/E	1 U	0.5 U	0.5 U	50 U	0.24 U/E	0.30 U/E	0.24 U/E	17 U/E	17 U/E
11-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.16 U/E	0.25 U/E	0.16 U/E	11 U/E	11 U/E
12-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.22 U/E	0.50 U/E	0.22 U/E	15 U/E	15 U/E
13-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.30 U/E	0.20 U/E	14 U/E	14 U/E
14-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.20 U/E	0.20 U/E	0.20 U/E	14 U/E	14 U/E
15-S	1 U	1 U	5 U	1 U	1 U	0.5 U	0.5 U	50 U	0.16 U/E	0.16 U/E	0.16 U/E	11 U/E	11 U/E

Data Qualifiers:

U = Undetected value

C = Indicates a probable hit which can not be confirmed due to matrix interferences

J = Value is less than the nominal detection limit

E = Estimated value

TABLE 10. PCBs FOR SEDIMENT SAMPLES (µg/kg dry)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Aroclor 1242/1016	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1221	Aroclor 1232
1-S	10 U	10 U	10 U	10 U	20 U	10 U
2-S	10 U	10 U	10 U	10 U	20 U	10 U
3-S	10 U	10 U	10 U	10 U	20 U	10 U
4-S	10 U	10 U	10 U	10 U	20 U	10 U
5-S	10 U	10 U	10 U	10 U	20 U	10 U
6-S	10 U	10 U	10 U	10 U	20 U	10 U
7-S	10 U	10 U	10 U	10 U	20 U	10 U
8-S	10 U	**11**	10 U	10 U	20 U	10 U
9-1-S	10 U	10 U/E	10 U	10 U	20 U	10 U
9-2-S	10 U	**7.3**	10 U	10 U	20 U	10 U
9-3-S	10 U	10 U	10 U	10 U	20 U	10 U
10-S	10 U	10 U	10 U	10 U	20 U	10 U
11-S	10 U	10 U	10 U	10 U	20 U	10 U
12-S	10 U	10 U	10 U	10 U	20 U	10 U
13-S	10 U	10 U	10 U	10 U	20 U	10 U
14-S	10 U	10 U/E	10 U	10 U	20 U	10 U
15-S	10 U	10 U	10 U	10 U	20 U	10 U

Data Qualifiers: U = Undetected value
E = Estimated value

TABLE 11. PESTICIDES FOR CRAYFISH SAMPLES (µg/kg wet)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	p,p'-DDE	Endrin	Endosulfan II	p,p'-DDD
2-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	6	5 U	5 U	5 U
3-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	3.8 J	5 U	5 U	5 U
4-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	3.5 J	5 U	5 U	5 U
5-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	4.5 J	5 U	5 U	5 U
6-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	3.5 J	5 U	5 U	5 U
7-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	5 U	5 U	5 U	5 U
8-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	2.8 J	5 U	5 U	5 U
9-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	3 J	5 U	5 U	5 U
10-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	2.4 J	5 U	5 U	5 U
11-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	9.3	5 U	5 U	5 U
12-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	10	5 U	5 U	5 U
13-1-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	10	5 U	5 U	5 U
13-2-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	13	5 U	5 U	5 U
13-3-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	12	5 U	5 U	5 U
14-CF	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	14	5 U	5 U	5 U

	Endosulfan Sulfate	p,p'-DDT	Methoxychlor	Endrin Ketone	Endrin Aldehyde	Gamma-Chlordane	Alpha-Chlordane	Toxaphene	o,p'-DDE	o,p'-DDD	o,p'-DDT	Dicofol	Methyl Parathion
2-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
3-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
4-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
5-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
6-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
7-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
8-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
9-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
10-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
11-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
12-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
13-1-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
13-2-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
13-3-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U
14-CF	5 U/E	5 U	25 U	5 U/E	5 U	2.5 U	2.5 U	250 U	5 U	5 U	5 U	62 U	62 U

Data Qualifiers:

U = Undetected value
J = Value is less than the nominal detection limit
E = Estimated value

TABLE 12. PCBs FOR CRAYFISH SAMPLES (µg/kg wet)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Aroclor 1242/1016	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1221	Aroclor 1232
2-S	50 U	50 U	50 U	50 U	100 U	50 U
3-S	50 U	50 U	50 U	50 U	100 U	50 U
4-S	50 U	50 U	50 U	50 U	100 U	50 U
5-S	50 U	50 U	50 U	50 U	100 U	50 U
6-S	50 U	50 U	50 U	50 U	100 U	50 U
7-S	50 U	50 U	50 U	50 U	100 U	50 U
8-S	50 U	50 U	50 U	50 U	100 U	50 U
9-1-S	50 U	50 U	50 U	50 U	100 U	50 U
9-2-S	50 U	50 U	50 U	50 U	100 U	50 U
9-3-S	50 U	50 U	50 U	50 U	100 U	50 U
10-S	50 U	50 U	50 U	**30 J**	100 U	50 U
11-S	50 U	50 U	50 U	50 U	100 U	50 U
12-S	50 U	50 U	50 U	50 U	100 U	50 U
13-S	50 U	50 U	50 U	50 U	100 U	50 U
14-S	50 U	50 U	50 U	50 U	100 U	50 U

Data Qualifiers: U = Undetected value
E = Estimated value

TABLE 13. PESTICIDES FOR FISH TISSUE SAMPLES (µg/kg wet)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Alpha-BHC	Beta-BHC	Delta-BHC	Lindane	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I	Dieldrin	p,p'-DDE	Endrin	Endosulfan II	p,p'-DDD
1-LS	2.5 U	2.5 U	8.0 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**110**	5 U	5 U	**31**
1-C	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**63**	5 U	5 U	**20**
2-LS	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**100**	5 U	5 U	**18**
3-LS	2.5 U	2.5 U	5.0 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**110**	5 U	5 U	**23**
4-LS	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**65**	5 U	5 U	**16**
5-LS	2.5 U	2.5 U	3.0 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**100**	5 U	5 U	**28**
6-LS	2.5 U	2.5 U	7.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**69**	5 U	5 U	**19**
7-LS	2.5 U/E	2.5 U	10 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**76**	5 U/E	5 U	**21**
8-LS	2.5 U/E	3.0 U	7.5 U/E	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**92**	5 U	5 U/E	**19**
9-LS	2.5 U/E	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**37**	5 U/E	5 U	**9.4**
10-LS	2.5 U/E	2.5 U	8.0 U	2.5 U/E	2.5 U	38 U	22 U	2.5 U	65 U	**86 C**	5 U/E	5 U	**31**
11-LS	2.5 U/E	2.5 U	7.0 U	2.5 U/E	2.5 U	2.5 U	6.1 U	2.5 U	5 U	**160**	5 U/E	5 U	**47**
12-LS	2.5 U/E	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**93**	5 U/E	5 U	**29**
13-1-LS	2.5 U/E	2.5 U	2.5 U	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**180**	5 U/E	5 U	**31**
13-2-LS	2.5 U/E	2.5 U	10 U/E	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**98**	5 U	5 U/E	**21**
13-3-LS	2.5 U/E	2.5 U	7.5 U/E	2.5 U/E	2.5 U	2.5 U	12 U	2.5 U	5 U	**78**	5 U	5 U/E	**27**
14-LS	2.5 U/E	2.5 U	2.5 U/E	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**98**	5 U	5 U/E	**27**
15-C	2.5 U/E	2.5 U	2.5 U/E	2.5 U/E	2.5 U	2.5 U	2.5 U	2.5 U	5 U	**100**	5 U	5 U/E	**21**

	Endosulfan Sulfate	p,p'-DDT	Methoxychlor	Endrin Ketone	Endrin Aldehyde	Gamma-Chlordane	Alpha-Chlordane	Toxaphene	o,p'-DDE	o,p'-DDD	o,p'-DDT	Dicofol	Methyl Parathion
1-LS	5 U/E	**12**	25 U	50 U/E	6 U	5 U	2.5 U	250 U	130 U	260 U	210 U	26 U	26 U
1-C	5 U/E	**3.7 J**	25 U	21 U/E	5 U	5 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
2-LS	5 U/E	**16**	25 U	42 U/E	6 U	4 U	2.6 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
3-LS	5 U/E	**13**	25 U	20 U/E	5 U	3.5 U	2.7 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
4-LS	5 U/E	**8.8**	25 U	8 U/E	5 U	3.5 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
5-LS	5 U/E	**11**	25 U	30 U/E	5 U	3.5 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
6-LS	5 U/E	**9.9**	25 U	30 U/E	5 U	3.5 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
7-LS	5 U	**11 E**	25 U	40 U	5 U	4.0 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
8-LS	5 U/E	**6.3**	25 U	25 U/E	5 U	5.0 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
9-LS	5 U	**4 J/E**	25 U	10 U	5 U	2.5 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
10-LS	5 U	**56 C/E**	25 U	200 U	5 U	44 U	6.0 U	250 U	130 U	260 U	210 U	26 U	26 U
11-LS	5 U	**13 E**	25 U	50 U	5 U	6.1 U	3.5 U	250 U	9.5 U	5.2 U	5.2 U	26 U	26 U
12-LS	5 U	**8.6 E**	25 U	5 U	5 U	4.5 U	2.6 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
13-1-LS	5 U	**27 E**	25 U	5 U	5 U	5.5 U	3.6 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
13-2-LS	5 U/E	**7.5**	25 U	30 U/E	5 U	3.1 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
13-3-LS	5 U/E	**9.6**	25 U	35 U/E	5 U	10 U	3.0 U	250 U	13 U	5.2 U	5.2 U	26 U	26 U
14-LS	5 U/E	**10**	25 U	25 U/E	5 U	4.0 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U
15-C	5 U/E	**3.9 J**	25 U	35 U/E	5 U	4.6 U	2.5 U	250 U	5.2 U	5.2 U	5.2 U	26 U	26 U

Data Qualifiers:

U = Undetected value

J = Value is less than the nominal detection limit

C = Indicates a probable hit which can not be confirmed due to matrix interferences

E = Estimated value

TABLE 14. PCBs FOR FISH TISSUE SAMPLES (µg/kg wet)
LOWER COLUMBIA BACKWATER RIVER RECONNAISSANCE SURVEY

	Aroclor 1242/1016	Aroclor 1248	Aroclor 1254	Aroclor 1221	Aroclor 1232	Aroclor 1260
1-LS	52 U	52 U	98	110 U	52 U	54
1-C	52 U	52 U	65	110 U	52 U	30 J
2-LS	52 U	52 U	84	110 U	52 U	51 J
3-LS	52 U	52 U	70	110 U	52 U	36 J
4-LS	52 U	52 U	47 J	110 U	52 U	52 U
5-LS	52 U	52 U	53	110 U	52 U	27 J
6-LS	52 U	52 U	42 J	110 U	52 U	52 U
7-LS	52 U	52 U	62	110 U	52 U	52 U
8-LS	52 U	52 U	55	110 U	52 U	31 J
9-LS	52 U	52 U	33 J	110 U	52 U	52 U
10-LS	52 U	52 U	2700	110 U	52 U	250 U
11-LS	52 U	52 U	86	110 U	52 U	41 J
12-LS	52 U	52 U	52	110 U	52 U	29 J
13-1-LS	52 U	52 U	68	110 U	52 U	56
13-2-LS	52 U	52 U	26 J	110 U	52 U	52 U
13-3-LS	52 U	52 U	170	110 U	52 U	37 J
14-LS	52 U	52 U	38 J	110 U	52 U	52 U
15-C	52 U	52 U	36 J	110 U	52 U	52 U

Data Qualifiers: U = Undetected value
J = Estimated value because it is less than the detection limit
E = Estimated value

Appendix A-8

Data Validation Report
Dioxins/Furans Analyses

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by: Tetra Tech, Inc.

Samples analyzed by: Pacific Analytical, Inc.

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey, and analyzed for dioxins and furans by Pacific Analytical, Inc. The samples were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Of the 33 tissue samples, 15 were crayfish and 18 were fish, either largescale sucker or carp. Crayfish samples were collected at only 13 of the 15 stations (all except stations 1 and 15). Triplicate field samples were collected at station 13 (samples 13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale suckers) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS).

Sediment and tissue samples were analyzed using U.S. EPA Method 1613 with some modifications made to improve the efficiency and accuracy during the data validation steps, and to reduce the occurrence of sample contamination with native 2,3,7,8-TCDD. Extraction and sample clean-up of tissue samples was performed according to guidelines outlined in Method 8290 since there are no protocols in Method 1613 for the extraction of tissue samples. The modifications made by the laboratory were consistent with procedures outlined in other EPA methods (Method 8280, Method 8290, Method 23, SAS CLP work, etc.), or have been suggested by NCASI (Method 90.01). Sample-specific Estimated Detection Limits (EDLs) have been calculated and reported according to standard EPA methods. Method 1613 does not specify how these values should be calculated and/or reported, but instead reports only the Lower Method Calibration Limit (LMCL).

Calculations and reporting of results conformed with EPA Methods. Where a peak was positively identified as one of the 2,3,7,8-substituted PCDD/PCDF isomers by passing all the QA criteria (retention times, analyte isotope ratios, and signal-to-noise ratios), a concentration was calculated in the usual manner and reported. Where the chromatogram was characterized by the absence of peaks in both native channels at the appropriate retention times, or where a peak was present in one or both channels but does not pass the signal-to-noise criteria of 2.5:1, the analyte could not be positively identified and was reported by the laboratory as Not Detected (ND) at or above the sample-specific Estimated Detection Limit (EDL). A data-review specialist inspected each of these chromatograms and calculated an EDL based on the reporting requirements specified in EPA Method 8290. These data were qualified by Tetra Tech reviewers with the a "U" and an "E" (appearing as "U/E") to indicate that the reported value is the EDL.

The data validation review was conducted according to guidelines presented in the U.S. EPA Functional Guidelines for Evaluating Data from IFB WA84-A002 Chemical Analytical Services for 2,3,7,8-tetrachlorodibenzo-p-dioxin (U.S. EPA 1985), procedures outlined in EPA Methods 1613 and 8290, and in consideration of laboratory evaluations of the data and analytical methods and the approved Sampling and QA/QC Plan for this project (Tetra Tech 1993).

A. HOLDING TIMES

Sediment and tissue samples were collected, placed on ice or frozen (tissue) in a cooler, and transported to the laboratory within 4 days of collection. The maximum recommended holding time (time of collection to time of extraction) for dioxins and furans in sediment/soil matrices has been established as one year in Method 1613. The recommended holding time between extraction and analysis is 40 days. The maximum recommended holding times for dioxin/furan analyses in tissue matrices for Method 8290 is 30 days from collection until extraction and 45 days from collection until analysis. The holding time established for this project was 14 days from collection to extraction and 40 days from collection until analysis. Table 1 presents a summary of sample numbers, dates collected, dates extracted, dates of analyses, and holding times. The holding times for extraction and analysis were met for all samples with the exception of three sediment samples (9-2-S, 9-3-S, and 11-S). Project-specific holding times between collection and extraction were exceeded by 10 days for these three samples because they were reextracted after it was determined that recoveries of labeled tetra congeners were outside of QC limits. However, because the 14 day extraction holding time was specific to this project and not based on method-specific holding times, no data qualifiers were assigned to these or any other sample results based on holding times.

B. CALIBRATION AND INSTRUMENT PERFORMANCE

Sediment

The initial calibration conducted on 7/19/93 was valid for all sediment samples. The mean relative response (RR) and the ion abundance ratios for the calibration solutions CS1 to CS5 were within QC guidelines for both native analytes (< 20 percent RSD for RR) and labelled compounds (< 30 percent RSD for RR).

The initial calibration was verified before each shift during which sediment samples were analyzed (7/20, 7/22, 7/23, and 7/28/93) through the analysis of calibration solution CS3. Ion abundance ratios were within QC limits for all continuing calibrations. The concentrations found for each native analyte and labelled compound were within the contract-required concentration range for all continuing calibrations. The continuing calibrations were further verified by examining the analyses of the isomer specificity standards. The percent valley height between compared peaks (1238-TCDD vs. 2378-TCDD) was less than 25 percent on all four days on which sediment samples were analyzed. These results indicate that GC resolution was adequate. The relative retention times for each of the native analytes and labelled compounds were within QC limits for all four days on which sediment samples were analyzed. Continuing calibration results indicate that the initial calibration remained valid throughout the analysis period of 7/20 to 7/28/93.

Crayfish

The initial calibration conducted on 8/10/93 was valid for all crayfish samples. The mean relative response (RR) and the ion abundance ratios for the calibration solutions CS1 to CS5 were within QC guidelines for both native analytes (< 20 percent RSD for RR) and labelled compounds (< 30 percent RSD for RR), with one minor exception. The RSD for OCDF, which is calculated relative to the labeled analog of OCDD, was 20.3. This deviation was considered minor and no action was taken by the laboratory.

The initial calibration was verified before each shift during which crayfish samples were analyzed (8/11,

8/12, and 8/13/93) through the analysis of calibration solution CS3. Ion abundance ratios were within QC limits for all continuing calibrations. The concentrations found for each native analyte and labelled compound were within the contract-required concentration range for all continuing calibrations. The continuing calibrations were further verified by examining the analyses of the isomer specificity standards. The percent valley height between compared peaks (1238-TCDD vs. 2378-TCDD) was less than 25 percent on all four days on which crayfish samples were analyzed. These results indicate that GC resolution was adequate. The relative retention times for each of the native analytes and labelled compounds were within QC limits for all four days on which crayfish samples were analyzed. Continuing calibration results indicate that the initial calibration remained valid throughout the analysis period of 8/10 to 8/13/93.

Fish

The initial calibration conducted on 8/25/93 was valid for all fish samples. The mean relative response (RR) and the ion abundance ratios for the calibration solutions CS1 to CS5 were within QC guidelines for both native analytes (< 20 percent RSD for RR) and labelled compounds (< 30 percent RSD for RR), with two minor exceptions. The RSD for OCDF, which is calculated relative to the labeled analog of OCDD, was 23.0 percent and the RSD for ^{13}C-12378-PeCDF was 31.6 percent. Both of these deviations were considered minor and no actions were taken by the laboratory.

The initial calibration was verified before each shift during which fish samples were analyzed (8/26, 8/27, 8/31, and 9/1/93) through the analysis of calibration solution CS3. Ion abundance ratios were within QC limits for all continuing calibrations. The concentrations found for each native analyte and labelled compound were within the contract-required concentration range for all continuing calibrations. The continuing calibrations were further verified by examining the analyses of the isomer specificity standards. The percent valley height between compared peaks (1238-TCDD vs. 2378-TCDD) was less than 25 percent on all four days on which fish samples were analyzed. These results indicate that GC resolution was adequate. The relative retention times for each of the native analytes and labelled compounds were within QC limits for all four days on which fish samples were analyzed. Continuing calibration results indicate that the initial calibration remained valid throughout the analysis period of 8/26 to 9/1/93.

C. LABELED COMPOUND AND CLEANUP STANDARD RECOVERIES

The spiking levels for labeled compounds and cleanup standards were identical to those specified in EPA Method 1613. All field, blank, and matrix spike samples were spiked with the isotopic compounds before analysis.

Sediment

Percent recoveries for all isotopically labeled congeners for all analyses were within the advisory recovery limits of 25-150 percent for sediment specified in EPA Method 1613, with the exception of ^{13}C-12378-PeCDF, for which a percent recovery of 1 percent was calculated for three different samples (1-S, 4-S, and 5-S). The native analyte 12378-PeCDF was not detected above the EDL for any of the samples. Because these samples have already been qualified as estimates for this congener due to the necessity of calculating an EDL, no additional qualification of the data was necessary.

Crayfish

Percent recoveries for all isotopically labeled congeners for all analyses were within the advisory recovery limits of 25-150 percent for crayfish specified in EPA Method 1613. No data qualification was necessary

based on percent recoveries of these compounds.

Fish
Percent recoveries for all isotopically labeled congeners for all analyses were within the advisory recovery limits of 25-150 percent for sediment specified in EPA Method 1613, with the exception of ^{13}C-234678-HxCDF, for which percent recoveries of 160-170 percent were calculated for three different blank samples (8/25, 8/26, and 8/27/93). The native analyte 234678-HxCDF was not detected above the EDL in any of these blank samples. Also, because these samples have already been qualified as estimates for this congener due to the necessity of calculating an EDL, no additional qualification of the data was necessary.

D. METHOD BLANKS

Sediment
A total of three method blanks were analyzed during the sediment analyses. No method blank was analyzed on 7/23/93, although three samples (13-S, 14-S, and 15-S) were analyzed on that day. The results of the blank analyses are presented in Table 2. None of the 17 congeners were detected above the EDL, with the exception of OCDD, which was detected at 36.8 ng/kg in the blank analyzed on 7/28/93. The laboratory could not determine the source and distribution of the contamination. For three samples analyzed on 7/28/93 (9-2-S, 9-3-S, and 11-S), OCDD was reported as "detected" at 53.4, 19.5, and 46.9 ng/kg, respectively. Because these amounts are all less than 2X the amount detected in the blank, they will be qualified as "U/B" (undetected) based on blank contamination. OCDD was also detected in two of the three samples (14-S and 15-S) analyzed on 7/23/93. The positive values for samples 14-S and 15-S were qualified as "E" (estimated), because the distribution of the OCDD contamination was not determined and no blank sample was analyzed on 7/23/93.

Crayfish
A total of six method blanks were analyzed during the crayfish analyses. Four of these blanks were analyzed on the four days during which crayfish samples were analyzed (8/10-8/13/93) and are reported in Table 2, while two blanks were analyzed on the two days during which 2378-TCDF confirmation occurred (8/16-8/17/93). None of the congeners were detected above the EDL for any of the blank samples. No data qualification was necessary based method blank results for crayfish analyses.

Fish
A total of six method blanks were analyzed during the fish analyses. The results of the blank analyses are presented in Table 2. None of the congeners were detected above the EDL for any of the blank samples. No data qualification was necessary based method blank results for the fish analyses.

E. PAR SAMPLES

Sediment
Three Precision and Recovery (PAR) samples were analyzed with the sediment samples. Results, given as percent recoveries, are listed in Table 3. Recovery for the various analytes is a measure of laboratory accuracy. The recoveries of the native analytes and labeled compounds were all within method QC guidelines, with the exception of ^{13}C-OCDD, which was recovered at 20.1 percent (QC guidelines 25-150 percent) of the spiked amount in the 7/28/93 PAR sample. Because the deviation was minor and the

native analyte OCDD was recovered within QC guidelines (111 percent), OCDD sample data for 7/28/93 (samples 9-2-S, 9-3-S, and 11-S) were not qualified.

Crayfish

Three Precision and Recovery (PAR) samples were analyzed with the crayfish samples. Results, given as percent recoveries, are listed in Table 3. The recoveries of the native analytes and labeled compounds were all within method QC guidelines. No data qualifiers were added to crayfish sample results due to PAR sample recoveries.

Fish

One Precision and Recovery (PAR) sample was analyzed with the fish samples. Results, given as percent recoveries, are listed in Table 3. The recoveries of the native analytes and labeled compounds were all within method QC guidelines. No data qualifiers were added to fish sample results due to PAR sample recoveries.

F. MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSIS

Sediment

One MS/MSD analysis was performed on sediment sample 13-S on 7/23/93. Native analytes and labeled compounds were spiked at concentrations equal to those used in the PAR samples. Results, given as percent recoveries, are presented in Table 4. All percent recoveries were within method QC guidelines with the exception of OCDD in sample 13-S_MSD, which was recovered at 144.1 percent, slightly above the upper QC boundary of 141.4 percent. The RPD between the MS and MSD for OCDD (38.3 percent) was outside the QC guidelines specified in the project sampling and QA/QC plan (± 20 percent). These results make the accuracy and precision of the OCDD analyses performed on 7/23/93 somewhat questionable. The OCDD results for the samples analyzed on 7/23/93 (samples 13-S, 14-S, and 15-S) were qualified as estimates. For two of the internal standards (^{13}C-1234678-HpCDD and ^{13}C-1234789-HpCDF), the RPD was also slightly greater than 20 percent (20.9 and 23.4, respectively). Because QC data for the native analyte corresponding to these internal standards were within QC guidelines, no data qualifiers were added to these samples based on these minor deviations. No other data qualifiers were assigned to sediment data based on MS/MSD results.

Crayfish

One MS/MSD analysis was performed on crayfish sample 11-CF on 8/11/93. Native analytes and labeled compounds were spiked at concentrations equal to those used in the PAR samples. Results, given as percent recoveries, are presented in Table 4. All percent recoveries were within method QC guidelines with the exception of 23478-PeCDF in both the MS and the MSD, for which the recoveries were both 147 percent, slightly outside the upper QC boundary (144 percent). Because the deviation was very slight, and the precision between the two analyses was excellent; no data qualifiers were added to 23478-PeCDF results. No data qualifiers were assigned to crayfish data based on MS/MSD results.

Fish

One MS/MSD analysis was performed on fish sample 1-LS on 8/26/93. Native analytes and labeled compounds were spiked at concentrations equal to those used in the PAR samples. Results, given as percent recoveries, are presented in Table 4. All percent recoveries were within method QC guidelines with the exception of 2378-TCDD, which was recovered at 141.0 percent, slightly above the upper QC boundary of 138.0 percent, and 2378-TCDF, which was recovered at 177.0 and 161.0 percent in the MS

and MSD, respectively, well above the acceptance criterion of 152. The 2378-TCDD was considered to be minor, but the 2378-TCDF results make the accuracy of the results questionable. The 2378-TCDF results for samples analyzed on 8/26/93 (1-LS, 3-LS, 5-LS, 6-LS, and 7-LS) were qualified as estimates based on these results. For two of the internal standards (^{13}C-12378-PeCDD and ^{13}C-23478-PeCDF), the RPD was slightly greater (23.3 and 23.5, respectively) than the $\pm$ 20 percent acceptance criterion specified in the project sampling and QA/QC plan (Tetra Tech 1993). Because QC data for the native analyte corresponding to these internal standards were within QC guidelines, no data qualifiers were added to these samples based on these minor deviations. No other data qualifiers were assigned to sediment data based on MS/MSD results.

G. FIELD TRIPLICATES

Sediment

One set of field triplicate samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). None of the seventeen 2378-congeners were detected in any of the three samples (Table 5). The laboratory reported positive values for OCDD in both samples 9-2-S and 9-3-S, but these have been qualified as undetected based on contamination detected in the blank (see section D). No estimate of field variability can be made using these sample results.

Crayfish

One set of field triplicate samples were collected at station 13 (sample 13-1-CF, 13-2-CF, and 13-3-CF). Only 2378-TCDF was detected in all three samples (Table 5). The congeners 2378-TCDD and 1234678-HpCDF were detected in sample 13-3-CF, but not in the other two samples. The RSD for the three 2378-TCDF values is approximately 20 percent. No other assessment of field variability is possible given the lack of additional positive values.

Fish

One set of field triplicate samples were collected at station 13 (sample 13-1-LS, 13-2-LS, and 13-3-LS). Several congeners were detected in each of the samples (Table 5). Five congeners (1234678-HpCDD, OCDD, 2378-TCDF, 123789-HxCDF, and 123678-HxCDF) were detected in all three samples. The RSDs between the three samples ranged from 20.4 percent for 234678-HxCDF to 57.8 percent for OCDD. Seven other congeners were detected in at least one of the three samples. Data qualifiers should not be assigned to sample results based on field triplicate results.

SUMMARY

Sediment

All sediment sample data were reported as ng/kg dry weight and are presented in Table 6. The data package submitted by the laboratory contained all the required deliverables. The estimated detection limits reported by the laboratory (0.3-10.2 ng/kg dry weight) were generally less than the detection limits specified in the sampling and QA/QC plan (Tetra Tech 1993)(1-10 ng/kg dry weight).

For the majority of the sample results, the data are reported as undetected at the sample-specific estimated detection limit (EDL). These data have been qualified as "U/E" to represent that the detection limit has been calculated by examining signal to noise data from each chromatogram and should be considered an estimate.

OCDD data for several samples were qualified based on an evaluation of all QA/QC data. Data for samples 9-2-S, 9-3-S, and 11-S, although reported as positive values by the laboratory, were qualified as undetected ("U") based on blank contamination. OCDD data for samples 14-S and 15-S were qualified as estimates ("E") based on blank contamination and the inadequate precision exhibited for this compound in the matrix spike/matrix spike duplicate analyses.

Based on the analysis of all available QA/QC data, dioxin and furan data for sediments are acceptable for their intended use.

Crayfish

All crayfish sample data were reported as ng/kg wet weight and are presented in Table 7. The data package submitted by the laboratory contained all the required deliverables. The estimated detection limits reported by the laboratory (0.1-5.6 ng/kg wet weight) were less than the detection limits specified in the sampling and QA/QC plan (Tetra Tech 1993)(1-10 ng/kg wet weight).

The congener 2378-TCDF was detected in all samples. A second column confirmation, using a Rtx-200 column, was performed for each sample. The values reported in Table 7 are from the second column confirmation.

For the majority of the sample results, the data are reported as undetected at the sample-specific estimated detection limit (EDL). These data have been qualified as "U/E" to represent that the detection limit has been calculated by examining signal to noise data from each chromatogram and should be considered an estimate.

No data qualifiers were added to sample results based on the evaluation of QC data. Based on the analysis of all available QA/QC data, dioxin and furan data for crayfish are acceptable for their intended use.

Fish

All fish sample data were reported as ng/kg wet weight and are presented in Table 8. The data package

submitted by the laboratory contained all the required deliverables. The estimated detection limits reported by the laboratory (0.1-2.5 ng/kg wet weight) were less than the detection limits specified in the sampling and QA/QC plan (Tetra Tech 1993)(1-10 ng/kg wet weight).

The congener 2378-TCDF was detected in all but one of the fish samples. A second column confirmation, using a Rtx-200 column, was performed for each sample. Concentrations detected in the second column were often considerably higher (10X) than the primary analysis. Examination of the SIR chromatograms indicated a response in the 376 trace for the chlorinated ether in most instances. This interference was not present in the primary column. Therefore, the values reported in Table 8 are from the primary column and not the secondary column.

Results for 2378-TCDF in several samples (1-LS, 3-LS, 5-LS, 6-LS, and 7-LS) were qualified as estimated due to unreasonably high recovery of the congener in matrix spike and matrix spike duplicate samples.

For the majority of the sample results, the data are reported as undetected at the sample-specific estimated detection limit (EDL). These data have been qualified as "U/E" to represent that the detection limit has been calculated by examining signal to noise data from each chromatogram and should be considered an estimate.

No other data qualifiers were added to sample results based on the evaluation of QC data. Based on the analysis of all available QA/QC data, dioxin and furan data for fish are acceptable for their intended use.

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TABLE 1. DIOXIN/FURAN ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Pacific Analytical Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Sediment							
1-S	58101	6/28/93	6/30/93	7/6/93	7/20/93	8	22
2-S	58102	6/27/93	6/30/93	7/6/93	7/20/93	9	23
3-S	58103	6/27/93	6/30/93	7/6/93	7/20/93	9	23
4-S	58104	6/26/93	6/30/93	7/6/93	7/20/93	10	24
5-S	58105	6/26/93	6/30/93	7/6/93	7/20/93	10	24
6-S	58106	6/25/93	6/30/93	7/6/93	7/20/93	11	25
7-S	58107	6/25/93	6/30/93	7/6/93	7/20/93	11	25
8-S	58108	6/24/93	6/30/93	7/6/93	7/20/93	12	26
9-1-S	58901	6/29/93	7/3/93	7/9/93	7/22/93	10	23
9-2-S	58902R	6/29/93	7/3/93	7/23/93	7/28/93	24	29
9-3-S	58903R	6/29/93	7/3/93	7/23/93	7/28/93	24	29
10-S	58109	6/28/93	6/30/93	7/6/93	7/20/93	8	22
11-S	58904RX	6/29/93	7/3/93	7/23/93	7/28/93	24	29
12-S	58905	6/30/93	7/3/93	7/9/93	7/22/93	9	22
13-S	58906	7/1/93	7/3/93	7/9/93	7/23/93	8	22
14-S	58907	7/1/93	7/3/93	7/9/93	7/23/93	8	22
15-S	58908	6/30/93	7/3/93	7/9/93	7/23/93	9	23
Crayfish							
2-CF	60910	7/22/93	7/27/93	8/2/93	8/12/93	11	21
3-CF	60911	7/22/93	7/27/93	8/2/93	8/12/93	11	21
4-CF	60912	7/24/93	7/27/93	8/2/93	8/12/93	9	19
5-CF	60913	7/23/93	7/27/93	8/2/93	8/12/93	10	20
6-CF	60901	7/16/93	7/21/93	7/27/93	8/10/93	11	25
7-CF	60902	7/16/93	7/21/93	7/27/93	8/11/93	11	26
8-CF	60903	7/16/93	7/21/93	7/27/93	8/11/93	11	26
9-CF	60904	7/16/93	7/21/93	7/27/93	8/11/93	11	26
10-CF	60914	7/20/93	7/27/93	8/2/93	8/13/93	13	24
11-CF	60905	7/18/93	7/21/93	7/27/93	8/11/93	9	24
12-CF	60915	7/20/93	7/27/93	8/2/93	8/13/93	13	24
13-1-CF	60906	7/18/93	7/21/93	7/27/93	8/11/93	9	24
13-2-CF	60907	7/18/93	7/21/93	7/27/93	8/13/93	9	26
13-3-CF	60908	7/18/93	7/21/93	7/27/93	8/12/93	9	25
14-CF	60909	7/18/93	7/21/93	7/27/93	8/12/93	9	25
Fish							
1-LS	63001	8/6/93	8/10/93	8/12/93	8/26/93	6	20
1-C	63002	8/6/93	8/10/93	8/12/93	8/25/93	6	19
2-LS	63003	8/6/93	8/10/93	8/12/93	8/25/93	6	19
3-LS	63004	8/5/93	8/10/93	8/12/93	8/26/93	7	21
4-LS	63005	8/5/93	8/10/93	8/12/93	8/31/93	7	26
5-LS	63006	8/5/93	8/10/93	8/12/93	8/26/93	7	21
6-LS	63007	8/5/93	8/10/93	8/12/93	8/26/93	7	21
7-LS	63008	8/5/93	8/10/93	8/12/93	8/26/93	7	21
8-LS	63009	8/5/93	8/10/93	8/12/93	8/27/93	7	22
9-LS	63010	8/5/93	8/10/93	8/12/93	8/27/93	7	22
10-LS	63011	8/4/93	8/10/93	8/12/93	8/27/93	8	23
11-LS	63012	8/4/93	8/10/93	8/12/93	8/27/93	8	23
12-LS	63013	8/4/93	8/10/93	8/12/93	8/27/93	8	23
13-1-LS	63014	8/3/93	8/10/93	8/12/93	8/27/93	9	24
13-2-LS	63015	8/3/93	8/10/93	8/12/93	8/27/93	9	24
13-3-LS	63016	8/3/93	8/10/93	8/12/93	8/31/93	9	28
14-LS	63017	8/3/93	8/10/93	8/12/93	9/1/93	9	29
15-C	63018	8/3/93	8/10/93	8/12/93	8/31/93	9	28

TABLE 2. METHOD BLANK RESULTS (ng/kg)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins Date Analyzed	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
Sediment							
7/20/93	0.3 U/E	0.8 U/E	0.5 U/E	0.4 U/E	0.7 U/E	0.6 U/E	2.9 U/E
7/22/93	0.5 U/E	0.8 U/E	1.0 U/E	1.0 U/E	1.3 U/E	1.2 U/E	1.7 U/E
7/28/93	0.9 U/E	0.7 U/E	0.5 U/E	0.6 U/E	0.7 U/E	3.2 U/E	**36.8**
Crayfish							
8/10/93	0.2 U/E	0.5 U/E	0.3 U/E	0.4 U/E	0.4 U/E	1.2 U/E	1.1 U/E
8/11/93	0.2 U/E	0.2 U/E	0.3 U/E	0.3 U/E	0.4 U/E	0.4 U/E	0.6 U/E
8/12/93	0.2 U/E	0.4 U/E	0.4 U/E	0.6 U/E	0.6 U/E	1.1 U/E	1.1 U/E
8/13/93	0.2 U/E	0.3 U/E	0.2 U/E	0.3 U/E	0.2 U/E	0.4 U/E	0.5 U/E
Fish							
8/25/93	0.1 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.3 U/E
8/26/93	0.2 U/E	0.3 U/E	0.2 U/E	0.3 U/E	0.2 U/E	0.3 U/E	0.7 U/E
8/27/93	0.1 U/E	0.2 U/E	0.2 U/E	0.3 U/E	0.2 U/E	0.2 U/E	0.5 U/E
8/31/93	0.1 U/E	0.2 U/E	0.2 U/E	0.3 U/E	0.2 U/E	0.3 U/E	0.6 U/E
8/31/93	0.1 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E
9/1/93	0.1 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.1 U/E	0.3 U/E

Furans Date Analyzed	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
Sediment										
7/20/93	0.2 U/E	0.2 U/E	0.2 U/E	0.9 U/E	0.9 U/E	1.1 U/E	0.9 U/E	0.3 U/E	0.4 U/E	0.5 U/E
7/22/93	0.4 U/E	0.6 U/E	0.6 U/E	1.2 U/E	1.2 U/E	1.6 U/E	1.4 U/E	0.6 U/E	0.8 U/E	0.6 U/E
7/28/93	0.4 U/E	0.3 U/E	0.4 U/E	1.1 U/E	1.0 U/E	1.6 U/E	1.1 U/E	2.7 U/E	3.7 U/E	3.0 U/E
Crayfish										
8/10/93	0.2 U/E	0.2 U/E	0.2 U/E	0.6 U/E	0.5 U/E	1.0 U/E	0.5 U/E	0.4 U/E	0.7 U/E	1.2 U/E
8/11/93	0.1 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.3 U/E	0.2 U/E	0.2 U/E	0.4 U/E	0.5 U/E
8/12/93	0.2 U/E	0.3 U/E	0.3 U/E	0.5 U/E	0.5 U/E	0.8 U/E	0.5 U/E	0.6 U/E	0.4 U/E	0.6 U/E
8/13/93	0.1 U/E	0.2 U/E	0.2 U/E	0.3 U/E	0.3 U/E	0.5 U/E	0.3 U/E	0.2 U/E	0.3 U/E	0.3 U/E
Fish										
8/25/93	0.2 U/E	0.2 U/E	0.2 U/E	0.6 U/E	0.5 U/E	1.0 U/E	0.5 U/E	0.4 U/E	0.7 U/E	1.2 U/E
8/26/93	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.3 U/E	0.4 U/E
8/27/93	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.2 U/E
8/31/93	0.1 U/E	0.2 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.2 U/E
8/31/93	0.1 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.1 U/E
9/1/93	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E

Data qualifiers: U/E = Congener undetected at the given estimated detection limit (EDL)

TABLE 3. PERFORMANCE AND RECOVERY RESULTS (Percent Recovery)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins (native analytes and labeled compounds)

Date Analyzed	2378-TCDD	13C-2378-TCDD	12378-PeCDD	13C-12378-PeCDD	123478-HxCDD	13C-123478-HxCDD	123678-HxCDD	13C-123678-HxCDD	123789-HxCDD	1234678-HpCDD	13C-1234678-HpCDD	OCDD	13C-OCDD
Sediment													
7/19/93	99.0	68.9	130.6	84.3	132.6	61.7	104.0	81.7	109.0	95.6	71.3	93.3	57.9
7/22/93	104.0	56.0	93.0	75.4	89.4	96.0	93.4	85.2	80.2	88.6	66.4	82.1	52.0
7/28/93	108.0	34.5	98.2	75.6	95.6	83.1	101.4	90.4	83.6	97.4	62.5	111.0	20.1
Crayfish													
8/10/93	105.0	64.3	105.4	89.7	103.4	106.6	103.8	88.2	92.8	96.0	82.0	88.2	75.5
8/12/93	116.0	58.9	124.8	94.1	120.8	103.0	112.8	87.3	102.8	105.2	89.9	112.0	35.2
Fish													
8/25/93	108.0	43.0	124.0	35.7	120.0	78.2	118.4	62.1	95.2	121.0	64.9	126.0	78.0

Furans (native analytes and labeled compounds)

Date Analyzed	2378-TCDF	13C-2378-TCDF	12378-PeCDF	13C-12378-PeCDF	23478-PeCDF	13C-23478-PeCDF	123478-HxCDF	13C-123478-HxCDF	123678-HxCDF	13C-123678-HxCDF	123789-HxCDF	13C-123789-HxCDF	234678-HxCDF	13C-234678-HxCDF	1234678-HpCDF	13C-1234678-HpCDF	1234789-HpCDF	13C-1234789-HpCDF	OCDF
Sediment																			
7/19/93	100.0	79.8	125.2	80.2	122.2	108.6	106.0	72.6	106.2	74.9	109.2	68.9	108.4	75.5	113.0	60.2	111.0	62.8	99.0
7/22/93	125.0	71.8	93.2	71.9	124.2	71.5	110.0	78.5	105.6	81.5	104.2	65.1	108.0	75.2	110.0	64.3	104.8	54.3	84.9
7/28/93	113.0	83.8	100.2	73.1	126.2	74.5	113.0	77.0	109.4	86.1	108.0	71.0	110.2	86.3	110.4	64.4	112.0	59.6	110.0
Crayfish																			
8/10/93	108.0	93.7	100.8	87.8	125.6	92.7	108.4	91.2	97.0	113.8	102.0	94.6	104.4	91.1	100.0	79.9	95.0	85.0	87.0
8/12/93	126.0	89.0	117.4	94.1	139.8	101.0	116.8	83.6	117.6	84.4	115.2	87.5	115.4	85.2	115.4	79.0	109.8	87.3	105.0
Fish																			
8/25/93	115.0	37.8	121.0	32.5	119.0	39.9	122.6	45.7	122.2	47.3	118.4	55.3	113.2	96.9	120.0	55.9	120.2	72.0	115.0

TABLE 4. MATRIX SPIKE/MATRIX SPIKE DUPLICATE RESULTS (Percent Recovery)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins (native analytes and labeled compounds)

Sample Number	2378-TCDD	13C-2378-TCDD	12378-PeCDD	13C-12378-PeCDD	123478-HxCDD	13C-123478-HxCDD	123678-HxCDD	13C-123678-HxCDD	123789-HxCDD	1234678-HpCDD	13C-1234678-HpCDD	OCDD	13C-OCDD
Sediment													
13-S_MS	99.5	67.2	102.0	92.1	89.3	120.6	101.7	94.9	84.9	91.3	81.5	97.8	52.5
13-S_MSD	98.5	62.3	99.9	89.0	93.0	116.5	96.8	87.0	82.8	98.2	66.1	**144.1**	43.9
RPD	1.0	7.6	2.1	3.4	4.1	3.5	4.9	8.7	2.5	7.3	**20.9**	**38.3**	17.8
Crayfish													
11-CF_MS	115.0	63.7	119.6	107.9	114.6	81.3	121.4	74.4	119.8	116.2	71.5	111.4	32.9
11-CF_MSD	112.0	67.2	118.8	109.7	115.4	86.9	117.0	72.9	119.8	116.4	78.4	110.8	48.8
RPD	2.6	5.3	0.7	1.7	0.7	6.7	3.7	2.0	0.0	0.2	9.2	0.5	**38.9**
Fish													
1-LS_MS	**141.0**	103.3	120.2	94.7	120.0	96.9	118.2	98.0	105.6	116.6	66.8	112.8	33.8
1-LS_MSD	**141.0**	103.5	119.8	119.7	118.6	100.0	115.8	96.2	103.8	115.4	68.5	108.0	36.2
RPD	0.0	0.2	0.3	**23.3**	1.2	3.1	2.1	1.9	1.7	1.0	2.5	4.3	6.9

Furans (native analytes and labeled compounds)

Sample Number	2378-TCDF	13C-2378-TCDF	12378-PeCDF	13C-12378-PeCDF	23478-PeCDF	13C-23478-PeCDF	123478-HxCDF	13C-123478-HxCDF	123678-HxCDF	13C-123678-HxCDF	123789-HxCDF	13C-123789-HxCDF	234678-HxCDF	13C-234678-HxCDF	1234678-HpCDF	13C-1234678-HpCDF	1234789-HpCDF	13C-1234789-HpCDF	OCDF
Sediment																			
13-S_MS	112.5	87.0	95.5	85.7	121.7	83.7	109.0	81.8	102.5	89.6	105.9	77.1	107.4	82.3	108.5	75.7	106.3	68.7	94.3
13-S_MSD	109.5	81.1	93.0	79.8	123.3	79.0	108.2	75.9	106.9	76.4	104.9	74.8	107.7	74.8	109.2	65.2	108.6	54.3	98.6
RPD	2.7	7.0	2.7	7.1	1.3	5.8	0.7	7.5	4.2	15.9	0.9	3.0	0.3	9.5	0.6	14.9	2.1	**23.4**	4.5
Crayfish																			
11-CF_MS	150.0	88.5	123.6	135.7	**147.6**	110.1	122.0	71.5	118.4	70.4	116.2	74.6	116.0	74.9	115.2	74.1	107.0	71.0	106.3
11-CF_MSD	147.0	84.2	126.2	143.5	**147.0**	103.7	119.6	67.7	120.6	65.8	116.4	76.7	117.2	72.5	118.6	76.0	110.0	82.3	111.2
RPD	2.0	5.0	2.1	5.6	0.4	6.0	2.0	5.5	1.8	6.8	0.2	2.8	1.0	3.3	2.9	2.5	2.8	14.7	4.5
Fish																			
1-LS_MS	**177.0**	78.8	132.4	136.9	116.4	101.0	113.6	78.4	126.0	79.9	124.6	89.5	115.8	97.9	118.4	65.2	113.6	62.0	107.9
1-LS_MSD	**161.0**	69.1	135.2	144.9	115.4	127.9	121.2	83.3	130.4	84.3	123.8	84.9	114.2	94.4	118.4	69.5	113.8	64.7	101.8
RPD	9.5	13.1	2.1	5.7	0.9	**23.5**	6.5	6.1	3.4	5.4	0.6	5.3	1.4	3.6	0.0	6.4	0.2	4.3	5.8

Values given in bold are outside the method acceptance criteria (for percent recoveries) or the data quality objectives (for RPDs)

TABLE 5. FIELD TRIPLICATE SAMPLE RESULTS (ng/kg)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins Sample Number	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
Sediment							
9-1-S	0.7 U/E	1.1 U/E	1.9 U/E	3.1 U/E	2.4 U/E	2.9 U/E	8.0 U/E
9-2-S	1.0 U/E	0.9 U/E	1.5 U/E	1.7 U/E	1.9 U/E	10.2 U/E	53.4 U/B
9-3-S	0.8 U/E	0.8 U/E	1.0 U/E	1.7 U/E	1.3 U/E	4.9 U/E	19.5 U/B
RSD	--	--	--	--	--	--	--
Crayfish							
13-1-CF	0.2 U/E	0.5 U/E	0.3 U/E	0.4 U/E	0.5 U/E	0.4 U/E	1.1 U/E
13-2-CF	0.2 U/E	0.8 U/E	0.5 U/E	0.5 U/E	0.6 U/E	0.3 U/E	1.3 U/E
13-3-CF	0.8	0.6 U/E	0.4 U/E	0.5 U/E	0.6 U/E	0.4 U/E	0.9 U/E
RSD	--	--	--	--	--	--	--
Fish							
13-1-LS	0.4 U/E	0.4 U/E	0.3 U/E	0.4 U/E	0.3 U/E	0.4	1.5
13-2-LS	0.7	0.5	0.5	0.3 U/E	0.3 U/E	0.9	4.3
13-3-LS	0.4 U/E	0.5 U/E	0.5 U/E	0.6 U/E	0.5 U/E	0.8	6.0
RSD	--	--	--	--	--	37.8	57.8

Furans Sample Number	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
Sediment										
9-1-S	0.7 U/E	0.5 U/E	0.6 U/E	1.4 U/E	1.3 U/E	1.8 U/E	1.5 U/E	1.1 U/E	1.5 U/E	0.7 U/E
9-2-S	1.8 U/E	1.1 U/E	1.2 U/E	1.6 U/E	1.4 U/E	1.6 U/E	1.5 U/E	2.1 U/E	2.8 U/E	4.3 U/E
9-3-S	1.0 U/E	0.6 U/E	0.7 U/E	1.1 U/E	1.1 U/E	1.8 U/E	1.3 U/E	1.5 U/E	2.3 U/E	2.4 U/E
RSD	--	--	--	--	--	--	--	--	--	--
Crayfish										
13-1-CF	1.30[1]	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.4 U/E	0.3 U/E	0.4 U/E	0.8 U/E	0.9 U/E
13-2-CF	1.06[1]	0.4 U/E	0.5 U/E	0.4 U/E	0.4 U/E	0.6 U/E	0.5 U/E	0.7 U/E	1.3 U/E	0.7 U/E
13-3-CF	1.60[1]	0.5 U/E	0.7 U/E	0.8 U/E	0.7 U/E	1.1 U/E	0.9 U/E	5.2	0.5 U/E	0.7 U/E
RSD	20.5	--	--	--	--	--	--	--	--	--
Fish										
13-1-LS	4.8	0.3	0.5 U/E	0.3 U/E	0.3 U/E	2.8	0.7	0.3 U/E	0.2 U/E	0.1 U/E
13-2-LS	2.7	0.6 U/E	1.8	0.7 U/E	0.7 U/E	1.3	0.5	4.0	0.4 U/E	2.0
13-3-LS	2.2	2.2	0.2 U/E	0.3 U/E	0.3 U/E	1.6	0.5	0.6 U/E	0.3 U/E	0.4 U/E
RSD	42.7	--	--	--	--	41.8	20.4	--	--	--

[1] From second-column confirmation using a Rtx-200 column

Data qualifiers: U/E = Congener undetected at the given estimated detection limit (EDL)
U/B = Congener undetected due to blank contamination

TABLE 6. SEDIMENT SAMPLE RESULTS (ng/kg dry weight)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins

Sample	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
1-S	0.6 U/E	1.0 U/E	1.2 U/E	1.7 U/E	1.5 U/E	0.9 U/E	**13.2**
2-S	0.4 U/E	0.5 U/E	0.5 U/E	0.8 U/E	0.6 U/E	3.3 U/E	7.7 U/E
3-S	0.3 U/E	0.5 U/E	0.8 U/E	0.8 U/E	0.9 U/E	1.8 U/E	4.5 U/E
4-S	0.4 U/E	0.6 U/E	1.6 U/E	2.1 U/E	2.1 U/E	2.7 U/E	**10.4**
5-S	0.7 U/E	0.8 U/E	0.9 U/E	1.3 U/E	1.2 U/E	4.5 U/E	**11.9**
6-S	0.3 U/E	1.1 U/E	0.4 U/E	0.7 U/E	0.5 U/E	2.3 U/E	6.9 U/E
7-S	1.4 U/E	0.9 U/E	0.8 U/E	1.4 U/E	1.0 U/E	4.7 U/E	**15.2**
8-S	0.6 U/E	0.8 U/E	0.5 U/E	1.0 U/E	0.6 U/E	1.9 U/E	7.4 U/E
9-1-S	0.7 U/E	1.1 U/E	1.9 U/E	3.1 U/E	2.4 U/E	2.9 U/E	8.0 U/E
9-2-S	1.0 U/E	0.9 U/E	1.5 U/E	1.7 U/E	1.9 U/E	10.2 U/E	53.4 U/B
9-3-S	0.8 U/E	0.8 U/E	1.0 U/E	1.7 U/E	1.3 U/E	4.9 U/E	19.5 U/B
10-S	0.7 U/E	0.4 U/E	0.6 U/E	0.9 U/E	0.7 U/E	**5.0**	**52.5**
11-S	0.4 U/E	0.6 U/E	1.1 U/E	1.4 U/E	1.3 U/E	6.9 U/E	46.9 U/B
12-S	0.4 U/E	1.0 U/E	0.8 U/E	1.1 U/E	1.0 U/E	3.5 U/E	9.7 U/E
13-S	0.5 U/E	0.7 U/E	0.7 U/E	1.1 U/E	0.9 U/E	3.1 U/E	8.0 U/E
14-S	0.4 U/E	0.9 U/E	1.2 U/E	1.8 U/E	1.5 U/E	3.3 U/E	**12.7** E
15-S	0.4 U/E	0.8 U/E	0.6 U/E	1.1 U/E	0.8 U/E	4.3 U/E	**34.7** E

Furans

Sample	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
1-S	0.6 U/E	1.0 U/E	1.0 U/E	2.1 U/E	1.9 U/E	2.7 U/E	2.3 U/E	7.1 U/E	1.9 U/E	3.5 U/E
2-S	0.6 U/E	0.3 U/E	0.3 U/E	0.8 U/E	0.7 U/E	1.0 U/E	0.8 U/E	0.5 U/E	0.7 U/E	0.6 U/E
3-S	0.6 U/E	0.4 U/E	0.4 U/E	0.9 U/E	0.9 U/E	1.2 U/E	1.0 U/E	0.8 U/E	1.0 U/E	0.4 U/E
4-S	0.6 U/E	0.6 U/E	0.5 U/E	0.9 U/E	0.8 U/E	1.2 U/E	0.9 U/E	1.3 U/E	1.7 U/E	1.1 U/E
5-S	1.1 U/E	0.7 U/E	0.5 U/E	1.1 U/E	1.0 U/E	1.5 U/E	1.2 U/E	1.3 U/E	1.9 U/E	1.6 U/E
6-S	0.6 U/E	0.6 U/E	0.5 U/E	1.0 U/E	1.0 U/E	1.3 U/E	1.2 U/E	0.9 U/E	1.2 U/E	0.5 U/E
7-S	1.3 U/E	1.1 U/E	1.3 U/E	1.1 U/E	1.1 U/E	1.5 U/E	1.3 U/E	1.5 U/E	2.1 U/E	1.7 U/E
8-S	0.9 U/E	0.8 U/E	0.8 U/E	1.0 U/E	0.9 U/E	1.5 U/E	1.1 U/E	0.9 U/E	1.2 U/E	0.9 U/E
9-1-S	0.7 U/E	0.5 U/E	0.6 U/E	1.4 U/E	1.3 U/E	1.8 U/E	1.5 U/E	1.1 U/E	1.5 U/E	0.7 U/E
9-2-S	1.8 U/E	1.1 U/E	1.2 U/E	1.6 U/E	1.4 U/E	1.6 U/E	1.5 U/E	2.1 U/E	2.8 U/E	4.3 U/E
9-3-S	1.0 U/E	0.6 U/E	0.7 U/E	1.1 U/E	1.1 U/E	1.8 U/E	1.3 U/E	1.5 U/E	2.3 U/E	2.4 U/E
10-S	0.6 U/E	0.6 U/E	0.6 U/E	1.2 U/E	1.1 U/E	2.1 U/E	1.3 U/E	2.2 U/E	3.0 U/E	1.7 U/E
11-S	0.7 U/E	0.4 U/E	0.5 U/E	1.1 U/E	1.1 U/E	1.7 U/E	1.2 U/E	1.9 U/E	0.3 U/E	4.0 U/E
12-S	0.9 U/E	0.6 U/E	0.6 U/E	1.5 U/E	1.4 U/E	1.9 U/E	1.6 U/E	1.1 U/E	1.6 U/E	1.0 U/E
13-S	1.0 U/E	0.9 U/E	1.0 U/E	1.3 U/E	1.1 U/E	1.6 U/E	1.3 U/E	1.1 U/E	1.9 U/E	1.1 U/E
14-S	0.9 U/E	0.7 U/E	0.7 U/E	1.3 U/E	1.2 U/E	2.2 U/E	1.8 U/E	1.1 U/E	1.9 U/E	1.6 U/E
15-S	0.9 U/E	0.8 U/E	1.0 U/E	1.5 U/E	1.5 U/E	2.2 U/E	1.8 U/E	1.5 U/E	2.2 U/E	3.5 U/E

Data qualifiers: U/E = Congener undetected at the given estimated detection limit (EDL)
U/B = Congener undetected due to blank contamination
E = Estimated value due to evaluation of QA/QC data

TABLE 7. CRAYFISH SAMPLE RESULTS (ng/kg wet weight)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins

Sample	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
2-CF	0.4 U/E	1.1 U/E	0.7 U/E	0.8 U/E	0.9 U/E	0.5 U/E	1.4 U/E
3-CF	0.4 U/E	1.3 U/E	0.7 U/E	0.7 U/E	0.9 U/E	0.7 U/E	2.8 U/E
4-CF	0.3 U/E	0.8 U/E	0.7 U/E	1.0 U/E	1.0 U/E	0.5 U/E	2.3 U/E
5-CF	0.3 U/E	1.5 U/E	0.8 U/E	1.0 U/E	1.0 U/E	1.2 U/E	1.9 U/E
6-CF	**1.0**	2.3 U/E	1.9 U/E	2.1 U/E	2.5 U/E	2.3 U/E	1.8 U/E
7-CF	0.4 U/E	0.3 U/E	0.4 U/E	0.5 U/E	0.5 U/E	0.2 U/E	**6.7**
8-CF	0.1 U/E	0.6 U/E	0.3 U/E	0.3 U/E	0.4 U/E	0.6 U/E	2.7 U/E
9-CF	0.2 U/E	0.3 U/E	0.3 U/E	0.3 U/E	0.3 U/E	0.2 U/E	0.6 U/E
10-CF	0.1 U/E	0.1 U/E	0.7 U/E	0.7 U/E	0.9 U/E	1.9 U/E	**23.7**
11-CF	0.3 U/E	0.4 U/E	0.3 U/E	0.3 U/E	0.4 U/E	0.5 U/E	1.1 U/E
12-CF	0.1 U/E	1.0 U/E	0.4 U/E	0.4 U/E	0.5 U/E	0.3 U/E	0.5 U/E
13-1-CF	0.2 U/E	0.5 U/E	0.3 U/E	0.4 U/E	0.5 U/E	0.4 U/E	1.1 U/E
13-2-CF	0.2 U/E	0.8 U/E	0.5 U/E	0.5 U/E	0.6 U/E	0.3 U/E	1.3 U/E
13-3-CF	**0.8**	0.6 U/E	0.4 U/E	0.5 U/E	0.6 U/E	0.4 U/E	0.9 U/E
14-CF	**0.7**	0.9 U/E	0.6 U/E	0.6 U/E	0.8 U/E	0.4 U/E	1.1 U/E

Furans

Sample	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
2-CF	**2.23**[1]	0.3 U/E	0.4 U/E	0.9 U/E	0.8 U/E	1.3 U/E	1.1 U/E	1.2 U/E	2.1 U/E	0.8 U/E
3-CF	**1.50**[1]	0.8 U/E	0.9 U/E	0.8 U/E	0.7 U/E	1.2 U/E	0.9 U/E	0.8 U/E	1.5 U/E	1.5 U/E
4-CF	**2.02**[1]	0.6 U/E	0.7 U/E	0.7 U/E	0.6 U/E	1.2 U/E	0.9 U/E	0.6 U/E	1.5 U/E	1.3 U/E
5-CF	**1.58**[1]	0.7 U/E	0.9 U/E	1.0 U/E	0.7 U/E	1.5 U/E	1.2 U/E	1.1 U/E	2.6 U/E	1.5 U/E
6-CF	**1.27**[1]	2.1 U/E	2.8 U/E	2.6 U/E	2.7 U/E	1.9 U/E	1.1 U/E	5.6 U/E	0.3 U/E	0.7 U/E
7-CF	**0.78**[1]	0.2 U/E	0.2 U/E	0.3 U/E	0.3 U/E	0.5 U/E	0.4 U/E	1.0 U/E	1.5 U/E	0.3 U/E
8-CF	**1.05**[1]	0.2 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.4 U/E	0.3 U/E	1.4 U/E	3.1 U/E	1.5 U/E
9-CF	**0.63**[1]	0.1 U/E	0.1 U/E	0.1 U/E	0.1 U/E	0.2 U/E	0.1 U/E	0.4 U/E	0.7 U/E	0.3 U/E
10-CF	**0.70**[1]	0.1 U/E	0.1 U/E	0.2 U/E	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.4 U/E	1.4 U/E
11-CF	**2.24**[1]	0.2 U/E	0.3 U/E	0.3 U/E	0.3 U/E	0.4 U/E	0.3 U/E	0.3 U/E	0.5 U/E	0.5 U/E
12-CF	**2.62**[1]	0.3 U/E	0.4 U/E	0.3 U/E	0.3 U/E	0.5 U/E	0.4 U/E	0.5 U/E	0.9 U/E	0.3 U/E
13-1-CF	**1.30**[1]	0.1 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.4 U/E	0.3 U/E	0.4 U/E	0.8 U/E	0.9 U/E
13-2-CF	**1.06**[1]	0.4 U/E	0.5 U/E	0.4 U/E	0.4 U/E	0.6 U/E	0.5 U/E	0.7 U/E	1.3 U/E	0.7 U/E
13-3-CF	**1.60**[1]	0.5 U/E	0.7 U/E	0.8 U/E	0.7 U/E	1.1 U/E	0.9 U/E	**5.2**	0.5 U/E	0.7 U/E
14-CF	**1.88**[1]	0.3 U/E	0.5 U/E	0.8 U/E	0.8 U/E	1.2 U/E	0.9 U/E	1.1 U/E	1.9 U/E	0.6 U/E

[1] From second-column confirmation using a Rtx-200 column

Data qualifiers: U/E = Congener undetected at the given estimated detection limit (EDL)
E = Estimated value due to evaluation of QA/QC data

TABLE 8. FISH SAMPLE RESULTS (ng/kg wet weight)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Dioxins

Sample	2378-TCDD	12378-PeCDD	123478-HxCDD	123678-HxCDD	123789-HxCDD	1234678-HpCDD	OCDD
1-LS	0.1 U/E	1.4 U/E	0.7 U/E	0.8 U/E	0.7 U/E	1.1	5.6
1-C	1.1 U/E	1.1 U/E	1.6 U/E	1.6 U/E	1.7 U/E	3.8	7.5
2-LS	0.6 U/E	0.5 U/E	0.5 U/E	0.6 U/E	0.5 U/E	0.4	3.3
3-LS	0.8 U/E	0.7 U/E	1.1 U/E	0.5	0.1 U/E	2.6	36.9
4-LS	0.9	0.7 U/E	0.4	0.2 U/E	0.2 U/E	0.8	5.6
5-LS	0.9 U/E	0.8 U/E	1.7 U/E	1.7 U/E	1.8 U/E	0.7	3.6
6-LS	1.4 U/E	1.1 U/E	0.6 U/E	0.6 U/E	0.6 U/E	1.1	4.9
7-LS	1.8 U/E	1.0 U/E	0.8 U/E	0.8 U/E	0.8 U/E	2.1	9.9
8-LS	0.3 U/E	0.3 U/E	0.3 U/E	0.4 U/E	0.4 U/E	1.3	8.9
9-LS	0.4 U/E	0.8 U/E	0.3	0.4 U/E	0.4 U/E	0.8	3.9
10-LS	0.7 U/E	1.1 U/E	1.1 U/E	1.2 U/E	1.2 U/E	1.2	5.4
11-LS	0.7 U/E	0.7 U/E	0.4 U/E	0.6	0.4 U/E	1.2	2.6
12-LS	0.6 U/E	0.5 U/E	0.4 U/E	0.5 U/E	0.4 U/E	0.5	2.2
13-1-LS	0.4 U/E	0.4 U/E	0.3 U/E	0.4 U/E	0.3 U/E	0.4	1.5
13-2-LS	0.7	0.5	0.5	0.3 U/E	0.3 U/E	0.9	4.3
13-3-LS	0.4 U/E	0.5 U/E	0.5 U/E	0.6 U/E	0.5 U/E	0.8	6.0
14-LS	0.4 U/E	0.3 U/E	0.2 U/E	0.2 U/E	0.2 U/E	0.4	3.7
15-C	0.3 U/E	0.5 U/E	0.3	0.6	0.2 U/E	1.2	3.9

Furans

Sample	2378-TCDF	12378-PeCDF	23478-PeCDF	123478-HxCDF	123678-HxCDF	123789-HxCDF	234678-HxCDF	1234678-HpCDF	1234789-HpCDF	OCDF
1-LS	4.9 E	9.9	0.9 U/E	1.3 U/E	5.2	2.4	5.2	5.5	0.5 U/E	2.7
1-C	3.6	2.3	0.3 U/E	0.6 U/E	0.5 U/E	2.5	1.0	0.3 U/E	0.5 U/E	0.6 U/E
2-LS	5.0	5.6	0.7 U/E	0.3 U/E	0.3 U/E	4.5	1.2	0.3 U/E	0.6 U/E	0.2 U/E
3-LS	3.2 E	2.7	0.6 U/E	0.6 U/E	0.6 U/E	0.8	1.6	0.7 U/E	0.4 U/E	2.4
4-LS	2.6	1.8	0.3 U/E	0.4 U/E	0.4 U/E	1.1	0.4 U/E	0.7 U/E	1.2 U/E	0.3 U/E
5-LS	5.2 E	0.6 U/E	0.6 U/E	0.5 U/E	0.5 U/E	3.4	0.8	0.4 U/E	0.2 U/E	0.2 U/E
6-LS	5.9 E	1.4	1.3 U/E	0.8 U/E	0.8 U/E	1.3	0.3	0.5 U/E	0.2 U/E	0.2 U/E
7-LS	5.4 E	2.0	0.1 U/E	0.7 U/E	0.7 U/E	2.1	0.6	1.3	0.4 U/E	1.3
8-LS	2.6	1.5	0.2 U/E	0.2 U/E	0.2 U/E	1.6	0.4	0.8 U/E	1.2 U/E	0.9
9-LS	1.6	0.4 U/E	1.0	0.3 U/E	0.4 U/E	0.9	0.3	0.7 U/E	0.2 U/E	0.4 U/E
10-LS	2.1 U/E	1.2	0.5 U/E	1.0 U/E	0.9 U/E	1.7 U/E	1.1 U/E	1.3 U/E	2.5 U/E	0.8 U/E
11-LS	6.5	3.9	1.1 U/E	0.8 U/E	0.9 U/E	4.0	1.0	0.4	0.4 U/E	0.3 U/E
12-LS	3.8	1.7	0.3 U/E	0.3 U/E	0.3 U/E	1.7	0.4	0.4 U/E	0.3 U/E	0.1 U/E
13-1-LS	4.8	0.3	0.5 U/E	0.3 U/E	0.3 U/E	2.8	0.7	0.3 U/E	0.2 U/E	0.1 U/E
13-2-LS	2.7	0.6 U/E	1.8	0.7 U/E	0.7 U/E	1.3	0.5	4.0	0.4 U/E	2.0
13-3-LS	2.2	2.2	0.2 U/E	0.3 U/E	0.3 U/E	1.6	0.5	0.6 U/E	0.3 U/E	0.4 U/E
14-LS	4.1	0.9 U/E	0.3 U/E	0.1 U/E	0.1 U/E	1.4	0.4 U/E	0.2 U/E	0.2 U/E	0.3
15-C	3.9	3.9	0.2	0.3 U/E	0.4 U/E	2.3	0.7	0.2 U/E	0.2 U/E	0.2 U/E

Data qualifiers: U/E = Congener undetected at the given estimated detection limit (EDL)
E = Estimated value due to evaluation of QA/QC data

Appendix A-9

Data Validation Report
Poly-Butyl Tin Analyses

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by Tetra Tech, Inc.

Samples analyzed by: Pacific Analytical, Inc.

Data Reviewed by: Tad Deshler

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey and analyzed for poly-butyl tins using U.S. EPA Method 1656 by Pacific Analytical, Inc. of Carlsbad, California. The samples were collected at 15 different stations. For sediment samples, triplicate field samples were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Of the 33 tissue samples, 15 were crayfish and 18 were fish, either largescale sucker or carp. Crayfish samples were collected at only 13 of the 15 stations (all except stations 1 and 15). Triplicate field samples were collected at station 13 (13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale sucker) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS). The data validation review was conducted according to guidelines presented in the U.S. EPA Contract Laboratory Program Statement of Work (SOW) for organics analyses (U.S. EPA 1991), the Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses (U.S. EPA 1988), and the sampling and QA/QC plan for the project (Tetra Tech 1993).

A. HOLDING TIMES

Samples were collected, placed on ice or frozen (tissue) in a cooler, and transported to the laboratory within 4 days of collection. The maximum holding time established for this project for poly-butyl tins in sediment and tissue matrices is 14 days until extraction and an additional 26 days until analysis (Tetra Tech 1993). Table 1 presents a summary of sample numbers, dates collected, extracted, and analyzed, and holding times. All samples were extracted and analyzed well within applicable holding times, with the exception of thirteen of the tissue samples (five crayfish and eight fish; see Table 1) which were extracted 1-4 days outside the specified extraction holding time. These tissue samples were all analyzed within 40 days, however, so no data qualifiers were added to these sample results based on these minor deviations. No data qualifiers were assigned to any sample results for poly-butyl tins based on holding times.

B. CALIBRATION AND INSTRUMENT PERFORMANCE

Dual megabore columns of dissimilar phases (DB-5 and DB-608) were used for quantitation and confirmation of poly-butyl tin concentrations. The detector used was a Flame Photometric Detector with a 600 nm band bypass filter.

Sediment

An initial five-point calibration using tri-n-butyl tin, di-n-butyl tin, and n-butyl tin at 100, 25, 5, 1, and 0.2 ng/μl was conducted on 7/16/93 for both columns. The percent relative standard deviations (%RSD) of the calibration factors for the five standards were 26-27 percent on the DB-5 column, and 12-14 percent on the DB-608 column. Because the RSD for the DB-5 column exceeded 20 percent, linearity

criteria were not met and entire calibration curve was used rather than the average calibration factor for the five standards. In accordance with SW-846 guidelines for a stepped calibration, the initial calibration was valid (U.S. EPA 1986).

Continuing calibration analyses were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of the mid-point calibration standard (5 ng/μl). Calculated amounts for each compound in the mid-point standard had RPDs less than or equal to 25 percent from the nominal amount established in the initial calibration. The absolute retention times for each compound were within the retention time windows established from the initial calibration. The results of the continuing calibration indicate that the initial calibration remained valid through the analysis of all field samples.

Crayfish Tissue

An initial five-point calibration using tri-n-butyl tin, di-n-butyl tin, and n-butyl tin at 100, 25, 5, 1, and 0.2 ng/μl was conducted on 8/16/93 for both columns. The percent relative standard deviations (%RSD) of the calibration factors for the five standards were 36-52 percent on the DB-5 column, and 20-35 percent on the DB-608 column. Because the RSD for both columns exceeded 20 percent, linearity criteria were not met and entire calibration curve was used rather than the average calibration factor for the five standards. In accordance with SW-846 guidelines for a stepped calibration, the initial calibration was valid (U.S. EPA 1986).

Continuing calibration analyses were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of the mid-point calibration standard (5 ng/μl). Calculated amounts for each compound in the mid-point standard had RPDs less than or equal to 25 percent from the nominal amount established in the initial calibration. The absolute retention times for each compound were within the retention time windows established from the initial calibration. The results of the continuing calibration indicate that the initial calibration remained valid through the analysis of all field samples.

Fish Tissue

An initial five-point calibration using tri-n-butyl tin, di-n-butyl tin, and n-butyl tin at 100, 25, 5, 1, and 0.2 ng/μl was conducted on 8/27/93 for both columns. The percent relative standard deviations (%RSD) of the calibration factors for the five standards were 43-77 percent on the DB-5 column, and 29-38 percent on the DB-608 column. Because the RSD for both columns exceeded 20 percent, linearity criteria were not met and entire calibration curve was used rather than the average calibration factor for the five standards. In accordance with SW-846 guidelines for a stepped calibration, the initial calibration was valid (U.S. EPA 1986).

Continuing calibration analyses were conducted at the required frequency (i.e., within each twelve hour period for each GC column). The initial calibration was verified through the analysis of the mid-point calibration standard (5 ng/μl). Calculated amounts for each compound in the mid-point standard had RPDs less than or equal to 25 percent from the nominal amount established in the initial calibration. The absolute retention times for each compound were within the retention time windows established from the initial calibration. The results of the continuing calibration indicate that the initial calibration remained valid through the analysis of all field samples.

C. SURROGATE RECOVERIES

All field, blank, and spike samples were spiked with the surrogate compounds tri-n-propyltin chloride and dimethyldiphenyltin before analysis. Although there are no published guidelines for acceptance criteria for these compounds, U.S. EPA generally assumes advisory QC limits for surrogate percent recovery of 50-150 percent when published guidelines do not exist.

Sediment

The percent recovery of surrogates for all sediment samples is given in Table 2A. All percent recoveries were within the advisory QC guidelines of 50-150 percent with the exception of tri-n-propyltin chloride in both the MS and MSD (245 and 220 percent, respectively) and the second method blank (0 percent), and dimethyldiphenyltin in sample 10-S (0 percent). Because of the low surrogate recovery for sample 10-S, sample results were qualified as estimated.

Crayfish Tissue

The percent recovery of surrogates for all sediment samples is given in Table 2B. All percent recoveries were within the advisory QC guidelines of 50-150 percent with the exception of tri-n-propyltin chloride in the first method blank (49 percent). This exceedance was considered minor. No data qualifiers were added to crayfish sample results based on surrogate recoveries.

Fish Tissue

The percent recovery of surrogates for all sediment samples is given in Table 2C. All percent recoveries were within the advisory QC guidelines of 50-150 percent with the exception of tri-n-propyltin chloride in samples 7-LS and 13-2-LS (23 and 20 percent, respectively). Because of the low surrogate recoveries for these samples, the results were qualified as estimated.

D. METHOD BLANKS

Sediment

For the sediment sample data, two method blanks were performed immediately following the initial calibration on 7/16/93 and two were performed following the continuing calibration check on 7/17/93. The results of the method blank analyses are given in Table 3. None of the three tin compounds were detected in any of the blanks, with the exception of n-butyltin trichloride, which was detected at the detection limit of 4 μg/kg in the first blank following the initial calibration. The average n-butyltin trichloride concentration (assuming zero concentration for the undetected sample) in the two blanks performed immediately after the initial calibration was 2 μg/kg. All n-butyltin trichloride values reported subsequent to the analysis of these blank samples and before the analysis of the second set of blank samples (which did not show any evidence of blank contamination) were potentially subject to data qualification. If the reported value was less than 5X the average amount detected in the blanks (i.e., 10 μg/kg), the value was qualified as undetected due to blank contamination (qualifier code "U/B"). The n-butyltin trichloride values for samples 8-S and 10-S, which were originally reported as 8 and 7 μg/kg, respectively, were qualified in this manner. No other data qualifiers were added to sediment sample results based on method blank results.

Crayfish Tissue

For the crayfish sample data, two method blanks were performed immediately following the initial calibration on 8/16/93 and two were performed toward the end of the analysis of the field samples, also

on 8/17/93. The results of the method blank analyses are given in Table 3. Two of the three tin compounds, di-n-butyltin dichloride and tri-n-butyltin chloride, were detected in at least two of the blank samples at low levels (less than the nominal detection limit). For di-n-butyltin dichloride, the average concentration (assuming zero concentration for the undetected sample) of the later pair of blank samples was 3.6 μg/kg. All di-n-butyltin dichloride values reported subsequent to the analysis of these blank samples were potentially subject to data qualification. If the reported value was less than 5X the average amount detected in the blanks (i.e., 18 μg/kg), the value was qualified as undetected due to blank contamination (qualifier code "U/B"). Because detected values of di-n-butyltin dichloride were not reported for any of the samples analyzed after the two blanks described above, no data qualification was necessary.

Tri-n-butyltin chloride was detected in three of the four blank samples. The average concentration for the two pairs of blank samples (assuming zero concentration for the undetected sample) was 3 and 4.4 μg/kg for the first and second pair, respectively. Thus, all reported tri-n-butyltin chloride values are potentially subject to data qualification. All reported values from samples analyzed after the first set of blank samples but before the second set were qualified as undetected due to blank contamination (qualifier code "U/B") unless the reported concentration was at least 5X (i.e., 15 μg/kg) the average amount detected in the blank samples. Likewise, all reported values from samples analyzed after the second pair of blanks were qualified as undetected due to blank contamination unless the reported concentration was at least 5X (i.e., 22 μg/kg) the average amount detected in the blank samples. The tri-n-butyltin chloride values for samples 9-CF and 13-1-CF, which were originally reported as 8 and 12 μg/kg, respectively, were qualified in this manner. No other data qualifiers were added to crayfish sample results based on method blank results.

Fish Tissue

For the fish sample data, one pair of method blanks were analyzed immediately following the initial calibration on 8/27/93. The results of the method blank analyses are given in Table 3. Tri-n-butyltin chloride and n-butyltin trichloride were both detected in at least one of the blanks at low levels (less than the nominal detection limit). Thus, all reported concentrations from these two compounds are potentially subject to data qualification. For n-butyltin trichloride, the average concentration (assuming zero concentration for the undetected sample) of the pair of blank samples was 0.8 μg/kg. If the reported value was less than 5X the average amount detected in the blanks (i.e., 4 μg/kg), the value was qualified as undetected due to blank contamination (qualifier code "U/B"). The n-butyltin trichloride value for samples 2-LS, which was originally reported as 0.8 μg/kg, was qualified in this manner.

For tri-n-butyltin chloride, the average concentration of the pair of blank samples was 1.6 μg/kg. If the reported value was less than 5X the average amount detected in the blanks (i.e., 8 μg/kg), the value was qualified as undetected due to blank contamination (qualifier code "U/B"). The tri-n-butyltin chloride values for samples 1-LS, 9-LS, 14-LS, and 15-C, which were originally reported as 2, 4, 4, and 1.6 μg/kg, respectively, were qualified in this manner.

E. MATRIX SPIKE/MATRIX SPIKE DUPLICATE ANALYSIS

Sediment

MS/MSD analyses were performed on Sample 13-S by spiking tri-n-butyltin chloride at a final concentration of 200 μg/ml. The percent recovery of this compound was 124 and 122 percent for the MS and MSD, respectively. The RPD between the two analyses was 1.6 percent. The results of the

MS/MSD analyses for sediment samples indicate the analytical system was performing with excellent precision and accuracy.

Crayfish Tissue

MS/MSD analyses were performed on Sample 11-CF by spiking tri-n-butyltin chloride at a final concentration of 100 μg/ml. The percent recovery of this compound was 97 and 96 percent for the MS and MSD, respectively. The RPD between the two analyses was 1.0 percent. The results of the MS/MSD analyses for crayfish samples indicate the analytical system was performing with excellent precision and accuracy.

Fish Tissue

MS/MSD analyses were performed on Sample 1-LS by spiking tri-n-butyltin chloride at a final concentration of 100 μg/ml. The percent recovery of this compound was 82 percent for both the MS and MSD. The results of the MS/MSD analyses for fish samples indicate the analytical system was performing with excellent precision and accuracy.

F. LABORATORY REPLICATES

Sediment

One pair of sediment analyses, the non-spiked compounds in the MS/MSD analysis of sample 13-S, were considered to be laboratory replicates. Di-n-butyltin dichloride was detected at 219 and 263 μg/kg in the MS and MSD, respectively, for a RPD of 18.3 percent. N-butyltin trichloride was detected at 15 and 22 μg/kg in the MS and MSD, respectively, for a RPD of 37.8 percent. These latter two values, however, must be considered estimates because the concentration difference between the two columns was greater than 25 percent. The RPD for di-n-butyltin dichloride satisfies the data quality objective for precision (RPD ≤ 30 percent) specified in the sampling and QA/QC plan (Tetra Tech 1993).

Crayfish Tissue

One pair of crayfish analyses, the non-spiked compounds in the MS/MSD analysis of Sample 11-CF, were considered to be laboratory replicates. Di-n-butyltin dichloride was detected at 80 μg/kg in both the MS and MSD, while n-butyltin trichloride was undetected in both samples. The RPD for di-n-butyltin dichloride satisfies the data quality objective for precision (RPD ≤ 30 percent) specified in the sampling and QA/QC plan (Tetra Tech 1993).

Fish Tissue

One pair of fish analyses, the non-spiked compounds in the MS/MSD analysis of Sample 1-LS, were considered to be laboratory replicates. Di-n-butyltin dichloride was detected at 80 μg/kg in both the MS and MSD. N-butyltin trichloride was detected at 16 and 4 μg/kg in the MS and MSD, respectively, for a RPD of 60 percent. The latter of the two n-butyltin trichloride values, however, must be considered as an estimate because it was below the nominal detection limit of 8 μg/kg. The RPD for di-n-butyltin dichloride satisfies the data quality objective for precision (RPD ≤ 30 percent) specified in the sampling and QA/QC plan (Tetra Tech 1993).

G. FIELD TRIPLICATES

Sediment

One set of field triplicate samples (9-1-S, 9-2-S, and 9-3-S) were analyzed for poly-butyl tins. None of the tin compounds were detected in any of the samples, with the exception of tri-n-butyltin chloride, which was detected in sample 9-3-S at 9 μg/kg. Given the paucity of positive values, an estimate of field variability is difficult to make.

Crayfish Tissue

One set of field triplicate samples (13-1-CF, 13-2-CF, 13-3-CF) were analyzed for poly-butyl tins. None of the tin compounds were detected in any of the three samples. Given the lack of positive values, an estimate of field variability is impossible to make.

Fish Tissue

One set of field triplicate samples (13-1-LS, 13-2-LS, 13-3-LS) were analyzed for poly-butyl tins. None of the tin compounds were detected in any of the samples, with the exception of tri-n-butyltin chloride, which was detected in samples 13-1-LS at 8 μg/kg and 13-3-LS at 16 μg/kg. Since this compound was not detected in the third sample (13-2-LS), it would not be appropriate to calculate a RSD. Given the paucity of positive values, an estimate of field variability is difficult to make.

SUMMARY

Sediment

All sample data were reported by the laboratory in µg/kg (dry weight) and are presented in Table 4. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (4 µg/kg) were equal to those specified in the sampling and QA/QC plan (Tetra Tech 1993).

Data from several samples were qualified based on analysis of QC results. Because of blank contamination noted in one of the method blanks for n-butyltin trichloride, two of the sample results for this compound (samples 8-S and 7-S) were qualified as undetected due to blank contamination (qualifier code "U/B"). Due to low surrogate recoveries, the sample results of sample 10-S were qualified as estimated. Laboratory qualifiers added by the laboratory included "P", for a concentration which differed by more than 25 percent between the two columns.

The precision, accuracy, and completeness of the poly-butyl tin analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Crayfish Tissue

All sample data were reported by the laboratory in µg/kg (wet weight) and are presented in Table 4. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (8 µg/kg) were slightly higher than those specified in the sampling and QA/QC plan (4 µg/kg)(Tetra Tech 1993) due to the necessity of using gel permeation chromatography to remove tissue lipids.

Data from several samples were qualified based on analysis of QC results. Because of blank contamination noted in three of the method blanks for tri-n-butyltin chloride, two of the sample results for this compound (samples 9-CF and 13-1-CF) were qualified as undetected due to blank contamination (qualifier code "U/B").

The precision, accuracy, and completeness of the poly-butyl tin analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

Fish Tissue

All sample data were reported by the laboratory in µg/kg (dry weight) and are presented in Table 4. The data package submitted by the laboratory contained all the required deliverables. Detection limits reported by the laboratory (8 µg/kg) were slightly higher than those specified in the sampling and QA/QC plan (4 µg/kg)(Tetra Tech 1993) due to the necessity of using gel permeation chromatography to remove tissue lipids.

Data from several samples were qualified based on analysis of QC results. Because of blank

contamination noted in the method blanks for n-butyltin trichloride and tri-n-butyltin chloride, results for sample 2-LS for n-butyltin trichloride and samples 1-LS, 9-LS, 14-LS, and 15-C for tri-n-butyltin chloride were qualified as undetected due to blank contamination (qualifier code "U/B"). Due to low surrogate recoveries, the sample results of sample 7-LS and 13-2-LS were qualified as estimated. Laboratory qualifiers added by the laboratory included "J", for compounds detected at a concentration below the nominal detection limit.

The precision, accuracy, and completeness of the poly-butyl tin analyses were within project guidelines and the data are considered acceptable for their intended use within the limits of the assigned data qualifiers.

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TABLE 1. POLY-BUTYL TIN ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Pacific Analytical Sample Number	Date Collected	Receipt Date	Extraction Date	Analysis Date	Extraction Holding Time (d)	Analysis Holding Time (d)
Sediment							
1-S	58101TS	6/28/93	6/30/93	7/2/93	7/16/93	4	18
2-S	58102TS	6/27/93	6/30/93	7/2/93	7/16/93	5	19
3-S	58103TS	6/27/93	6/30/93	7/2/93	7/16/93	5	19
4-S	58104TS	6/26/93	6/30/93	7/2/93	7/16/93	6	20
5-S	58105TS	6/26/93	6/30/93	7/2/93	7/16/93	6	20
6-S	58106TS	6/25/93	6/30/93	7/2/93	7/16/93	7	21
7-S	58107TS	6/25/93	6/30/93	7/2/93	7/16/93	7	21
8-S	58108TS	6/24/93	6/30/93	7/2/93	7/16/93	8	22
9-1-S	58901TS	6/29/93	7/3/93	7/9/93	7/17/93	10	18
9-2-S	58902TS	6/29/93	7/3/93	7/9/93	7/17/93	10	18
9-3-S	58903TS	6/29/93	7/3/93	7/9/93	7/17/93	10	18
10-S	58109TS	6/28/93	6/30/93	7/2/93	7/17/93	4	19
11-S	58904TS	6/29/93	7/3/93	7/9/93	7/17/93	10	18
12-S	58905TS	6/30/93	7/3/93	7/9/93	7/17/93	9	17
13-S	58906TS	7/1/93	7/3/93	7/9/93	7/17/93	8	16
14-S	58907TS	7/1/93	7/3/93	7/9/93	7/17/93	8	16
15-S	58908TS	6/30/93	7/3/93	7/9/93	7/17/93	9	17
Crayfish							
2-CF	60910TS	7/22/93	7/27/93	8/7/93	8/17/93	16	26
3-CF	60911TS	7/22/93	7/27/93	8/7/93	8/17/93	16	26
4-CF	60912TS	7/24/93	7/27/93	8/7/93	8/17/93	14	24
5-CF	60913TS	7/23/93	7/27/93	8/7/93	8/17/93	15	25
6-CF	60901TS	7/16/93	7/21/93	7/28/93	8/17/93	12	32
7-CF	60902TS	7/16/93	7/21/93	7/28/93	8/17/93	12	32
8-CF	60903TS	7/16/93	7/21/93	7/28/93	8/17/93	12	32
9-CF	60904TS	7/16/93	7/21/93	7/28/93	8/17/93	12	32
10-CF	60914TS	7/20/93	7/27/93	8/7/93	8/17/93	18	28
11-CF	60905TS	7/18/93	7/21/93	7/28/93	8/17/93	10	30
12-CF	60915TS	7/20/93	7/27/93	8/7/93	8/17/93	18	28
13-1-CF	60906TS	7/18/93	7/21/93	7/28/93	8/17/93	10	30
13-2-CF	60907TS	7/18/93	7/21/93	7/28/93	8/17/93	10	30
13-3-CF	60908TS	7/18/93	7/21/93	7/28/93	8/17/93	10	30
14-CF	60909TS	7/18/93	7/21/93	7/28/93	8/17/93	10	30
Fish							
1-LS	63001TS	8/6/93	8/10/93	8/19/93	8/27/93	13	21
1-C	63002TS	8/6/93	8/10/93	8/19/93	8/27/93	13	21
2-LS	63003TS	8/6/93	8/10/93	8/19/93	8/27/93	13	21
3-LS	63004TS	8/5/93	8/10/93	8/19/93	8/27/93	14	22
4-LS	63005TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
5-LS	63006TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
6-LS	63007TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
7-LS	63008TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
8-LS	63009TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
9-LS	63010TS	8/5/93	8/10/93	8/19/93	8/28/93	14	23
10-LS	63011TS	8/4/93	8/10/93	8/19/93	8/28/93	15	24
11-LS	63012TS	8/4/93	8/10/93	8/19/93	8/28/93	15	24
12-LS	63013TS	8/4/93	8/10/93	8/19/93	8/28/93	15	24
13-1-LS	63014TS	8/3/93	8/10/93	8/19/93	8/28/93	16	25
13-2-LS	63015TS	8/3/93	8/10/93	8/19/93	8/28/93	16	25
13-3-LS	63016TS	8/3/93	8/10/93	8/19/93	8/28/93	16	25
14-LS	63017TS	8/3/93	8/10/93	8/19/93	8/28/93	16	25
15-C	63018TS	8/3/93	8/10/93	8/19/93	8/28/93	16	25

TABLE 2. PERCENT RECOVERIES FOR POLYBUTYL TIN SURROGATE COMPOUNDS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

A. Sediment

Sample Number	CPD. 1	CPD. 2
MS	**245**	108
MSD	**220**	108
MB 1	87	90
MB 2	**0**	85
MB 3	54	98
MB 4	58	92
1-S	94	95
2-S	83	115
3-S	91	105
4-S	63	100
5-S	87	110
6-S	96	99
7-S	90	100
8-S	64	87
9-1-S	87	110
9-2-S	64	84
9-3-S	101	121
10-S	63	**0**
11-S	100	115
12-S	103	121
13-S	105	118
14-S	100	111
15-S	93	98

B. Crayfish

Sample Number	CPD. 1	CPD. 2
MS	77	88
MSD	78	85
MB 1	**49**	86
MB 2	72	96
MB 3	92	99
MB 4	146	105
2-CF	59	94
3-CF	87	84
4-CF	111	**88**
5-CF	93	**88**
6-CF	84	92
7-CF	82	99
8-CF	88	91
9-CF	86	96
10-CF	140	99
11-CF	84	82
12-CF	93	93
13-1-CF	82	87
13-2-CF	123	94
13-3-CF	71	90
14-CF	85	95

C. Fish

Sample Number	CPD. 1	CPD. 2
MS	63	81
MSD	86	79
MB 1	48	80
MB 2	89	100
1-LS	83	100
1-C	115	94
2-LS	102	101
3-LS	79	100
4-LS	83	103
5-LS	102	107
6-LS	123	102
7-LS	**23**	103
8-LS	89	101
9-LS	74	101
10-LS	87	102
11-LS	46	104
12-LS	54	106
13-1-LS	48	103
13-2-LS	**20**	113
13-3-LS	92	100
14-LS	58	102
15-C	86	98

CPD. 1 = tri-n-propyltin chloride, CPD. 2 = dimethyldiphenyltin
Advisory QC limits specified by U.S. EPA are 50-150 percent for both compounds
Values in bold exceed advisory QC guidelines

TABLE 3. POLYBUTYL TIN BLANK SAMPLE DATA (µg/kg)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Date Analyzed	n-Butyltin trichloride		di-n-Butyltin dichloride		tri-n-Butyltin chloride	
Sediment	7/16/93 18:54	4.0		4.0	U	4.0	U
	7/16/93 19:27	4.0	U	4.0	U	4.0	U
	7/17/93 1:28	4.0	U	4.0	U	4.0	U
	7/17/93 2:01	4.0	U	4.0	U	4.0	U
Crayfish	8/17/93 2:57	24.0	U	24.0	U	24.0	U
	8/17/93 3:30	24.0	U	24.0	U	6.0	J
	8/17/93 11:07	24.0	U	7.2	J	5.2	J
	8/17/93 11:40	24.0	U	24.0	U	3.6	J
Fish	8/27/93 20:04	1.6	J	24.0	U	1.2	J
	8/27/93 20:37	24.0	U	24.0	U	2.0	J

U = Not detected at the listed value
J = Value is below nominal detection limit

TABLE 4. POLYBUTYL TIN DATA (µg/kg)
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Sample Number	n-Butyltin trichloride		di-n-Butyltin dichloride		tri-n-Butyltin chloride	
Sediment	1-S	17	P	4	U	4	U
	2-S	4	U	4	U	5	P
	3-S	20		11		17	
	4-S	19		10	P	16	P
	5-S	34		19		43	
	6-S	16		4	U	8	
	7-S	12		4	U	4	U
	8-S	8	U/B	7		9	
	9-1-S	4	U	4	U	4	U
	9-2-S	4	U	4	U	4	U
	9-3-S	4	U	4	U	9	
	10-S	7	U/B/E	4	U/E	6	E
	11-S	4	U	4	U	5	
	12-S	4	U	4	U	8	P
	13-S	4	U	4	U	3	P
	14-S	4	U	4	U	4	U
	15-S	4	U	4	U	6	
Crayfish	2-CF	8	U	8	U	8	U
	3-CF	8	U	8	U	8	U
	4-CF	8	U	8	U	8	U
	5-CF	8	U	8	U	8	U
	6-CF	8	U	8	U	8	U
	7-CF	8	U	8	U	8	U
	8-CF	8	U	8	U	8	U
	9-CF	8	U	8	U	8	U/B
	10-CF	8	U	8	U	8	U
	11-CF	8	U	8	U	8	U
	12-CF	8	U	8	U	8	U
	13-1-CF	8	U	8	U	12	U/B
	13-2-CF	8	U	8	U	8	U
	13-3-CF	8	U	8	U	8	U
	14-CF	8	U	8	U	8	U
Fish	1-LS	8	U	8	U	2	U/B
	1-C	8	U	2	J	36	
	2-LS	0.8	U/B	2.4	J	48	
	3-LS	8	U	8	U	20	
	4-LS	8	U	8	U	16	
	5-LS	8	U	2	J	36	
	6-LS	8	U	4	J	68	
	7-LS	8	U/E	2.4	J/E	8	J/E
	8-LS	8	U	8	U	16	
	9-LS	8	U	8	U	4	U/B
	10-LS	8	U	2.8	J	32	
	11-LS	8	U	8	U	16	
	12-LS	8	U	8	U	20	
	13-1-LS	8	U	8	U	8	
	13-2-LS	8	U/E	8	U/E	8	U/E
	13-3-LS	8	U	8	U	16	
	14-LS	8	U	8	U	4	U/B
	15-C	8	U	8	U	1.6	U/B

Note: Sediment data are reported on a dry-weight basis, while tissue data are reported on a wet-weight basis
U = undetected, U/B = undetected due to blank contamination, J = value below nominal detection limit
P = concentration difference between two columns greater than 25 percent, E = estimated value

Appendix A-10

Data Validation Report
Radionuclide Analyses

Survey: Lower Columbia River Backwater Reconnaissance Survey

Samples collected and reported by: Tetra Tech, Inc.

Samples analyzed by: Analytical Resources, Inc.

Data Reviewed by: Curtis DeGasperi

INTRODUCTION

This report presents the results for the data validation review of 17 sediment samples and 33 tissue samples collected for the Lower Columbia River Backwater Reconnaissance Survey, and analyzed for selected alpha and gamma emitting radionuclides by Analytical Resources, Inc. The samples were collected at 15 different stations. Triplicate field composite samples of sediments were collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Of the 33 tissue samples, 15 were composite samples of 8 to 21 crayfish, and 18 were composite samples of 2 to 5 fish, either largescale sucker or carp. Crayfish samples were collected at 13 of the 15 stations (all except stations 1 and 15). Triplicate field composite samples of crayfish were collected at station 13 (samples 13-1-CF, 13-2-CF, and 13-3-CF). Fish samples were collected at all 15 stations. Largescale suckers were collected at 14 stations (all except station 15), while carp were collected at 2 stations (stations 1 and 15). Both largescale suckers and carp were collected and analyzed at station 1. Triplicate fish samples (largescale suckers) were collected at station 13 (samples 13-1-LS, 13-2-LS, and 13-3-LS).

Sediment and tissue samples were analyzed for the radionuclides plutonium 239/240 (Pu-239/240), plutonium 238 (Pu-238), and americium 241 (Am-241) using alpha spectroscopy. The method used by the laboratory involved the acid digestion of a 5 gram wet subsample spiked with the radiotracers Pu-242 and Am-243, except for the reanalyses of sediment sample 15-S which were conducted using 2.5 gram subsamples. Digestion of sediment samples included the use of nitric, hydrochloric, and hydrofluoric acid to ensure complete dissolution of the sample. Digestion of the tissue samples included the use of nitric and hydrochloric acid as well as hydrogen peroxide to ensure dissolution of fatty materials. Following digestion, the sample radionuclides and tracers were co-precipitated with ferric hydroxide. The sample precipitate was then dissolved in 9 N hydrochloric acid and passed through an anion exchange column which binds with plutonium. Americium passes through the column. The americium sample was further processed with a crown ether column (EiChrom) and then the americium was separated from lanthanide elements in a second anion exchange column. The americium sample was then mounted on a filter with cerium fluoride for analysis. The plutonium fraction was eluted from the first column using hydrobromic acid. The purified fraction of plutonium was then co-precipitated with cerium fluoride for analysis. The alpha spectroscopy results for Pu-239/240, Pu-238, and Am-241 were corrected for internal standard recoveries of Pu-242 and Am-243 as well as method tracer blank and background concentrations.

Sediment and tissue samples were analyzed for the radionuclides cobalt 60 (Co-60), cesium 137 (Cs-137), europium 152 (Eu-152), europium 154 (Eu-154), and europium 155 (Eu-155) using gamma spectroscopy. The method used by the laboratory involved the placement of a wet sub-sample on the detector for gamma analysis for 1000 minutes. Sub-sample sizes varied depending on the amount of material available for analysis. Sediment sample sizes ranged from 390 to 560 g, crayfish sample sizes ranged from 100 to 125 g, and fish sample sizes ranged from 110 to 410 g. The gamma spectroscopy results are corrected for background radiation, including internal sample radiation effects due primarily to mass attenuation.

The results reported by the laboratory are not decay corrected. Decay corrections would be insignificant for the radionuclides detected due to their relatively long half-lifes. Sediment data are reported as pCi/g dry sediment. Tissue data are reported as pCi/g wet weight.

There are currently no published guidelines for evaluating radionuclide analytical data. Therefore, the data validation review was conducted in relation to the analytical procedures outlined in the method references (EMSL-LV-0539-17 and EPA 600 4-80-032), in consideration of the contract laboratory evaluations of the data, and the approved Sampling and QA/QC Plan for this project (Tetra Tech 1993).

A. HOLDING TIMES

Composited sediment samples were placed on ice in coolers and transported to Analytical Resources, Inc. within 4 days of collection. Fish and crayfish samples were frozen in the field using dry ice and transported to Pacific Analytical, Inc. (the laboratory responsible for tissue sample homogenization) for sample compositing and tissue homogenization. Subsamples of the station composite tissue homogenate were then shipped to Analytical Resources, Inc. for radionuclide analysis.

Although there is no established holding time for the analysis of the targeted radionuclides in fish tissue or sediments, a maximum holding time of 6 months has been established for radionuclide analyses performed for this project (Tetra Tech 1993). Initial analyses of all samples were conducted within 29 days of sample collection. Reanalyses of the sediment sample from station 15 (sample 15-S) were conducted within 91 days of sample collection. All analyses were conducted well within the 6 month holding time established for this project. Table 1 presents a summary of sample numbers and dates of sample collection, analysis, and holding times.

B. CALIBRATION AND INSTRUMENT PERFORMANCE

The alpha spectrometer consisted of a six-detector system. Each detector was initially calibrated to a National Institute of Standards (NIST) traceable standard for thorium 230 and americium 241. Calibration and instrument performance of each detector was checked daily by the detector's internal test peak. The test peak verifies that the detector is in energy calibration and that the resolution meets manufacturers specifications. Also, an alpha point source of high activity is used to verify the efficiency of each detector. Calibration and instrument performance criteria were met for all radionuclide analyses conducted for this project.

The gamma spectrometer was initially calibrated to a NIST traceable standard (Amersham). Calibration and instrument performance were checked daily using an internal standard of barium 133, cesium 137, and cobalt 60. Calibration and instrument performance criteria were met for all radionuclide analyses conducted for this project.

C. METHOD BLANKS AND BACKGROUND RADIATION

Method tracer blanks are prepared and analyzed by alpha spectroscopy due to the extensive chemical processing of the samples analyzed by this method. The method tracer blank results reported for analysis of each medium are presented in Table 2. Method tracer blank concentration was highest for Am-241 analysis of sediments (0.008 pCi/g dry weight). All data reported for alpha spectroscopic analyses have been corrected for method tracer blank contribution. Background alpha radiation was also subtracted from the gross alpha radionuclide results.

No method blank analyses were performed for gamma spectroscopic analyses since the samples were not processed prior to analysis. However, gross analytical results were corrected for background radiation contributions and mass attenuation.

D. DETECTION LIMITS

The reported lower limit of detection (LLD) for radioanalyses performed by alpha spectroscopy were similar among the sediment, crayfish, and fish media and ranged from 0.000-0.011 pCi/g for Pu-239/240, 0.004-0.018 pCi/g for Pu-238, and 0.006-0.027 pCi/g for Am-241 (Table 3). The LLD for analyses conducted by alpha spectroscopy was calculated based on an error function that included background alpha radiation, counting time, sample weight, and internal standard recovery. The error associated with the reported concentration value was also calculated for the analyses conducted by alpha spectroscopy based on an error function that includes measured isotope alpha radioactivity of the sample, background alpha radiation, counting time, sample weight, and internal standard recovery. The error reported is the 2 sigma error (i.e., ± 2 standard deviations). Results of alpha spectroscopy analyses that were equal to or lower than the LLD have been qualified with a "U" to indicate that the radionuclide was not detected.

The reported LLD for analyses conducted by gamma spectroscopy for Co-60, Cs-137, Eu-152, Eu-154, and Eu-155 ranged from 0.02-0.5 pCi/g with the highest LLDs reported for the crayfish tissue analyses (Table 3). The higher LLDs reported for crayfish tissue analyses were due to the more limited sample size available for analysis. A smaller sample size for the largescale sucker sample collected from station 10 (sample 10-LS) also resulted in relatively higher LLDs for this sample.

E. ANALYSIS OF STANDARD REFERENCE MATERIALS

One Standard Reference Material (SRM) and two interlaboratory comparison check samples were analyzed in conjunction with the three analytical matrices (i.e., sediment, crayfish, and fish) (Table 4). The external samples were a soil certified by the National Bureau of Standards for Pu-239/240, Am-241, and Cs-137 (SRM 4353) and two Environmental Protection Agency interlaboratory comparison water samples of known Pu-239/240 and Am-241 concentration. The relative difference between the concentrations reported by the laboratory and the known concentrations was small. Percent accuracy ranged from 76 to 104 percent (Table 4), indicating acceptable analytical performance.

F. FIELD TRIPLICATES

Sediment

One set of field triplicate samples was collected at station 9 (samples 9-1-S, 9-2-S, and 9-3-S). Only one of the eight target radionuclides (Cs-137) was detected in all three samples (Table 5). The relative standard deviation (RSD) of these three values was 3.3 percent.

Crayfish

One set of field triplicate samples was collected at station 13 (sample 13-1-CF, 13-2-CF, and 13-3-CF). None of the eight target radionuclides were detected in any of the three samples (Table 6). Therefore, no estimate of variability can be made using these sample results.

Fish

One set of field triplicate largescale sucker composite samples was collected at station 13 (sample 13-1-LS, 13-2-LS, and 13-3-LS). None of the eight target radionuclides were detected in all three samples (Table 7). The radionuclides Pu-239/240 were detected in two, and Cs-137 was detected in one of the three samples. Therefore, no estimate of variability among the three samples can be made using these sample results.

SUMMARY

Sediment

All sediment sample data were reported as pCi/g dry weight and are presented in Table 8. The data package submitted by the laboratory contained all the required deliverables.

For the majority of the sample results, with the exception of Pu-239/240 and Cs-137, the data are reported as undetected at the sample-specific lower limit of detection (LLD). These data have been qualified as "U".

The initial analysis of the composite sediment sample collected from station 15 resulted in a relatively high reported concentration of Am-241. Two additional analyses of this sample for Am-241 did not detect the presence of Am-241 at detection limits similar to those achieved in the first analysis. All three values are reported in Table 8.

No data qualifiers were added to sample results based on the evaluation of QC data. Based on the analysis of all available QA/QC data, radionuclide data for sediments are acceptable for their intended use.

Crayfish

All crayfish sample data were reported as pCi/g wet weight and are presented in Table 9. The data package submitted by the laboratory contained all the required deliverables.

For all of the sample results, the data are reported as undetected at the sample-specific LLD. These data have been qualified as "U".

No data qualifiers were added to sample results based on the evaluation of QC data. Based on the analysis of all available QA/QC data, radionuclide data for crayfish are acceptable for their intended use.

Fish

All fish sample data were reported as pCi/g wet weight and are presented in Table 10. The data package submitted by the laboratory contained all the required deliverables.

For the majority of the sample results, with the exception of Pu-239/240 and Cs-137, the data are reported as undetected at the sample-specific LLD. These data have been qualified as "U".

No other data qualifiers were added to sample results based on the evaluation of QC data. Based on the analysis of all available QA/QC data, radionuclide data for fish are acceptable for their intended use.

REFERENCES

Tetra Tech. 1993. Lower Columbia River Backwater Reconnaissance Survey. Sampling and quality assurance/quality control (QA/QC) plan. Prepared for the Lower Columbia River Bi-State Program. Tetra Tech, Inc. Redmond, Washington.

TABLE 1. RADIONUCLIDE ANALYSIS SUMMARY
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Tetra Tech Sample Number	Analytical Resources, Inc Sample Number	Date Collected	Receipt Date	Analysis Dates	Maximum Analysis Holding Time (d)
Sediment					
1-S	X046A	6/28/93	6/29/93	7/1-7/10/93	12
2-S	X046B	6/27/93	6/29/93	7/2-7/10/93	13
3-S	X046C	6/27/93	6/29/93	7/4-7/15/93	18
4-S	X046D	6/26/93	6/29/93	7/4-7/11/93	15
5-S	X046E	6/26/93	6/29/93	7/5-7/11/93	15
6-S	X046F	6/25/93	6/29/93	7/6-7/12/93	17
7-S	X046G	6/25/93	6/29/93	7/7-7/12/93	17
8-S	X046H	6/24/93	6/29/93	7/3-7/15/93	21
9-1-S	X046I	6/29/93	7/2/93	7/10-7/15/93	16
9-2-S	X046J	6/29/93	7/2/93	7/10-7/15/93	16
9-3-S	X046K	6/29/93	7/2/93	7/13-7/19/93	20
10-S	X046L	6/28/93	6/29/93	7/10-7/14/93	16
11-S	X046M	6/29/93	7/2/93	7/14-7/19/93	20
12-S	X046N	6/30/93	7/2/93	7/14-7/19/93	19
13-S	X046O	7/1/93	7/2/93	7/15-7/19/93	18
14-S	X046P	7/1/93	7/2/93	7/14-7/20/93	19
15-S	X046Q	6/30/93	7/2/93	7/19-7/28/92	25
15-S reanalysis	X046Q	6/30/93	7/2/93	8/27/93	58
15-S reanalysis	X046Q	6/30/93	7/2/93	9/29/93	91
Crayfish					
2-CF	X047J	7/22/93	7/29/93	8/3-8/6/93	15
3-CF	X047K	7/22/93	7/29/93	8/3-8/10/93	19
4-CF	X047L	7/24/93	7/29/93	8/6-8/20/93	27
5-CF	X047M	7/23/93	7/29/93	8/5-8/17/93	25
6-CF	X047A	7/16/93	7/23/93	7/30-8/4/93	19
7-CF	X047B	7/16/93	7/23/93	7/30-8/4/93	19
8-CF	X047C	7/16/93	7/23/93	7/31-8/4/93	19
9-CF	X047D	7/16/93	7/23/93	8/2-8/6/93	21
10-CF	X047N	7/20/93	7/29/93	8/4-8/13/93	24
11-CF	X047E	7/18/93	7/23/93	8/2-8/4/93	17
12-CF	X047O	7/20/93	7/29/93	8/6-8/17/93	28
13-1-CF	X047F	7/18/93	7/23/93	7/28-8/5/93	18
13-2-CF	X047G	7/18/93	7/23/93	8/3-8/7/93	20
13-3-CF	X047H	7/18/93	7/23/93	8/3-8/6/93	19
14-CF	X047I	7/18/93	7/23/93	8/3-8/8/93	21
Fish					
1-LS	X047P	8/6/93	8/13/93	8/17-8/21/93	15
1-C	X047Q	8/6/93	8/13/93	8/16-8/21/93	15
2-LS	X047R	8/6/93	8/13/93	8/17-8/21/93	15
3-LS	X047S	8/5/93	8/13/93	8/18-8/21/93	16
4-LS	X047T	8/5/93	8/13/93	8/18-8/22/93	17
5-LS	X047U	8/5/93	8/13/93	8/19-8/22/93	17
6-LS	X047V	8/5/93	8/13/93	8/19-8/22/93	17
7-LS	X047W	8/5/93	8/13/93	8/19-8/22/93	17
8-LS	X047X	8/5/93	8/13/93	8/19-8/22/93	17
9-LS	X047Y	8/5/93	8/13/93	8/19-8/23/93	18
10-LS	X047Z	8/4/93	8/13/93	8/20-9/2/93	29
11-LS	X047AA	8/4/93	8/13/93	8/20-8/24/93	20
12-LS	X047AB	8/4/93	8/13/93	8/20-8/24/93	20
13-1-LS	X047AC	8/3/93	8/13/93	8/20-8/25/93	22
13-2-LS	X047AD	8/3/93	8/13/93	8/20-8/25/93	22
13-3-LS	X047AE	8/3/93	8/13/93	8/21-8/26/93	23
14-LS	X047AF	8/3/93	8/13/93	8/24-8/26/93	23
15-C	X047AG	8/3/93	8/13/93	8/24-8/30/93	27

TABLE 2. RADIONUCLIDE METHOD TRACER BLANK ANALYSIS RESULTS

	Date Analyzed	Plutonium 239/240	Plutonium 238	Americium 241
		(pCi/g)		
Sediment	7/8-19/93	0.000	0.001	0.008
Crayfish	8/9-20/93	0.000	0.001	0.001
Fish	8/25-26/93	0.000	0.000	0.004

TABLE 3. RADIONUCLIDE ANALYTICAL DETECTION LIMIT RESULTS

Radionuclide	Sample Media		
	Sediment	Crayfish	Fish
	(pCi/g)		
Plutonium 239/240	0.003-0.009	0.002-0.011	0.000-0.006
Plutonium 238	0.007-0.014	0.004-0.018	0.006-0.017
Americium 241	0.011-0.026	0.006-0.026	0.009-0.027
Cobalt 60	0.02	0.15	0.02-0.15
Cesium 137	0.02	0.12	0.02-0.12
Europium 152	0.2	0.40	0.2-0.4
Europium 154	0.2	0.25	0.2-0.25
Europium 155	0.05	0.50	0.05-0.50

TABLE 4. RADIONUCLIDE STANDARD REFERENCE MATERIAL ANALYSIS RESULTS

	Concentration Units	Reported Concentration	Reference Concentration	Percent Accuracy
Sediment:				
SRM 4353[1]				
Plutonium 239/240	pCi/g dry wt	0.170	0.217	78
Americium 241	pCi/g dry wt	0.026	0.034	76
SRM 4353				
Cesium 137	pCi/g dry wt	0.460	0.476	97
Crayfish:				
EPA INTERCOMPARISON SAMPLE[2]				
Plutonium 239/240	pCi/L	15.9	18.5	86
Americium 241	pCi/L	25.5	30.0	85
SRM 4353				
Cesium 137	pCi/g dry wt	0.488	0 476	103
Fish:				
EPA INTERCOMPARISON SAMPLE[2]				
Plutonium 239/240	pCi/L	17.6	18.5	95
Americium 241	pCi/L	25.8	30.0	86
SRM 4353				
Cesium 137	pCi/g dry wt	0.495	0.476	104

[1]SRM 4353 - National Bureau of Standards certified soil sample (Rocky Flats soil #1) for plutonium 239/240. americium 241. and cesium 137

[2]EPA intercomparison water samples (Am-241 -- 1992: Pu-239/240 -- 1992).

TABLE 5. RADIONUCLIDE ANALYSIS
SEDIMENT FIELD REPLICATE RESULTS
LOWER COLUMBIA RIVER RECONNAISSANCE SURVEY

	Sample 9-1-S	Sample 9-2-S (pCi/g dry sediment)	Sample 9-3-S	Relative Standard Deviation
Plutonium 239/240	0.007	0.003 U	0.005	NC
Plutonium 238	-0.002 U	0.001 U	-0.001 U	-
Americium 241	-0.006 U	-0.003 U	-0.006 U	-
Cobalt 60	0.02 U	0.02 U	0.02 U	-
Cesium 137	0.164	0.174	0.165	3.3 %
Europium 152	0.2 U	0.2 U	0.2 U	-
Europium 154	0.2 U	0.2 U	0.2 U	-
Europium 155	0.05 U	0.05 U	0.05 U	-

NC = Not calculated due to one or more non-detected values.
U = Not detected above the lower limit of detection.

TABLE 6. RADIONUCLIDE ANALYSIS
CRAYFISH REPLICATE RESULTS
LOWER COLUMBIA RIVER RECONNAISSANCE SURVEY

	Sample 13-1-CF	Sample 13-2-CF (pCi/g wet weight)	Sample 13-3-CF	Relative Standard Deviation
Plutonium 239/240	0.002 U	0.001 U	0.00 U	-
Plutonium 238	-0.001 U	-0.001 U	0.001 U	-
Americium 241	0.001 U	-0.001 U	-0.001 U	-
Cobalt 60	0.15 U	0.15 U	0.15 U	-
Cesium 137	0.12 U	0.12 U	0.12 U	-
Europium 152	0.40 U	0.40 U	0.40 U	-
Europium 154	0.25 U	0.25 U	0.25 U	-
Europium 155	0.50 U	0.50 U	0.50 U	-

U = Not detected above the lower limit of detection.

TABLE 7. RADIONUCLIDE ANALYSIS
FISH REPLICATE RESULTS
LOWER COLUMBIA RIVER RECONNAISSANCE SURVEY

	Sample 13-1-LS	Sample 13-2-LS (pCi/g wet weight)	Sample 13-3-LS	Relative Standard Deviation
Plutonium 239/240	0.003	0.001 U	0.001	NC
Plutonium 238	0.003 U	0.002 U	0.002 U	-
Americium 241	0.005 U	0.002 U	0.004 U	-
Cobalt 60	0.02 U	0.02 U	0.02 U	-
Cesium 137	0.02 U	0.02	0.02 U	-
Europium 152	0.2 U	0.2 U	0.2 U	-
Europium 154	0.2 U	0.2 U	0.2 U	-
Europium 155	0.05 U	0.05 U	0.05 U	-

NC = Not calculated due to one or more non-detected values.
U = Not detected above the lower limit of detection.

TABLE 8 SEDIMENT RADIONUCLIDE CONCENTRATIONS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

Samples	Plutonium 239/240 pCi/g dry sediment		error	LLD	Plutonium 238 pCi/g dry sediment		error	LLD	Americium 241 pCi/g dry sediment		error	LLD	Cobalt 60 pCi/g dry sediment	error	LLD	Cesium 137 pCi/g dry sediment	error	LLD	Europium 152 pCi/g dry sediment	LLD	Europium 154 pCi/g dry sediment	LLD	Europium 155 pCi/g dry sediment	LL
1-S	0.007		±0.006	0.005	0.001	U	±0.001	0.014	-0.003	U	±0.007	0.012	U		0.02	0.071	±0.010	0.02	U	0.20	U	0.20	U	0.0
2-S	0.004	U	±0.004	0.004	-0.001	U	±0.004	0.009	0.000	U	±0.006	0.013	U		0.02	0.053	±0.008	0.02	U	0.20	U	0.20	U	0.0
3-S	0.001	U	±0.003	0.004	-0.001	U	±0.004	0.008	-0.002	U	±0.010	0.018	U		0.02	0.065	±0.009	0.02	U	0.20	U	0.20	U	0.0
4-S	0.004		±0.004	0.003	-0.001	U	±0.005	0.010	-0.010	U	±0.010	0.02	U		0.02	0.083	±0.010	0.02	U	0.20	U	0.20	U	0.0
5-S	0.003	U	±0.003	0.003	0.000	U	±0.004	0.008	0.000	U	±0.008	0.016	U		0.02	0.078	±0.010	0.02	U	0.20	U	0.20	U	0.0
6-S	0.009		±0.005	0.005	0.002	U	±0.006	0.010	-0.003	U	±0.007	0.013	U		0.02	0.110	±0.010	0.02	U	0.20	U	0.20	U	0.0
7-S	0.001	U	±0.003	0.004	-0.001	U	±0.004	0.008	-0.008	U	±0.006	0.012	U		0.02	0.050	±0.009	0.02	U	0.20	U	0.20	U	0.0
8-S	0.007		±0.005	0.003	0.000	U	±0.006	0.011	0.003	U	±0.010	0.016	0.022	±0.008	0.02	0.155	±0.016	0.02	U	0.20	U	0.20	U	0.0
9-1-S	0.007		±0.004	0.004	-0.002	U	±0.004	0.009	-0.006	U	±0.005	0.011	U		0.02	0.164	±0.015	0.02	U	0.20	U	0.20	U	0.0
9-2-S	0.003	U	±0.003	0.004	0.001	U	±0.004	0.007	-0.003	U	±0.011	0.019	U		0.02	0.174	±0.015	0.02	U	0.20	U	0.20	U	0.0
9-3-S	0.005		±0.004	0.004	-0.001	U	±0.004	0.007	-0.006	U	±0.010	0.019	U		0.02	0.165	±0.014	0.02	U	0.20	U	0.20	U	0.0
10-S	0.004		±0.004	0.003	0.005	U	±0.006	0.009	-0.004	U	±0.009	0.017	U		0.02	0.094	±0.010	0.02	U	0.20	U	0.20	U	0.0
11-S	0.001	U	±0.002	0.003	-0.001	U	±0.005	0.010	0.000	U	±0.010	0.016	U		0.02	0.081	±0.012	0.02	U	0.20	U	0.20	U	0.0
12-S	0.010		±0.005	0.003	-0.001	U	±0.004	0.009	-0.008	U	±0.008	0.015	U		0.02	0.176	±0.015	0.02	U	0.20	U	0.20	U	0.0
13-S	0.002	U	±0.003	0.004	-0.004	U	±0.004	0.008	-0.002	U	±0.012	0.021	U		0.02	0.082	±0.010	0.02	U	0.20	U	0.20	U	0.0
14-S	0.003	U	±0.004	0.005	-0.001	U	±0.004	0.008	0.001	U	±0.009	0.014	0.012	±0.006	0.02	0.119	±0.012	0.02	U	0.20	U	0.20	U	0.0
15-S	0.005	U	±0.007	0.009	-0.002	U	±0.006	0.012	0.069		±0.028	0.026	0.019	±0.005	0.02	0.143	±0.013	0.02	U	0.20	U	0.20	U	0.0
15-S-1R[1]									-0.006	U	±0.013	0.026												
15-S-2R[1]									-0.001	U	±0.013	0.024												

[1]Results of reanalysis of sample 15-S for americium 241.

Data Qualifiers:

LLD = Lower limit of detection
U = Not detected above the LLD.

TABLE 9. CRAYFISH TISSUE RADIONUCLIDE CONCENTRATIONS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Plutonium 239/240			Plutonium 238			Americium 241			Cobalt 60		Cesium 137		Europium 152		Europium 154		Europium 155	
Samples	pCi/g wet weight	error	LLD	pCi/g wet weight	error	LLD	pCi/g wet weight	error	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD
2-CF	0.001 U	±0.002	0.003	-0.001 U	±0.003	0.006	0.004 U	±0.006	0.008	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
3-CF	-0.001 U	±0.002	0.003	0.000 U	±0.003	0.006	0.003 U	±0.005	0.007	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
4-CF	0.000 U	±0.001	0.003	-0.001 U	±0.003	0.006	0.000 U	±0.006	0.011	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
5-CF	0.000 U	±0.001	0.003	0.003 U	±0.004	0.005	0.002 U	±0.006	0.01	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
6-CF	0.001 U	±0.003	0.005	-0.006 U	±0.008	0.016	-0.005 U	±0.014	0.026	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
7-CF	0.000 U	±0.003	0.008	-0.001 U	±0.009	0.018	-0.001 U	±0.006	0.011	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
8-CF	0.000 U	±0.002	0.006	-0.001 U	±0.004	0.010	-0.001 U	±0.005	0.01	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
9-CF	0.004 U	±0.005	0.005	-0.002 U	±0.004	0.010	-0.004 U	±0.010	0.019	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
10-CF	0.001 U	±0.002	0.003	-0.004 U	±0.005	0.010	-0.003 U	±0.006	0.014	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
11-CF	0.002 U	±0.006	0.011	0.004 U	±0.009	0.015	0.002 U	±0.005	0.009	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
12-CF	0.001 U	±0.003	0.004	-0.001 U	±0.004	0.008	-0.003 U	±0.005	0.012	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
13-1-CF	0.002 U	±0.002	0.003	-0.001 U	±0.003	0.006	0.001 U	±0.005	0.008	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
13-2-CF	0.001 U	±0.002	0.003	-0.001 U	±0.004	0.008	-0.001 U	±0.006	0.011	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
13-3-CF	0.000 U	±0.001	0.003	0.001 U	±0.004	0.006	-0.001 U	±0.004	0.008	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50
14-CF	0.000 U	±0.001	0.002	0.000 U	±0.003	0.004	0.003 U	±0.004	0.006	U	0.15	U	0.12	U	0.40	U	0.25	U	0.50

Data Qualifiers:

LLD = Lower limit of detection.
U = Not detected above the LLD.

TABLE 10. FISH TISSUE RADIONUCLIDE CONCENTRATIONS
LOWER COLUMBIA RIVER BACKWATER RECONNAISSANCE SURVEY

	Plutonium 239/240			Plutonium 238			Americium 241			Cobalt 60		Cesium 137			Europium 152		Europium 154		Europium 155	
Samples	pCi/g wet weight	error	LLD	pCi/g wet weight	error	LLD	pCi/g wet weight	error	LLD	pCi/g wet weight	LLD	pCi/g wet weight	error	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD	pCi/g wet weight	LLD
1-LS	0.001	±0.001	0.000	0.011	±0.006	0.007	0.003 U	±0.012	0.020	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
1-C	0.002	±0.002	0.000	0.002 U	±0.004	0.009	-0.001 U	±0.007	0.014	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
2-LS	0.001	±0.001	0.000	0.000 U	±0.004	0.008	0.003 U	±0.008	0.015	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
3-LS	0.001	±0.001	0.000	0.001 U	±0.003	0.007	-0.004 U	±0.011	0.024	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
4-LS	0.000	±0.000	0.000	0.001 U	±0.004	0.007	-0.003 U	±0.005	0.010	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
5-LS	0.001	±0.002	0.000	0.001 U	±0.004	0.008	-0.004 U	±0.007	0.014	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
6-LS	0.001	±0.002	0.000	-0.001 U	±0.005	0.010	0.002 U	±0.009	0.017	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
7-LS	0.003	±0.003	0.000	0.003 U	±0.006	0.011	-0.002 U	±0.013	0.027	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
8-LS	0.001	±0.001	0.000	0.001 U	±0.004	0.007	0.001 U	±0.008	0.015	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
9-LS	0.001	±0.002	0.000	0.001 U	±0.004	0.008	0.003 U	±0.009	0.017	U	0.02	0.016	±0.009	0.02	U	0.20	U	0.20	U	0.05
10-LS	0.001	±0.001	0.000	-0.002 U	±0.006	0.011	0.002 U	±0.010	0.018	U	0.15	U		0.12	U	0.20	U	0.20	U	0.05
11-LS	0.002	±0.002	0.000	0.001 U	±0.005	0.010	0.004 U	±0.006	0.009	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
12-LS	0.001	±0.001	0.000	0.003 U	±0.004	0.007	0.007 U	±0.007	0.010	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
13-1-LS	0.003	±0.003	0.000	0.003 U	±0.005	0.008	0.005 U	±0.006	0.010	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
13-2-LS	0.001 U	±0.002	0.003	0.002 U	±0.004	0.008	0.002 U	±0.005	0.009	U	0.02	0.020	±0.009	0.02	U	0.20	U	0.20	U	0.05
13-3-LS	0.001	±0.001	0.000	0.002 U	±0.004	0.007	0.004 U	±0.007	0.012	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
14-LS	0.000 U	±0.003	0.006	0.001 U	±0.003	0.006	0.000 U	±0.005	0.010	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05
15-C	0.001	±0.003	0.000	0.001 U	±0.008	0.017	-0.002 U	±0.006	0.013	U	0.02	U		0.02	U	0.20	U	0.20	U	0.05

Data Qualifiers:

LLD = Lower limit of detection.
U = Not detected above the LLD.