2022 Spokane River Regional Toxics Task Force Evaluation of PCBs in Spokane River Redband Trout

Prepared for:
Spokane River Regional Toxics Task Force

With support from:
Washington State Department of Fish & Wildlife

June 30, 2023

LimnoTech

Water | Scientists
Environment | Engineers

Blank Page

501 Avis Drive
Ann Arbor, MI 48108
734.332.1200
www.limno.com

2022 Spokane River Regional Toxics Task Force Evaluation of PCBs in Spokane River Redband Trout

Prepared for:
Spokane River Regional Toxics Task Force

With support from:
Washington State Department of Fish & Wildlife

June 30, 2023

Blank page

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Blank page

Executive Summary

Segments of the Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters due to elevated concentrations of polychlorinated biphenyls (PCBs) in fish tissue, as specified by Washington's Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements (Water Quality Program Policy 1-11)[1]. To address these impairments, the Department of Ecology (Ecology) has been pursuing a toxics reduction strategy that included the establishment of a Spokane River Regional Toxics Task Force (Task Force) to identify and reduce PCBs at their source in the watershed. One of the key missions of the Task Force is to make measurable progress toward meeting applicable water quality criteria for PCBs. Demonstrating that this progress is occurring requires a long-term monitoring program. The Task Force subsequently endorsed a long-term monitoring program consisting of parallel effort monitoring PCB concentrations in the water column (using semipermeable membrane devices) and fish tissue (using year old Redband Trout). This study describes the continuation of monitoring of fish tissue PCB concentrations using year old Redband Trout. The results of this study are designed to support long term trend assessment of PCB concentrations in fish tissue that may be used as one measure of the effectiveness of PCB control actions aimed at the reduction of PCBs in the Spokane River.

The Washington State Department of Fish and Wildlife (WDFW) collected fish in four reaches of the river, selected to be comparable to past studies while including new reaches with similar hydrology for direct comparison across a geographic range (Lee et al, 2020). The following conclusions can be gathered from the data collected:

- PCB concentrations in rainbow trout are similar to those observed in 2020 for all study reaches.
- PCBs concentrations were higher at a statistically significant level in the downstream reaches (Mission Reach [Reach 4], Water St. to TJ Meenach Bridge [Reach 5], and Riverside Park Water Reclamation Facility [RPWRF] to the kayak takeout location [Reach 6]) than the upstream reaches (Spokane Valley [Reach 2] and Upriver [Reach 3]).

[1]Fish tissue PCB concentrations are considered as part of narrative water quality standards.

- Blank page

1 Introduction

Segments of the Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters due to elevated concentrations of polychlorinated biphenyls (PCBs) in fish tissue, as specified by Washington's Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements (Water Quality Program Policy 1-11)[2]. To address these impairments, the Department of Ecology (Ecology) has been pursuing a toxics reduction strategy that included the establishment of a Spokane River Regional Toxics Task Force (Task Force) to identify and reduce PCBs at their source in the watershed. One of the key missions of the Task Force is to make measurable progress toward meeting applicable water quality criteria for PCBs. Demonstrating that this progress is occurring requires a long-term monitoring program, and development of such a program was identified as a priority activity as an outcome of a May 2019 Data Synthesis Workshop. The Task Force subsequently endorsed a long-term monitoring program consisting of parallel efforts monitoring PCB concentrations in the water column and fish tissue.

This study describes collection and analysis of wild, year old Redband Trout to support the fish tissue trend assessment. It represents the second round of data collection for this program, with the initial collection conducted in 2020 (LimnoTech, 2021). The study uses index reaches that are comparable to past studies while including new reaches with similar hydrology for direct comparison across a geographic range. The study reduces variability by limiting the sampling to a single species of similar size and age. Additionally, fish processing and analysis methods have been standardized to provide directly comparable results over time. The standardization allows the study to be repeated for use as a "yardstick" to monitor PCB concentrations in fish tissue over time. These analyses will provide a direct link to the efficacy of control actions on the bioaccumulation of PCBs in the tissue of Redband Trout in the Spokane River. This differs from the objectives of previous studies of fish tissue PCB conducted by the Washington Department of Ecology.

This report documents the results of the above monitoring program and subsequent analyses. It is divided into sections of:

- Sampling activities
- Analytical results
- Data interpretation

[2]Fish tissue PCB concentrations are considered as part of narrative water quality standards.

Blank Page

2 Sampling Activities

The field monitoring program consisted of five one-day sampling events on five reaches of the Spokane River. Sampling activities are described below, divided into sections corresponding to:

- Sampling locations
- Monitoring dates
- Field sampling activities
- Quality assurance

2.1 Sampling Locations

Sampling locations consisted of five reaches of the Spokane River between Spokane Valley and downstream of the Riverside Park Water Reclamation Facility. Reach descriptions and geographic coordinates are provided in Table 1 and mapped in Figure 1.

Table 1. 2022 Fish Sampling Reaches*

Reach	Description	Latitude (start, end)	Longitude (start, end)
2	Flora Road to Donkey Island	47.6787307° N 47.6892723° N	-117.17507466° W -117.2627728° W
3	Upriver Dam to Crestline St.	47.681113° N 47.6772427° N	-117.33394842° W -117.3789251° W
4	Crestline St. to Division St.	47.6772427° N 47.6626718° N	-117.3789251° W -117.4112242° W
5	Water Ave. to T.J. Meenach Bridge	47.6598654° N 47.6801865° N	-117.4391485° W -117.4525107° W
6	Riverside Park Water Reclamation Facility to the Kayak Takeout Site	47.69326° N 47.69667° N	-117.47206° W -117.47900° W

*The original monitoring design included a Reach 1, located at the Washington/Idaho border. This reach was subsequently dropped from the monitoring program after the 2020 fish collection could not obtain suitably sized Redband Trout from that location.

2.2 Monitoring Dates

Monitoring was conducted across four dates in the fall of 2022, starting on October 20 and concluding on October 26. The intent was to capture 25 fish per reach in Reaches 2 through 5 and 15 fish in Reach 6[3]. In all cases, all fish in a given reach were captured in a single day. The number of fish collected by reach and date are provided in Table 2.

[3] Fish collection in Reach 6 was intentionally reduced to 15 fish after the 2020 sampling event to address concerns over potential negative population impacts of removing fish from the small numbers present in that reach. The Task Force also recommended that future fish trend assessment sampling be conducted every four years (versus the present two year frequency) to minimize population impacts in Reach 6.

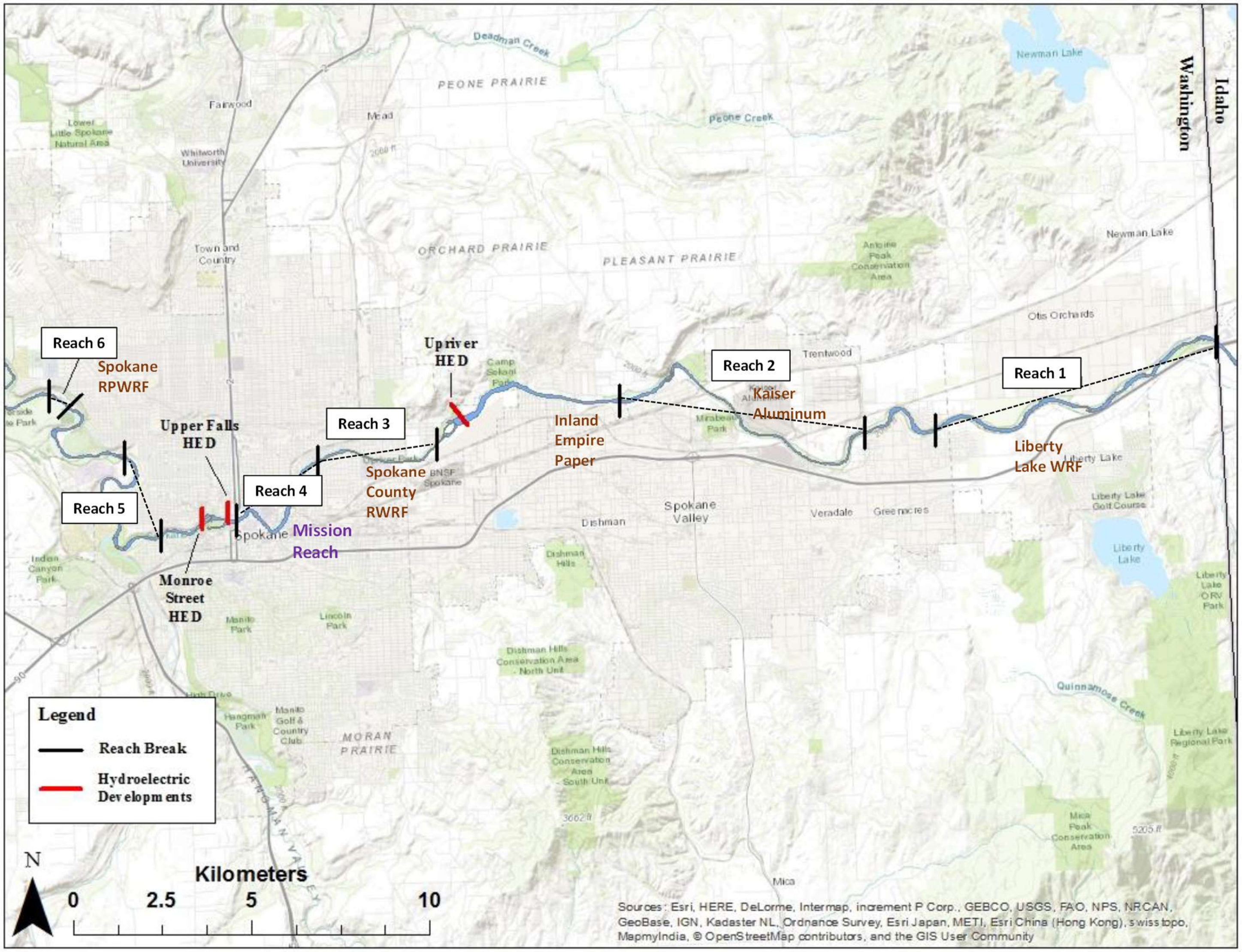

Figure 1. Fish Sampling Reaches (adapted from Lee et al, 2020 to show location of Mission Reach and known PCB loads)

Table 2. Sampling Dates and Number of Fish Collected by Reach

Reach	Location Descriptor	Number of Fish Collected	Date
2	Flora Road to Donkey Island	25	10/24/2022
3	Upriver Dam to Crestline Street	25	10/20/2022
4	Crestline Street to Division Street	25	10/20/2022
5	Water Ave. to TJ Meenach Bridge	25	10/25/2022
6	Riverside Park WRF to kayak takeout site	15	10/26/2022

2.3 Field Sampling Activities

The field sampling activities as planned and implemented are detailed in the project QAPP and QAPP Addendum (Lee et al, 2020; LimnoTech, 2022). This section summarizes those activities. Sampling was conducted by boat electrofishing. A crew of two to three individuals, one boat captain/rower and one to two netters, conducted the surveys. A maximum of two sampling passes were conducted at each of the five survey reaches. Sampling was conducted along the left or right shoreline for approximately 600 seconds of "electrofishing on" time. The crew then anchored and processed the samples (if any). The boat crew then crossed the river and sampled the opposite shoreline for approximately 600 seconds. This process was repeated until the full sample (n=15 or 25) for the survey reach was collected or the end of the reach was encountered. If necessary, WDFW conducted a second sampling pass. The intent of this study is to use wild fish only, and not hatchery fish in the assessment of trends in PCB concentrations over time. Hatchery Rainbow Trout were excluded from the study because they are stocked as 1-year old fish and as such their PCB exposure is vastly different to that of wild Redband Trout (Lee et al, 2020). Wild fish were identified as those having an intact adipose fin. All hatchery fish planted in the Spokane River have their adipose fins clipped prior to release. Fin condition was also examined in the field for deformities indicative of hatchery origin (in case of a poor or missed fin clip). As a precaution, fish with deformed fins (i.e., bent dorsal, bent pectorals, missing pectoral fins) but having an intact adipose fin were not used for the study.

Biological data collected on each fish included total length (mm) and weight (g). Fish did not have age or sex determined as the variability presented by those characteristics are accounted for based on the targeted total lengths of the fish (200-300 mm) which represent sub-adult and sexually immature fish. Sample collection location data included GPS coordinates (start and end) of the survey reach, date of collection, and time of day.

2.4 Quality Assurance

Field samples were shipped to AXYS Analytical Laboratories, Ltd. in Wilmington, North Carolina for compositing (five whole fish per composite) and analysis of PCB concentrations (Method 1668), % lipids, and % moisture.

2.4.1 Data Quality Assessment

All data were reviewed for quality assurance in accordance with the project QAPP and as noted in the laboratory EDD-Excel files provided in the appendix. All reviewed quality control (QC) results for PCBs comply with QAPP data quality indicators/

2.4.2 Blank Censoring

Total PCB concentrations were corrected for method blank contamination following the procedures defined in the QAPP. Specifically, individual congeners found in the sample at a concentration less than three times the associated blank concentration were flagged and excluded from calculation of homolog and total PCB concentration. All total PCB and homolog results reported below are blank corrected using the above method.

3
Analytical Results

This section summarizes the results of the 2022 monitoring, in terms of concentrations of total PCBs and individual homologs. Furthermore, a detailed listing of PCB homolog concentrations for each composite sample of five fish is provided in Appendix A, and full laboratory data sheets are provided in Appendix C.

3.1 Total PCBs

Total PCB concentrations are shown below in Figure 2 and Table 3 for all Spokane River reaches. PCB concentrations are generally less than 20 ug/kg at the most upstream reach (Reach 2, Flora Rd. to Donkey Island) and increase to 25 to 35 ug/kg at the next reach downstream (Reach 3, Upriver Dam to Crestline). Fish tissue PCB concentrations continue to increase to concentrations between 45 and 90 ug/kg at Reach 4 (Crestline to Division). Average concentrations peaked at Reach 5 (Water Ave to TJ Meenach Bridge), largely driven by one high composite fish tissue concentration. However, median concentrations peaked at Reach 4. Concentrations decrease moving downstream to Reach 6 (Riverside Park WRF to Kayak Takeout), ranging from 30 to 75 ug/kg. Additional interpretation of these data is provided subsequently in Section 4 of this report.

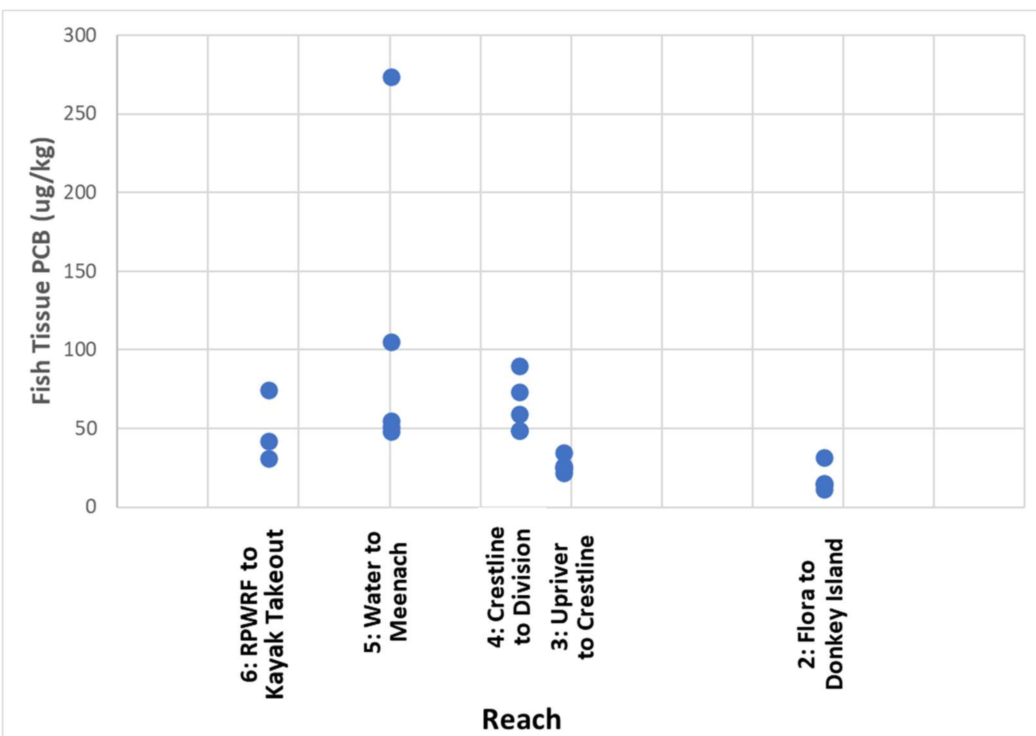

Figure 2. Spokane River Fish Tissue Total PCB Concentrations (ug/kg) Measured during 2022

Table 3. Spokane River Fish Tissue Total PCB Concentrations (ug/kg) Measured during 2022

	Fish Composite				
Reach	**1-5**	**6-10**	**11-15**	**16-20**	**21-25**
2: Flora Rd. to Donkey Island	15.2	14.9	31.5	11.6	14.4
3: Upriver Dam to Crestline	25.6	24.6	26.3	21.8	34.7
4: Crestline to Division	59.3	73.3	89.6	48.5	48.8
5: Water Ave to TJ Meenach Bridge	105.3	54.7	273.9	51.0	48.0
6: Riverside Park WRF to Kayak Takeout	31.2	74.8	41.8	na	na

3.2 Homolog Distributions

Homolog distributions for each reach are summarized in Figures 3 through 7, showing average concentration by homolog across all samples within a given reach. These data are provided in tabular format for each individual sample in Appendix A. All reaches have penta- and hexa-chlorinated homologs as the most prevalent.

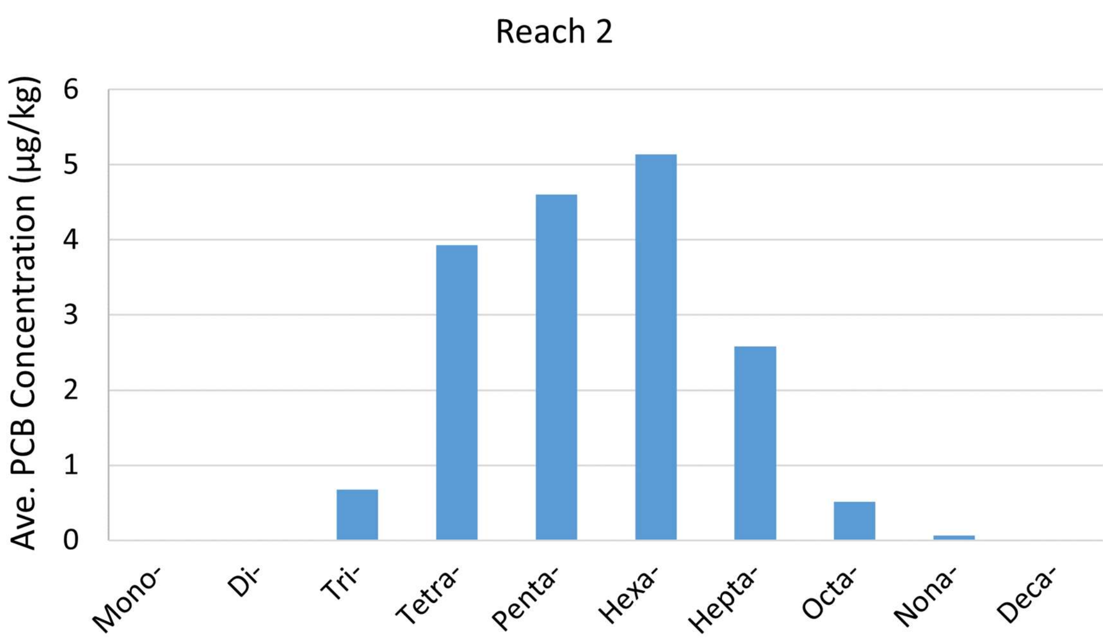

Figure 3. Average Blank-Corrected Homolog Concentrations for All Fish from Reach 2: Flora Rd. to Donkey Island.

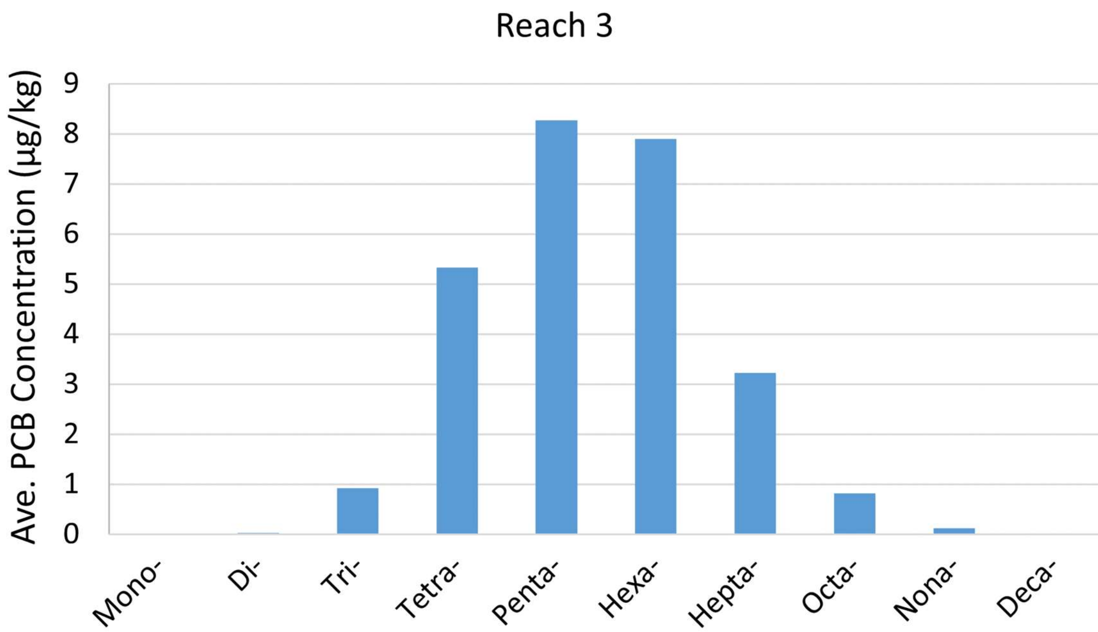

Figure 4. Average Blank-Corrected Homolog Concentrations for All Fish from Reach 3: Upriver Dam to Crestline.

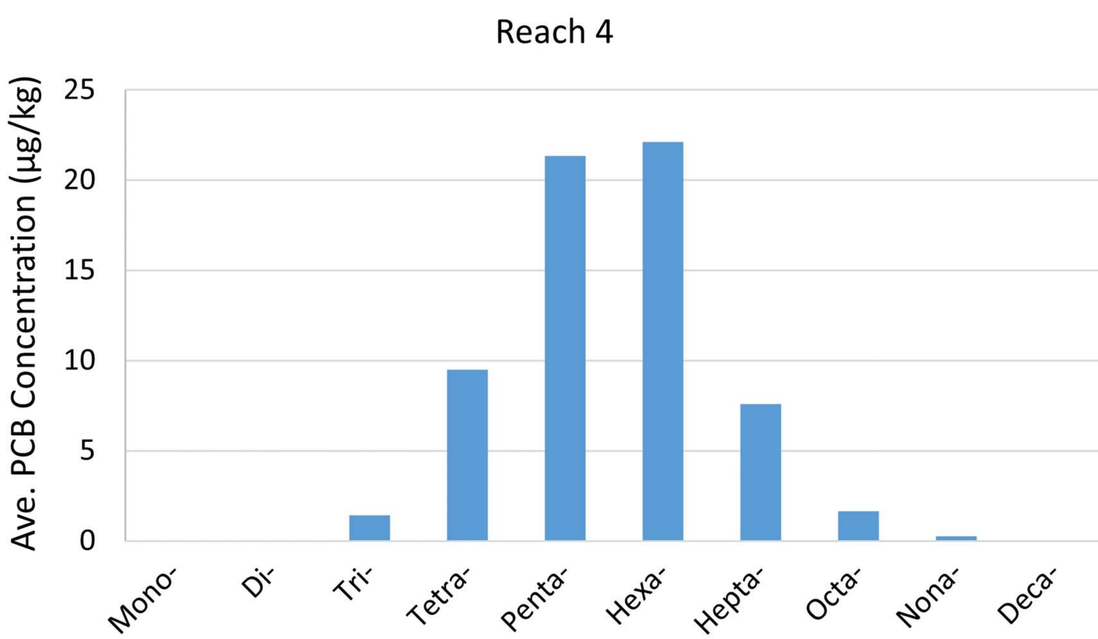

Figure 5. Average Blank-Corrected Homolog Concentrations for All Fish from Reach 4: Crestline to Division.

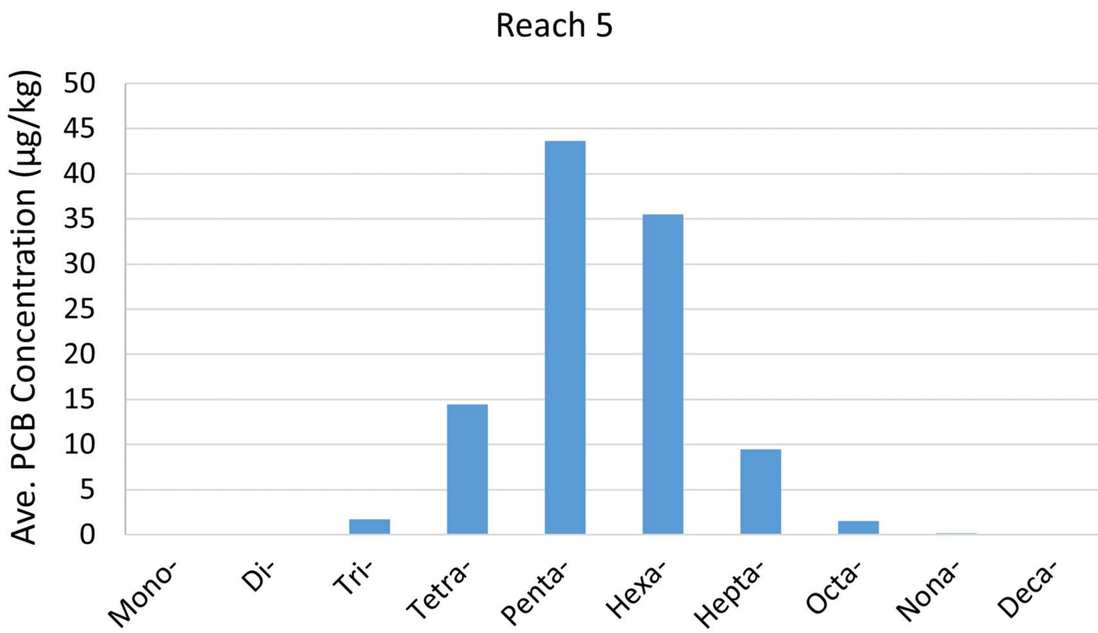

Figure 6. Average Blank-Corrected Homolog Concentrations for All Fish from Reach 5: Water Ave to TJ Meenach Bridge.

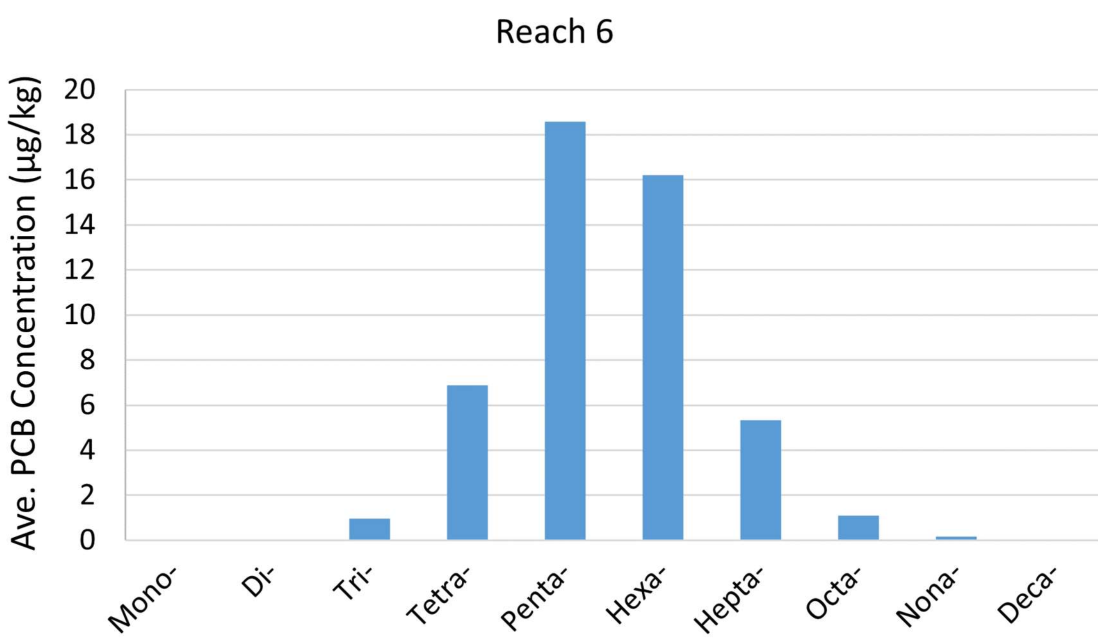

Figure 7. Average Blank-Corrected Homolog Concentrations for All Fish from Reach 6: Riverside Park WRF to Kayak Takeout.

4
Data Interpretation

The objective of this sampling is to continue to provide data to support the understanding of current fish tissue PCB concentrations, against which future concentrations can be compared to evaluate the effectiveness of ongoing PCB control efforts. This section provides an interpretation of the PCB results provided in Section 3 in terms of:

- Analysis of differences in total PCB concentration between stations
- Comparison to fish tissue PCB concentrations from prior years
- Comparison to regulatory thresholds
- Correlation between homolog distributions in fish and primary loading sources

4.1 Analysis of Differences in Total PCB Concentration between Stations

The results presented above were analyzed to assess whether statistically significant differences existed in fish tissue concentrations between reaches of the river, following the work done on 2012 fish tissue data by Seiders et al (2014). The null hypothesis was that no differences between concentrations at various locations existed. An alpha level of 0.05 was chosen to ensure that there was a low probability (5%) that the results from the test were not due to chance. The Mann-Whitney test was used to compare results between each station. Interpretations of these operations are summarized in Table 4.

Table 4. Outcome of Statistical Tests for Difference between Reaches in PCB Concentrations in Spokane River Redband Trout Tissue

Reach	Relation	Reach		Reach	Relation	Reach		Reach	Relation	Reach
2	=	3		4	>	2		6	>	2
2	<	4		4	>	3		6	>	3
2	<	5		4	=	5		6	=	4
2	<	6		4	=	6		6	=	5
3	=	2		5	>	2				
3	<	4		5	>	3				
3	<	5		5	=	4				
3	<	6		5	=	6				

Results of the statistical comparisons can be summarized as follows. PCB concentrations in juvenile, wild Redband trout in Reach 4, Reach 5, and Reach 6 were significantly greater than concentrations in Reach 2 and Reach 3. No other statistically significant differences between reaches were observed.

4.2 Comparison to Prior Trout Tissue PCB Concentrations

4.2.1 Comparison to 2020 Trout Tissue Total PCBs

The Washington State Department of Fish and Wildlife (WDFW) in coordination with the Task Force, measured fish tissue PCB concentrations of wild rainbow trout in the Spokane River in 2020. The 2020 sampling methods paralleled those of 2022 and involved the sampling of whole juvenile rainbow trout; therefore, the 2020 and 2022 datasets are directly comparable.

Concentrations across 2020 and 2022 appear to follow a similar spatial pattern with the greatest concentrations observed in Water to Meenach (Reach 5) and Mission Reach (Reach 4) (Figure 9).

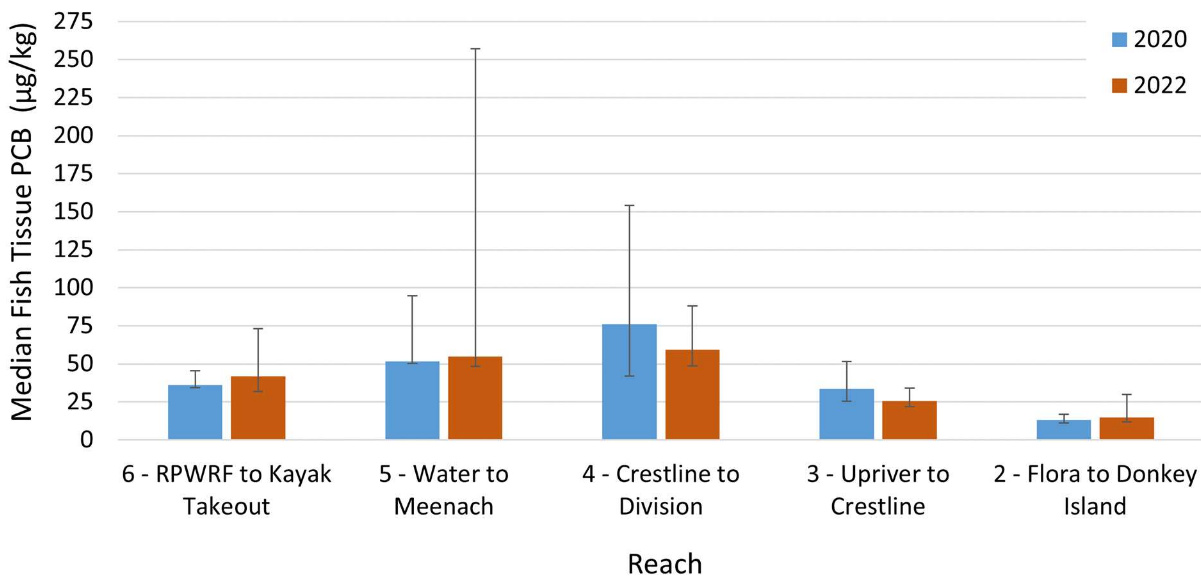

Figure 8. Spokane River Trout Tissue PCB Concentrations between Reaches in 2020 and 2022. Error bars represent the 95th percentile confidence limits for total PCB concentrations.

The statistical significance of the differences observed in fish tissue total PCB concentrations between 2020 and 2022 was analyzed using the Mann-Whitney test. This test compared concentrations at a given reach in 2020 to concentrations at the same reach in 2022. The null hypothesis was that no differences between concentrations in 2020 and concentrations in 2022 existed for a given reach. An alpha level of 0.05 was chosen to ensure that there was a low probability (5%) that the results from the test were not due to chance. For all reaches, there was no statistically significant difference between the total PCB concentrations observed in 2020 and those observed in 2022.

4.2.2 Comparison to Historical Rainbow Trout Tissue Total PCBs

The Washington State Department of Ecology measured fish tissue PCB concentrations of several fish species including rainbow trout in the Spokane River in 2012 (Seiders et al, 2014) and 2005 (Serdar and Johnson, 2006). Rainbow trout tissue data collected in 2005 and 2012 are not directly comparable with the 2020 and 2022 data because:

- Tissue PCB concentrations from 2022 and 2020 were measured using whole fish, while the 2005 and 2012 studies used fillets.
- The 2022 and 2020 studies collected only juvenile fish, while the 2005 and 2012 studies examine a wide range of age and size classes.

It is noted that the above two factors work in opposition in terms of fish tissue PCB concentration (whole fish tend to have higher PCB concentrations than fillets, while juvenile fish have lower concentrations than the rainbow trout population as a whole).

While the historic 2005 and 2012 data cannot be directly compared to the 2022 data, a qualitative comparison can provide beneficial insight to PCB trends in the Spokane River. Rainbow trout tissue PCB concentrations can be understood to generally decrease from 2005 to 2022 as indicated by the Reach 4 and Reach 2 data in Figure 9. Historically, the greatest PCB concentration was observed at Mission Reach (Reach 4); however, the results of the Mann-Whitney test between the 5 reaches in 2022 (Table 4) showed that Mission Reach (Reach 4) is not statistically significantly different from the other downstream reaches.

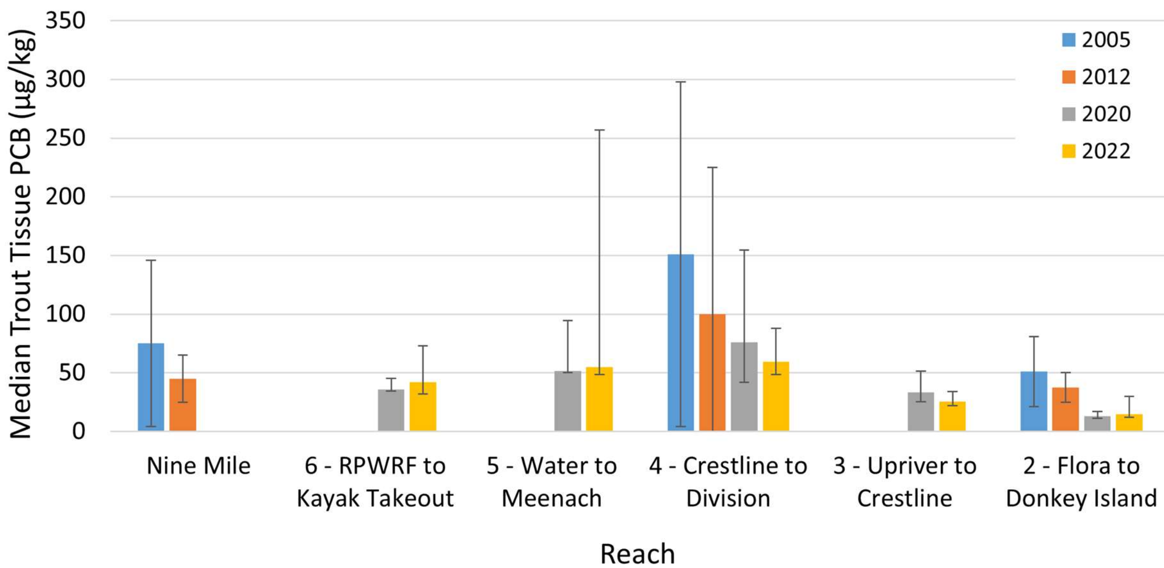

Figure 9. Spokane River Trout Tissue PCB Concentrations between Years and Reaches. Error bars represent the 95th percentile confidence limits for total PCB concentrations.

4.2.3 Comparison to 2020 Fish Tissue PCB Homologs

Homolog concentrations in 2020 and 2022 were compared using the Mann-Whitney test. This test compared concentrations at a given reach in 2020 to concentrations at the same reach in 2022 for a given homolog. The null hypothesis was that no differences between concentrations in 2020 and concentrations in 2022 existed for a given homolog at a given reach. An alpha level of 0.05 was chosen to ensure that there was a low probability (5%) that the results from the test were not due to chance. Penta- and hexa-chlorinated homologs dominated fish tissue PCB concentrations in all reaches in both 2020 and 2022. There was no statistically significant difference between these dominant homolog concentrations as well as tetra- and hepta-chlorinated homolog concentrations at any reach from 2020 to 2022. Significant differences between homologs in 2020 and 2022 are presented in Table 5.

Table 5. Reaches with Statistically Significant Difference in 2020 vs. 2022 Homolog Concentrations

Reach	Homolog	Relation
3	di-	2020 > 2022
	tri-	2020 > 2022
4	di-	2020 > 2022
5	mono-	2020 > 2022
	di-	2020 > 2022
6	mono-	2020 > 2022
	di-	2020 > 2022
	tri-	2020 > 2022
	octa-	2020 < 2022
	nona-	2020 < 2022
	deca-	2020 < 2022

4.3 Comparison to Regulatory Thresholds

Ecology assesses PCB-related designated use impairment for fish harvest by using what are called tissue exposure concentrations (TECs). Not to be confused with Fish Tissue Equivalent Concentrations (FTEC), a TEC represents the tissue level of concern at the adopted fish consumption rate. The TEC for PCBs does not represent a numeric water quality criterion because it has not been adopted into Chapter 173-201A WAC. TECs, however, are considered as part of the State's narrative criterion for purposes of impairment determinations. The threshold for impairment determinations (i.e., placement on the 303(d) list) occurs where the median composite sample value(s) from one or more resident species exceeds the TEC for carcinogens by a factor of ten or more. The TEC for carcinogenic effects for total PCBs is 0.23 ug/kg; therefore, the threshold for impairment due to carcinogenic effects of PCBs is 2.3 ug/kg (Ecology, 2020).

It is emphasized that the fish samples collected as part of this project are neither intended nor suitable for direct comparison to TEC thresholds representing designated use impairment. Ecology (2020) policy specifies that only the edible portions of fish tissue (i.e., skin on or skin off fillets) be used for impairment determinations. This project examined PCB concentrations in whole fish, which tend to have higher PCB concentrations than fillets. Furthermore, Ecology may consider the age of fish examined when determining if the samples in the dataset are representative of the site. This project examined only year-old fish, which tend to have lower PCB concentrations than older fish. Taking these competing factors into effect, fish tissue PCB concentrations for year-old whole trout may differ by a factor of two from fillet-only samples from a more diverse age range of fish.

While direct comparison of fish tissue PCB concentrations observed in this study to TECs is inappropriate, a more qualitative comparison can be informative. Median whole fish PCB concentrations observed in the Spokane River in 2022 ranged from 15 ug/kg in Reach 2 to 59 ug/kg in Reach 4. These values are roughly an order of magnitude larger than the impairment threshold (and two orders of magnitude larger than the TEC for carcinogens), suggesting that present day fish tissue PCB concentrations are likely higher than acceptable levels.

4.4 Correlation between Homolog Distributions in Fish and Primary Loading Sources

The homolog patterns observed in fish tissue generally do not correlate well to the homolog patterns observed in the previously identified primary PCB loading sources. The overall (i.e., considering both wastewater and groundwater) PCB loading from Kaiser Aluminum is dominated by the tetra-chlorinated homolog and secondarily by the tri-chlorinated homolog. Fish tissue PCB concentrations in the reach receiving the Kaiser discharge, as well as the next reach downstream, are dominated by the penta- and hexa-chlorinated homologs. PCB loading from Inland Empire Paper (IEP) is dominated by the tri-chlorinated homolog, while fish tissue PCB concentrations in the reach downstream of the IEP discharge are dominated by the penta- and hexa-chlorinated homologs. PCB loading from the City of Spokane RPWRF is dominated by the tri- and tetra-chlorinated homologs. However, PCB concentrations in the reach that receives RPWRF's discharge are dominated by penta- and hexa-chlorinated homologs. The difference in homolog distributions between the known primary PCB loading sources and fish tissue could be caused by markedly different bioaccumulation rates among homologs and/or the presence of a previously unidentified source contributing PCBs dominated by penta- and hexa-chlorinated homologs.

Blank page

5 References

Ecology, 2020. Water Quality Program Policy 1-11. Chapter 1. Washington's Water Quality Assessment Listing Methodology to Meet Clean Water Act Requirements. July 2020 (revised from July 2018). Publication no. 18-10-035. https://apps.ecology.wa.gov/publications/documents/1810035.pdf

Era-Miller, B., 2020. Using Biofilms to Identify Sources of PCBs to the Spokane River 2019 Preliminary Results. Presentation to Spokane River Regional Toxics Task Force. Using Biofilms to Identify Sources of PCBs. April 22, 2020. http://srrttf.org/wp-content/uploads/2020/04/4a-SRRTTF_Biofilm_4-22-20.pdf

Lee, Charles, C. Donley, B. Baker, and B. Era-Miller, 2020. Quality Assurance Project Plan: Evaluation of PCBs in Spokane River Redband Trout. Prepared for the Spokane River Regional Toxics Task Force.

LimnoTech, 2022. Addendum 1 to Quality Assurance Project Plan, Evaluation of PCBs in Spokane River Redband Trout. Prepared for the Spokane River Regional Toxics Task Force. September 21, 2022.

LimnoTech, 2021. Evaluation of PCBs in Spokane River Redband Trout. Prepared for the Spokane River Regional Toxics Task Force. July 30, 2021.

Seiders, K., C. Deligeannis, P. Sandvik and M. McCall, 2014. Freshwater Fish Contaminant Monitoring Program 2012 Results. Environmental Assessment Program, Washington State Department of Ecology. Publication No. 14-03-020. https://fortress.wa.gov/ecy/publications/SummaryPages/1403020.html

Serdar, D. and A. Johnson, 2006. PCBs, PBDEs, and Selected Metals in Spokane River Fish, 2005. Watershed Ecology Section, Environmental Assessment Program, Washington State Department of Ecology. www.ecy.wa.gov/biblio/0603025.html

Blank page

Appendix A:
Synoptic Survey Results - PCBs by Homolog

Blank Page

Table A-1: Blank-Corrected Analytical Results for Reach 2					
	1-5	6-10	11-15	16-20	21-25
Total PCBs (*ug*/kg)	15.23	14.86	31.50	11.62	14.43
Total Monochloro Biphenyls (*ug*/kg)	0.00	0.00	0.00	0.00	0.00
Total Dichloro Biphenyls (*ug*/kg)	0.01	0.01	0.02	0.01	0.01
Total Trichloro Biphenyls (*ug*/kg)	0.70	0.57	1.45	0.28	0.38
Total Tetrachloro Biphenyls (*ug*/kg)	2.81	2.54	10.89	1.32	2.09
Total Pentachloro Biphenyls (*ug*/kg)	3.78	3.55	9.43	2.71	3.55
Total Hexachloro Biphenyls (*ug*/kg)	4.84	5.04	6.20	4.49	5.12
Total Heptachloro Biphenyls (*ug*/kg)	2.52	2.56	2.89	2.30	2.65
Total Octachloro Biphenyls (*ug*/kg)	0.50	0.52	0.54	0.45	0.55
Total Nonachloro Biphenyls (*ug*/kg)	0.06	0.06	0.06	0.05	0.07
Total Decachloro Biphenyls (*ug*/kg)	0.01	0.01	0.01	0.01	0.01
% lipids	2.6	2.29	2.59	2.69	2.57
% moisture	74.18	75.19	72.38	73.51	73.82

Table A-2: Blank-Corrected Analytical Results for Reach 3					
	1-5	6-10	11-15	16-20	21-25
Total PCBs (*ug*/kg)	25.59	24.61	26.35	21.76	34.74
Total Monochloro Biphenyls (*ug*/kg)	0.00	0.00	0.00	0.00	0.00
Total Dichloro Biphenyls (*ug*/kg)	0.03	0.02	0.02	0.02	0.01
Total Trichloro Biphenyls (*ug*/kg)	1.00	1.02	0.93	0.92	0.72
Total Tetrachloro Biphenyls (*ug*/kg)	5.78	5.66	5.42	4.47	5.28
Total Pentachloro Biphenyls (*ug*/kg)	7.65	7.75	7.82	6.06	12.05
Total Hexachloro Biphenyls (*ug*/kg)	7.12	6.76	7.94	5.95	11.74
Total Heptachloro Biphenyls (*ug*/kg)	3.16	2.69	3.26	2.99	4.03
Total Octachloro Biphenyls (*ug*/kg)	0.72	0.60	0.81	1.14	0.79
Total Nonachloro Biphenyls (*ug*/kg)	0.11	0.09	0.12	0.19	0.10
Total Decachloro Biphenyls (*ug*/kg)	0.02	0.02	0.02	0.01	0.02
% lipids	2.34	2.1	1.95	2.01	1.4
% moisture	73.95	75.05	75.51	76.00	76.77

Table A-3: Blank-Corrected Analytical Results for Reach 4					
	1-5	6-10	11-15	16-20	21-25
Total PCBs (ug/kg)	59.25	73.29	89.57	48.54	48.82
Total Monochloro Biphenyls (ug/kg)	0.00	0.00	0.00	0.00	0.00
Total Dichloro Biphenyls (ug/kg)	0.02	0.04	0.03	0.01	0.02
Total Trichloro Biphenyls (ug/kg)	1.23	1.80	1.89	0.95	1.24
Total Tetrachloro Biphenyls (ug/kg)	9.35	11.24	12.62	6.63	7.58
Total Pentachloro Biphenyls (ug/kg)	19.00	24.73	31.54	16.12	15.33
Total Hexachloro Biphenyls (ug/kg)	21.13	24.84	31.22	16.58	16.81
Total Heptachloro Biphenyls (ug/kg)	6.85	8.70	9.91	6.34	6.13
Total Octachloro Biphenyls (ug/kg)	1.43	1.66	2.02	1.62	1.44
Total Nonachloro Biphenyls (ug/kg)	0.22	0.25	0.30	0.25	0.24
Total Decachloro Biphenyls (ug/kg)	0.03	0.03	0.04	0.03	0.04
% lipids	1.19	2.55	1.94	1.19	2.53
% moisture	76.09	72.90	74.22	75.57	74.43

Table A-4: Blank-Corrected Analytical Results for Reach 5					
	1-5	6-10	11-15	16-20	21-25
Total PCBs (ug/kg)	105.29	54.71	273.93	50.96	48.03
Total Monochloro Biphenyls (ug/kg)	0.00	0.00	0.00	0.00	0.00
Total Dichloro Biphenyls (ug/kg)	0.07	0.02	0.06	0.03	0.03
Total Trichloro Biphenyls (ug/kg)	2.35	1.26	2.32	1.29	1.25
Total Tetrachloro Biphenyls (ug/kg)	15.45	7.55	35.24	7.25	6.83
Total Pentachloro Biphenyls (ug/kg)	38.09	18.51	128.75	17.01	15.68
Total Hexachloro Biphenyls (ug/kg)	35.49	19.66	88.10	17.89	16.40
Total Heptachloro Biphenyls (ug/kg)	11.41	6.43	16.93	6.21	6.49
Total Octachloro Biphenyls (ug/kg)	2.11	1.13	2.26	1.14	1.16
Total Nonachloro Biphenyls (ug/kg)	0.27	0.13	0.23	0.13	0.16
Total Decachloro Biphenyls (ug/kg)	0.04	0.02	0.03	0.02	0.02
% lipids	3.52	1.29	2.49	2.16	2.08
% moisture	71.54	74.91	74.00	73.71	74.48

Table A-5: Blank-Corrected Analytical Results for Reach 6			
	1-5	**6-10**	**11-15**
Total PCBs (ug/kg)	31.24	74.78	41.85
Total Monochloro Biphenyls (ug/kg)	0.00	0.00	0.00
Total Dichloro Biphenyls (ug/kg)	0.02	0.03	0.02
Total Trichloro Biphenyls (ug/kg)	0.82	1.16	0.93
Total Tetrachloro Biphenyls (ug/kg)	4.43	10.27	5.94
Total Pentachloro Biphenyls (ug/kg)	10.25	31.95	13.50
Total Hexachloro Biphenyls (ug/kg)	10.17	23.76	14.71
Total Heptachloro Biphenyls (ug/kg)	4.29	6.26	5.45
Total Octachloro Biphenyls (ug/kg)	1.07	1.13	1.10
Total Nonachloro Biphenyls (ug/kg)	0.17	0.19	0.16
Total Decachloro Biphenyls (ug/kg)	0.02	0.04	0.03
% lipids	1.56	1.56	1.25
% moisture	75.39	74.09	75.27

Blank Page

Appendix B: Quality Assurance Project Plan

Provided separately as an electronic document

Blank Page

Appendix C:
Laboratory Results

Provided separately as electronic spreadsheets

Blank Page