Spokane River Regional Toxics Task Force 2022 Measurement of PCBs in Biofilm and Sediment in the Spokane River

Prepared for:
Spokane River Regional Toxics Task Force

TTWG REVIEW DRAFT
May 19, 2023

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Executive Summary

The Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters because of elevated concentrations of polychlorinated biphenyls (PCBs). To address these impairments, the Washington State 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.

Recent sampling conducted by the Washington State Department of Ecology's (Ecology's) Environmental Assessment Program in (Era-Miller and Wong, 2022) and the Task Force (LimnoTech, 2021) showed elevated PCB concentrations in biofilm and sediments in the section of the Spokane River downstream of the Mission Avenue bridge in Spokane. This section is referred to as the Mission Reach. Initial forensic analyses conducted for the Task Force could not positively identify the source of these elevated PCB concentrations, in part because the spatial resolution of the available monitoring stations was too coarse to pinpoint the locations where PCB contamination was entering the river.

This project consisted of monitoring PCB concentrations in Mission Reach biofilm and sediments in order to: 1) better define the spatial distribution of PCB contamination, and 2) help define the location(s) where previously unidentified PCB sources are entering the Mission Reach. Sediments were collected at seven locations in the Mission Reach, corresponding to areas where elevated PCB concentrations were observed in prior monitoring and areas where magnetic anomalies were observed during prior object detection surveys. Biofilm samples were collected at 42 locations, roughly corresponding to six locations in the direct vicinity of each Ecology monitoring location that showed elevated PCB concentrations in 2018 or 2019.

One of the seven sediment samples showed elevated PCB concentrations. This sample was taken near the left bank just downstream of the Iron Bridge and corresponding to an area where magnetic anomalies were observed during a prior object detection survey. Locations where elevated sediment PCB concentrations were observed in the past did not show elevated concentrations in the 2022 monitoring. The patchy and temporally inconsistent nature of the Mission Reach sediment PCB data make it difficult to draw strong conclusions regarding the location of unidentified sources.

Elevated PCB concentrations in biofilm were observed at all seven of the Ecology monitoring locations that previously showed elevated PCB concentrations. Analysis of the spatial distribution of the concentrations suggests that several different spatially diffuse sources are present. Homolog distributions at the elevated PCB locations were similar to the distributions observed by Ecology and dominated by the penta-chloro homolog. Comparison to Aroclor homolog distribution indicates that the homolog distribution of Aroclor 1254 is similar to that of the elevated stations, consistent with Ecology's findings.

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1 Introduction

The Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters because of elevated concentrations of polychlorinated biphenyls (PCBs). To address these impairments, the Washington State 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.

Sampling conducted by the Washington State Department of Ecology's (Ecology's) Environmental Assessment Program in 2018 and 2019 (Era-Miller and Wong, 2022) showed elevated PCB concentrations in biofilm and sediments in the section of the Spokane River downstream of the Mission Avenue bridge in Spokane. This section is referred to as the Mission Reach. Follow-up monitoring of Mission Reach sediments by the Task Force confirmed the presence of elevated PCB concentrations in the streambed (LimnoTech, 2022c). Initial forensic analyses conducted for the Task Force could not positively identify the source of these elevated PCB concentrations, in part because the spatial resolution of the available monitoring stations was too coarse to pinpoint the locations where PCB contamination was entering the river.

This project consisted of monitoring PCB concentrations in Mission Reach biofilm and sediments in order to: 1) better define the spatial distribution of PCB contamination, and 2) help define the location(s) where previously unidentified PCB sources are entering the Mission Reach. Sediments were collected at seven locations in the Mission Reach, corresponding to areas where elevated PCB concentrations were observed in prior monitoring and areas where magnetic anomalies were observed during prior object detection surveys. Biofilm samples were collected at 42 locations, corresponding to six locations in the vicinity of each Ecology monitoring location that showed elevated PCB concentrations in 2018 or 2019.

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

- Sampling activities
- Analytical results for sediment
- Analytical results for biofilm
- Data interpretation

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2 Sampling Activities

The field monitoring program consisted of a one-day sampling event for sediment at seven Spokane River locations and a five-day sampling event for biofilm at 42 locations. Sampling activities are described below, divided into sections corresponding to:

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

2.1 Sampling Locations

Separate sampling locations were employed for sediments and biofilm. The locations for each are described below. Sediment sampling locations were selected to meet one of two criteria: 1) five locations immediately downstream of magnetic anomalies identified during the 2021 and 2022 object detection surveys, and 2) two locations previously identified as having elevated sediment PCB concentrations during the 2018 Ecology monitoring or 2021 Task Force monitoring. The locations immediately downstream of magnetic anomalies were selected to indirectly determine whether the identified metallic objects are contributing measurable levels of PCBs to the river. The two locations associated with historically high sediment concentrations are designed to confirm the continued presence of elevated concentrations. The specific locations are described in Table 1 and shown in Figure 1.

Table 1. Sediment Sampling Locations

Station Name	Rationale	Latitude	Longitude
SD1	Sediment contamination previously identified by Ecology in 2018	47.66459˚N	-117.40681 ˚W
SD2	Sediment contamination previously identified by Task Force in 2021	47.66412 ˚N	-117.39119 ˚W
SD3	Magnetic anomaly identified during object detection survey	47.66244 ˚N	-117.39371 ˚W
SD4	Magnetic anomaly identified during object detection survey	47.66512 ˚N	-117.39248 ˚W
SD5	Magnetic anomaly identified during object detection survey	47.66412 ˚N	-117.39293 ˚W
SD6	Magnetic anomaly identified during object detection survey	47.66843 ˚N	-117.39008 ˚W
SD7	Magnetic anomaly identified during object detection survey	47.66382 ˚N	-117.39300 ˚W

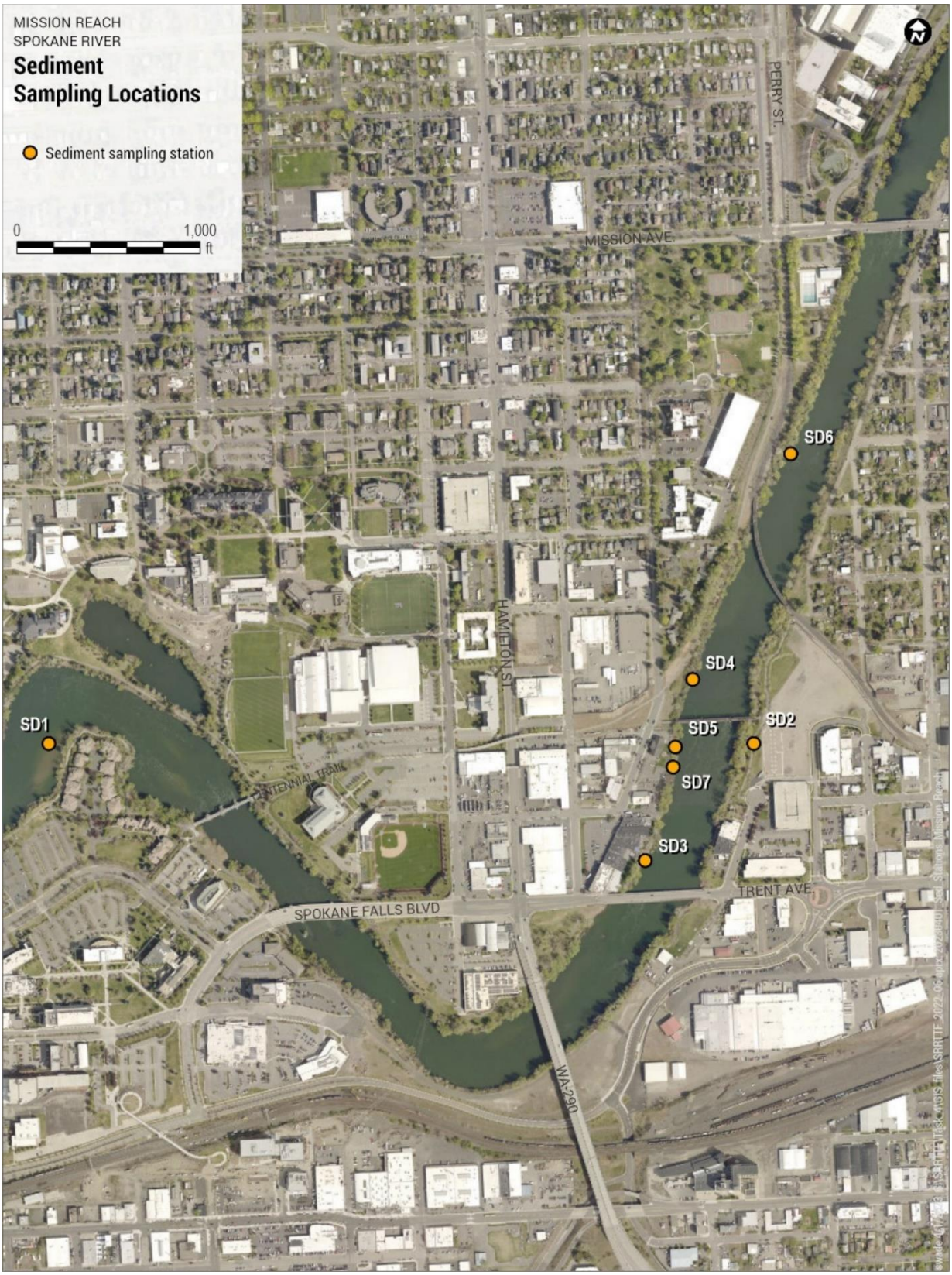

Figure 1. Map of 2022 Sediment Sampling Locations

Biofilm sampling locations were defined in collaboration with the SRRTTF to provide high spatial resolution sampling at areas where elevated biofilm PCB concentrations were observed in 2018 and 2019. The general design was to sample six locations in direct proximity to each of the seven locations where Ecology and observed elevated concentrations. Some locations were moved at the time of sampling due to unsafe access relating to steeply sloped banks or homeless encampments. A few other locations were moved due to limited biofilm availability which generally occurred in heavily shaded areas. Specific sampling locations are listed in Table 2 and mapped in Figure 2.

Table 2. Biofilm Sampling Locations

Station Name	Latitude	Longitude	Station Name	Latitude	Longitude
GZ	47.66467°N	-117.40518°W	SR3A-RB	47.66303°N	-117.39323°W
GZ-100U	47.66435°N	-117.40504°W	SR3A-RB-100U	47.66329°N	-117.39321°W
GZ-200U	47.66413°N	-117.40514°W	SR3A-RB-200U	47.66364°N	-117.39306°W
GZ-300U	47.66400°N	-117.40520°W	SR3A-RB-300U	47.66405°N	-117.39297°W
GZ-100D	47.66481°N	-117.40558°W	SR3A-RB-100D	47.66278°N	-117.39339°W
GZ-200D	47.66485°N	-117.40601°W	SR3A-RB-200D	47.66259°N	-117.39359°W
B-HAM-RB	47.66139°N	-117.39999°W	SR3A-LB	47.66277°N	-117.39214°W
B-HAM-RB-100U	47.66136°N	-117.39969°W	SR3A-LB-100U	47.66286°N	-117.39217°W
B-HAM-RB-200U	47.66084°N	-117.39928°W	SR3A-LB-200U	47.66340°N	-117.39187°W
B-HAM-RB-300U	47.66063°N	-117.39901°W	SR3A-LB-300U	47.66347°N	-117.39174°W
B-HAM-RB-100D	47.66157°N	-117.40011°W	SR3A-LB-100D	47.66251°N	-117.39242°W
B-HAM-RB-200D	47.66171°N	-117.40015°W	SR3A-LB-200D	47.66227°N	-117.39251°W
BSFB-LB	47.66275°N	-117.40294°W	ASFB-LB	47.66109°N	-117.40087°W
BSFB-LB-100U	47.66261°N	-117.40276°W	ASFB-LB-100U	47.66093°N	-117.40066°W
BSFB-LB-200U	47.66228°N	-117.40213°W	ASFB-LB-200U	47.66062°N	-117.40005°W
BSFB-LB-300U	47.66208°N	-117.40185°W	ASFB-LB-300U	47.65919°N	-117.39792°W
BSFB-LB-100D	47.66302°N	-117.40331°W	ASFB-LB-100D	47.66155°N	-117.40160°W
BSFB-LB-200D	47.66316°N	-117.40343°W	ASFB-LB-200D	47.66172°N	-117.40173°W
B-MIB-RB-M	47.6695°N	-117.38949°W	B-MIB-LB-M	47.66907°N	-117.38873°W
B-MIB-RB-D	47.66831°N	-117.39023°W	B-MIB-LB-U	47.66948°N	-117.38851°W
B-MIB-RB-U	47.67104°N	-117.38829°W	B-MIB-LB-D	47.66753°N	-117.38979°W

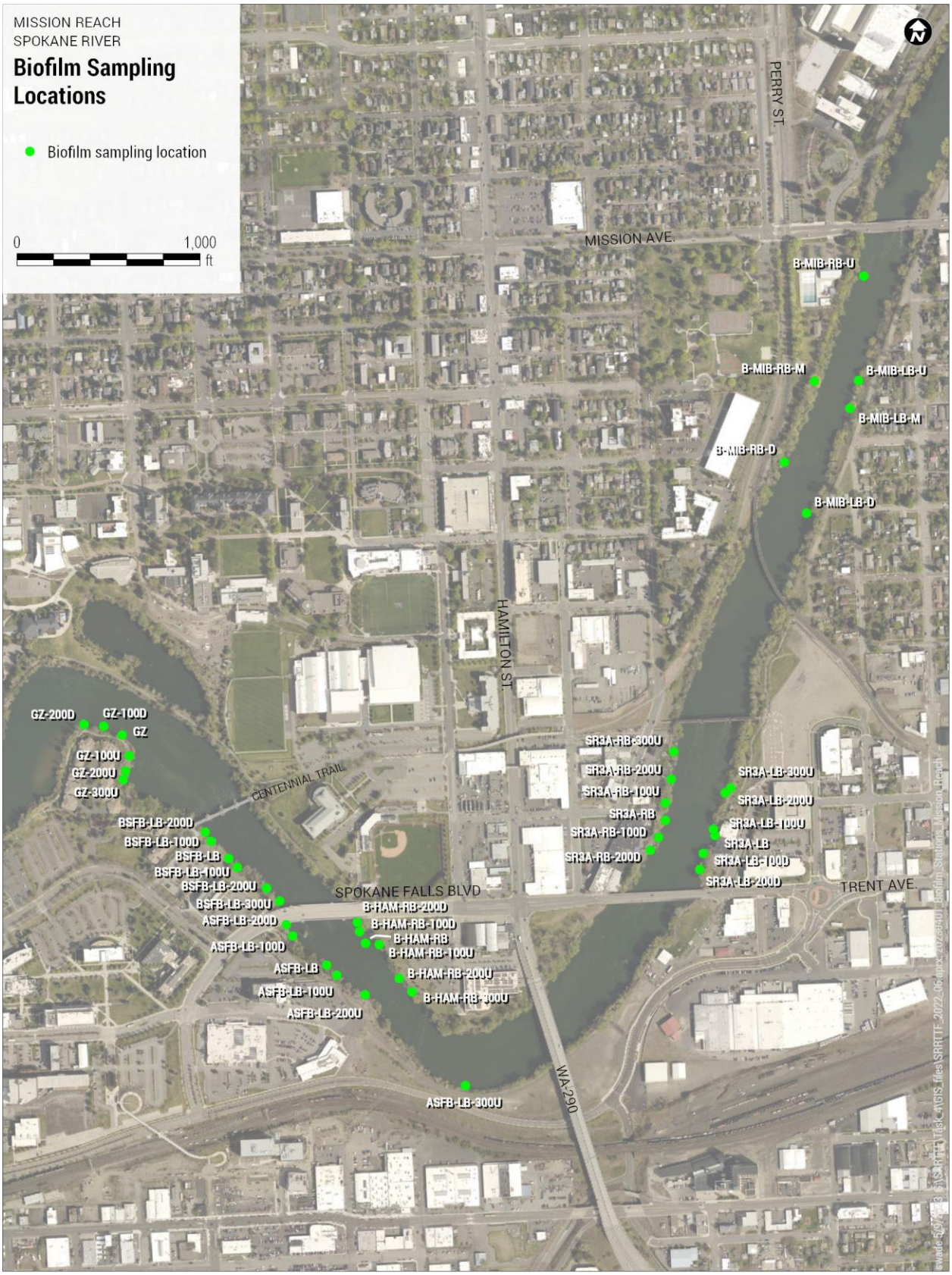

Figure 2. Map of 2022 Biofilm Sampling Locations

2.2 Monitoring Dates

Sediment samples were collected on September 3, 2022. Biofilm sampling was conducted between September 4 and September 8, 2022.

2.3 Field Sampling Activities

The field sampling activities as planned and implemented were detailed in the project QAPP (LimnoTech, 2022b). A watercraft was used to identify areas where sediment was visually present and to access sample locations. The QAPP described using a power grab sampler to collect surface sediment, however the abundance of rock, metal refuse, and woody debris precluded the use of a power grab. Instead, decontaminated trowels or a shovel were used to collect river sediment. The top two centimeters of sediment from were scooped into a decontaminated stainless-steel bowl using a decontaminated spoon, homogenized, then scooped into separate certified clean sampling jars for PCB, TOC, grain size, and percent moisture analyses.

At each biofilm sampling site, rocks with visible biofilm attached to the surface were collected. Rocks or cobblestones with an abundant layer of biofilm growing on an approximately flat surface were sampled. Prior to collecting the biofilm, any loose silt or debris on the rock was gently shaken off underwater, taking care not to slough off the biofilm. The biofilm was scraped off each rock into sample jars using a decontaminated oyster shucking blade. The biofilm sample was homogenized using the blade within the clean amber glass sample jar. Samples were stored in a cooler on ice until receipt by the laboratory.

2.4 Quality Assurance

Field samples were shipped to AXYS Analytical Laboratories, Ltd. in Sidney, British Columbia for analysis of PCB concentrations (Method 1668) and percent 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. Data quality indicators evaluated for PCBs included the following:

- Daily Calibration Verification
- Lab Control Sample Recovery
- Sample and Method Blank Surrogate Recovery
- Matrix Spike Sample Recovery
- Duplicate sample relative percent differences (RPDs)
- Completeness

All reviewed quality control (QC) results for PCBs comply with QAPP data quality indicators, with the following exceptions:

- To be completed.

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. It should be noted that there is no standard blank correction method, and numerous approaches are utilized, both nationally and within the Spokane River Basin. The selection of the most appropriate blank correction methodology must consider factors such as study objectives, sample matrix, sampling methodology, expected range of results, and tolerance for biased results.

3 Analytical Results for Sediment

This section summarizes the results of the sediment monitoring, in terms of concentrations of total PCBs and individual homologs. Furthermore, full laboratory data sheets are provided in Appendix B.

3.1 Total PCBs

Total PCB concentrations for each area and substrate type are provided in Table 3 and plotted in Figure 3.

Table 3. Spokane River Sediment Total PCB Concentrations

Station Name	**Total PCB (ug/kg)**
SD1	28.48
SD2	7.156
SD3	44.20
SD4	4.183
SD5	284.9
SD6	53.22
SD7	15.36

Figure 3. 2022 Spokane River Sediment Total PCB Concentrations

3.2 Homolog Distributions

Homolog distributions are provided in Table 4, showing concentration by homolog across all stations. Concentrations at stations 1, 2, 4, 6, and 7 are dominated by the penta-chloro homolog, while concentrations at stations 3 and 5 are dominated by the hexa-chloro homolog.

Table 4. Blank-Corrected Homolog Concentrations for All Sediment Samples.

Homolog	SD1	SD2	SD3	SD4	SD5	SD6	SD7
Mono-	0.009	0.005	0	0	0	0.077	0
Di-	0.501	0.052	0.359	0.050	0.088	0.194	0.043
Tri-	3.228	0.354	4.580	0.270	0.515	1.430	0.259
Tetra-	7.748	1.421	5.795	0.936	6.799	8.892	1.291
Penta-	10.130	2.080	8.054	1.362	106.818	23.964	5.742
Hexa-	5.127	1.802	12.175	0.996	128.482	15.179	5.352
Hepta-	1.336	0.826	9.531	0.412	32.387	2.879	1.857
Octa-	0.324	0.457	3.082	0.124	7.342	0.500	0.580
Nona-	0.058	0.134	0.494	0.023	2.134	0.080	0.175
Deca-	0.020	0.024	0.135	0.008	0.332	0.028	0.064

A comparison of homolog distributions to past sediment results and known Aroclor patterns is provided in Section 5.1.3.

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4 Analytical Results for Biofilm

This section summarizes the results of the biofilm monitoring, in terms of concentrations of total PCBs and individual homologs. Furthermore, full laboratory data sheets are provided in Appendix B.

4.1 Total PCBs

Total PCB concentrations for each station are provided in Table 5 and plotted in Figure 4.

Table 5. 2022 Spokane River Biofilm Total PCB Concentrations

Station Name	Total PCB (pg/g)	Station Name	Total PCB (pg/g)
GZ	742	SR3A-RB	3,325
GZ-100U	8,573	SR3A-RB-100U	1,375
GZ-200U	8,639	SR3A-RB-200U	5,879
GZ-300U	10,446	SR3A-RB-300U	12,432
GZ-100D	5,291	SR3A-RB-100D	13,870
GZ-200D	1,817	SR3A-RB-200D	6,507
B-HAM-RB	754	SR3A-LB	6,403
B-HAM-RB-100U	916	SR3A-LB-100U	15,441
B-HAM-RB-200U	830	SR3A-LB-200U	6,562
B-HAM-RB-300U	528	SR3A-LB-300U	1,790
B-HAM-RB-100D	694	SR3A-LB-100D	1,928
B-HAM-RB-200D	3,474	SR3A-LB-200D	5,607
BSFB-LB	5,931	ASFB-LB	10,614
BSFB-LB-100U	10,468	ASFB-LB-100U	35,902
BSFB-LB-200U	4,673	ASFB-LB-200U	30,989
BSFB-LB-300U	3,577	ASFB-LB-300U	885
BSFB-LB-100D	15,696	ASFB-LB-100D	3,538
BSFB-LB-200D	4,797	ASFB-LB-200D	4,954
B-MIB-RB-M	4,716	B-MIB-LB-M	660
B-MIB-RB-D	7,877	B-MIB-LB-U	1,133
B-MIB-RB-U	1,195	B-MIB-LB-D	968

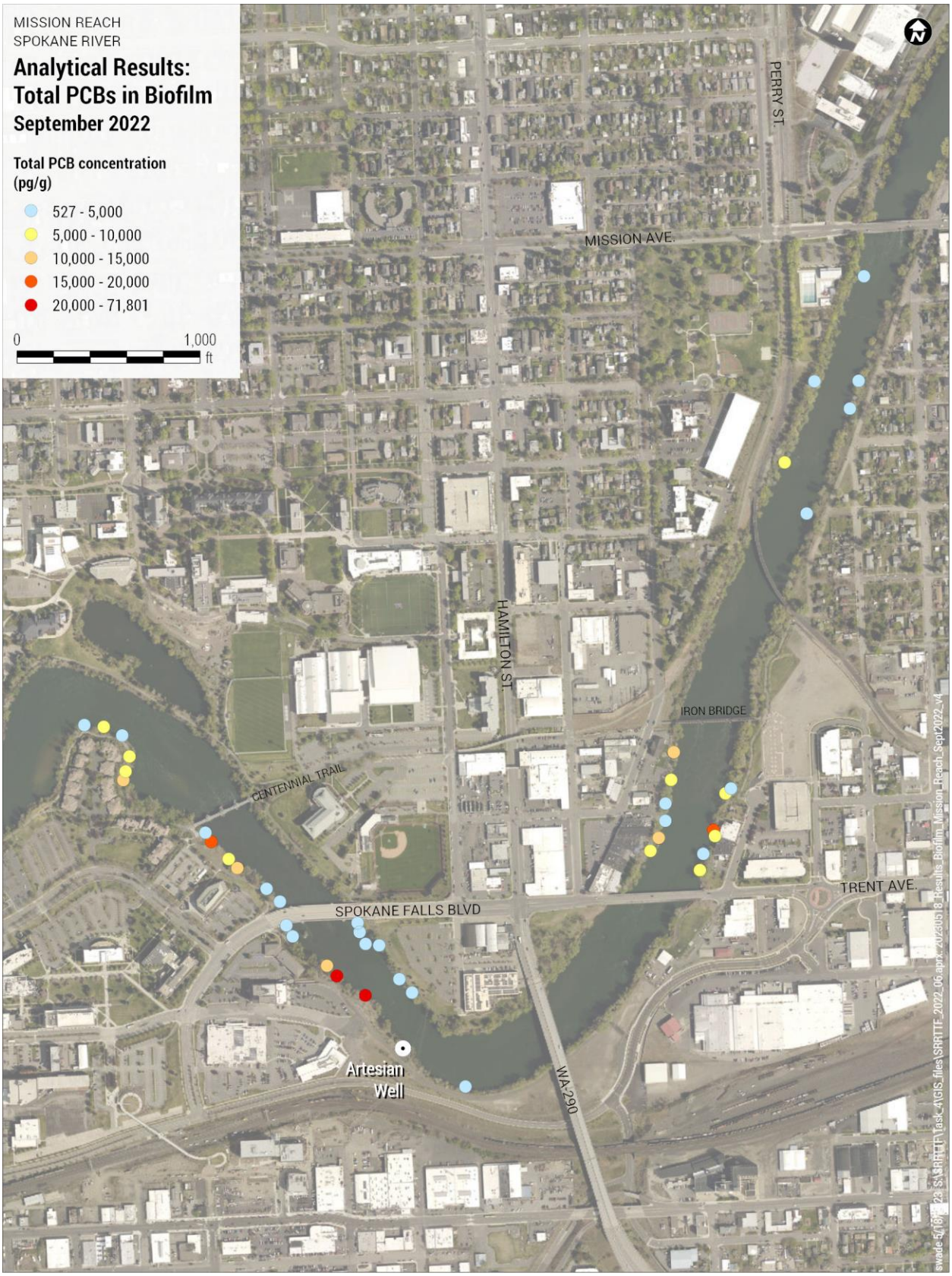

Figure 4. 2022 Spokane River Biofilm Total PCB Concentrations

Elevated PCB concentrations (nominally defined here as a concentration greater than 5,000 pg/g) were observed in the vicinity of each of the sites where elevated PCB concentrations were previously observed by Ecology. The highest concentrations (31,000 and 36,000 pg/g) were both observed upstream of Ecology's "Above Spokane Falls Blvd." site on the south bank of the river.

4.2 Homolog Distributions

Homolog distributions are listed in Table 6, showing concentration by homolog across for all samples with a total PCB concentration greater than 5,000 pg/g.

Concentrations at most of the elevated stations (all elevated GZ stations, all elevated BSFB stations, all elevated ASFB-LB stations, B-MID-RB-D, SR3A-RB-300U, SR3A-LB-200U, and SR3A-LB-100U) are dominated by the penta-chloro homolog while SR3A-RB-100D is dominated by the hexa-chloro homolog and SR3A-LB-200D is dominated by the tetra-chloro homolog.

Table 6. Blank-Corrected Homolog Concentrations for All Biofilm Samples with Elevated PCB Concentration (pg/g)

	SR3A-RB-300U	SR3A-RB-100D	SR3A-LB-200U	SR3A-LB-100U	SR3A-LB-200D
Mono-	4.66	9.36	0	1.5	2.75
Di-	123.12	312.94	120.59	415.18	160.71
Tri-	208.03	1329.44	311.09	764.01	680.71
Tetra-	1326.79	2359.10	1177.95	2118.15	1897.10
Penta-	4846.77	3479.11	2720.84	4160.28	1374.46
Hexa-	3660.90	3622.31	1713.00	4160.51	807.55
Hepta-	1199.28	2091.99	412.58	2739.37	476.89
Octa-	646.04	549.26	85.48	936.94	160.99
Nona-	353.8	95.14	15.66	125.2	32.21
Deca-	62.1	21.7	4.71	20	13.2

	GZ-300U	GZ-200U	GZ-100U	GZ-100D
Mono-	4.67	24.09	2.06	2.02
Di-	105.71	101.02	164.19	151.58
Tri-	492.32	380.24	298.54	284.55
Tetra-	1608.24	1514.5	1311.36	896.23
Penta-	3837.62	3727.16	3617.77	1973.29
Hexa-	3265.41	2160.66	2471.98	1499.03
Hepta-	834.57	481.98	523.95	367.74
Octa-	184.92	135.01	117.87	82.05
Nona-	71.72	71.14	42.17	24.18
Deca-	40.6	43.5	23	9.97

	BSFB-LB-100U	BSFB-LB	BSFB-LB-100D
Mono-	3.35	1.18	1.22
Di-	99.72	73.33	88.23
Tri-	508.70	403.61	327.78
Tetra-	1611.98	1097.94	1940.11
Penta-	4308.81	2254.65	7476.33
Hexa-	3073.75	1547.4	4938.56
Hepta-	643.50	396.55	636.81
Octa-	130.45	97.46	97.98
Nona-	42.61	27.25	52.48
Deca-	44.8	31.2	137
	ASFB-LB-200U	ASFB-LB-100U	ASFB-LB
Mono-	1.00	3.91	1.82
Di-	106.72	374.4	95.2
Tri-	348.08	4575.88	681.04
Tetra-	4567.86	8588.69	2000.35
Penta-	15579.82	13102.58	4390.36
Hexa-	9094.86	8055.75	2916.74
Hepta-	1158.35	1051.06	444.34
Octa-	112.98	107.84	60.48
Nona-	15.79	27.32	15.95
Deca-	3.76	15	7.46

	B-MIB-RB-D
Mono-	6.35
Di-	74
Tri-	184.17
Tetra-	1245.78
Penta-	3476.21
Hexa-	2305.27
Hepta-	475.12
Octa-	88.40
Nona-	15.65
Deca-	6.17

5 Data Interpretation

The objective of this sampling was to: 1) better define the spatial distribution of PCB contamination in the Mission Reach and 2) help define the location(s) where previously unidentified PCB sources are entering the reach. This section provides an interpretation of the PCB results provided in Sections 3 and 4 relative to those objectives.

5.1 Bottom Sediments

5.1.1 Spatial Distribution

The spatial distribution of sediment PCB concentration was assessed by considering the measurements from 2022 in conjunction with recently measured Spokane River sediment PCB concentrations.

The Washington State Department of Ecology measured sediment PCB concentrations within the past ten years as part of the following studies:

- Samples collected by Ecology's Urban Waters Program in 2013 (Era-Miller, 2015).
- Samples collected by Ecology's Environmental Assessment Program as part of the 2018 biofilm study (Era-Miller and Wong, 2022).

Ecology's Urban Waters Program sampled PCB content in Spokane River bottom sediments at eight locations in August 2013 (Figure 5). Seven of the stations were located upstream of Mission Reach with the eighth location (named PostTerm2) located within the Mission Reach.

Ecology's Environmental Assessment Program conducted a screening study measuring PCBs in biofilm, sediment, and invertebrates in the Spokane River in August 2018 (Era-Miller and Wong, 2022) that collected Spokane River sediment samples at Plantes Ferry (PF) and Gonzaga (GZ) plus a third sediment location from Latah (Hangman, HM) Creek (Figure 6).

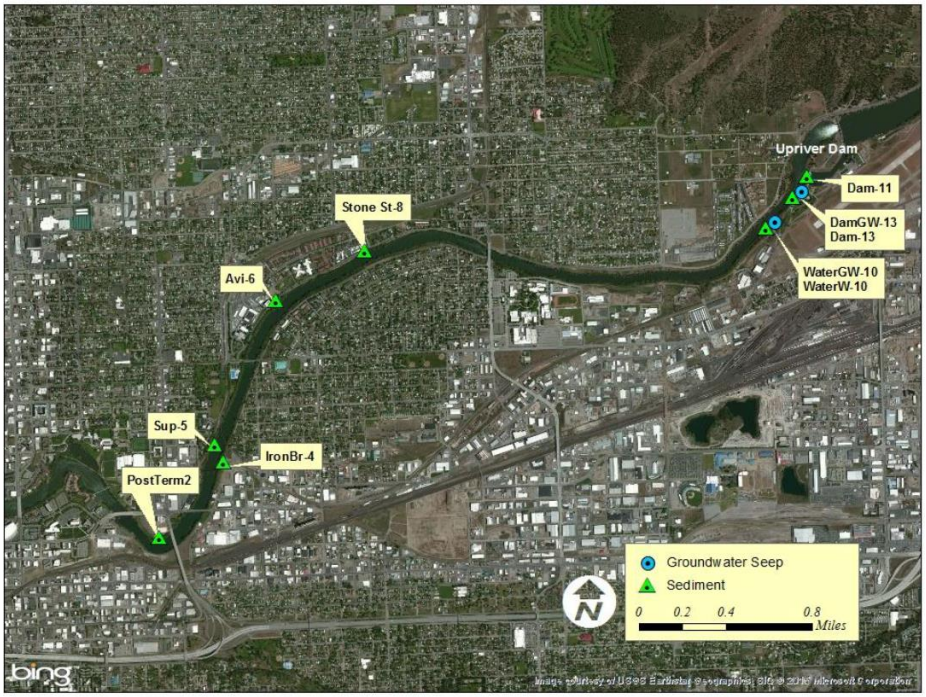

Figure 5. Ecology's Urban Waters Program 2013 Sediment Sampling Locations (from Era-Miller, 2015)

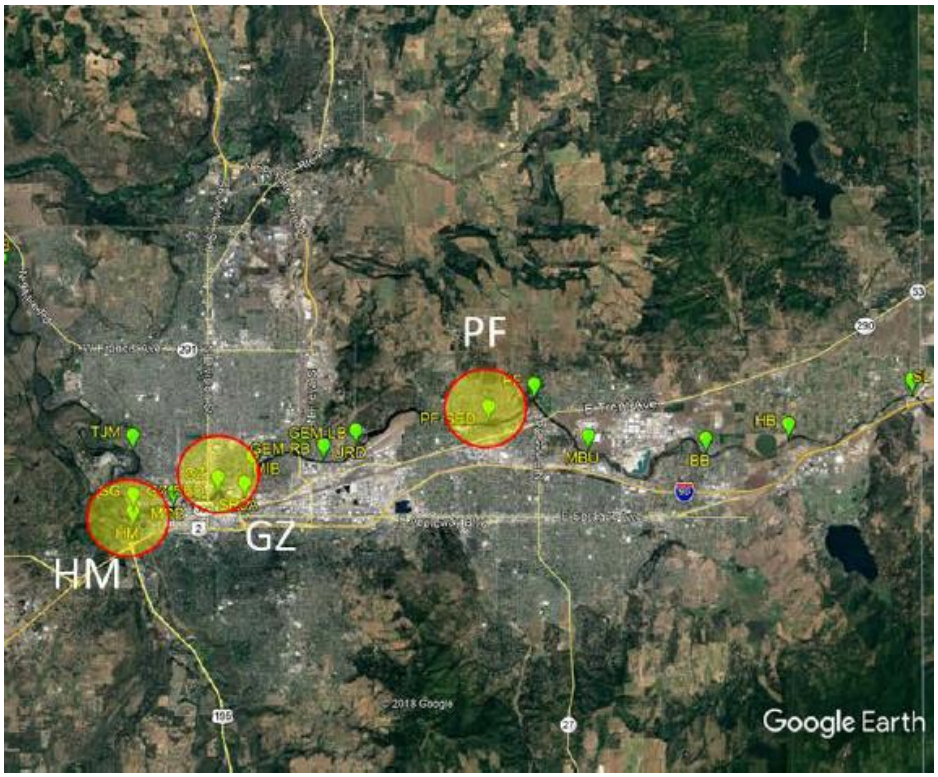

Figure 6. Ecology's Environmental Assessment Program 2018 Sediment Sampling Locations (from Era-Miller and Wong 2022)

The Task Force also conducted limited sediment monitoring in the Mission Reach in 2021 (LimnoTech, 2022c) with three stations sampled as shown in Figure 7.

Figure 7. Mission Reach Sediment Stations Monitored in 2021

Results from all studies are graphed in Figure 8. PCB concentrations measured in 2022 are consistent with the general pattern observed previously, i.e., Mission Reach concentrations are highly variable, with the majority of samples having less than 30 ug PCB/kg but occasional samples greater than 100 ug PCB/kg. The 2022 data are notable in the regard that the elevated concentration of 285 ug/kg is the second highest of all of the other recently observed sediment concentrations.

No consistent spatial trends in sediment PCB concentrations are observed within Mission Reach. Of particular note is that the monitoring stations selected because of previously observed elevated sediment PCB concentrations did not show elevated concentrations in 2022. The Gonzaga station that had a PCB concentration of 125 ug/kg in 2018 had a concentration of 28 ug/kg when sampled in 2022. The station on the east bank below Iron Bridge (labelled SED2/SD2) had a PCB concentration of 300 ug/kg in 2021 and a concentration of 7 ug/kg when sampled in 2022.

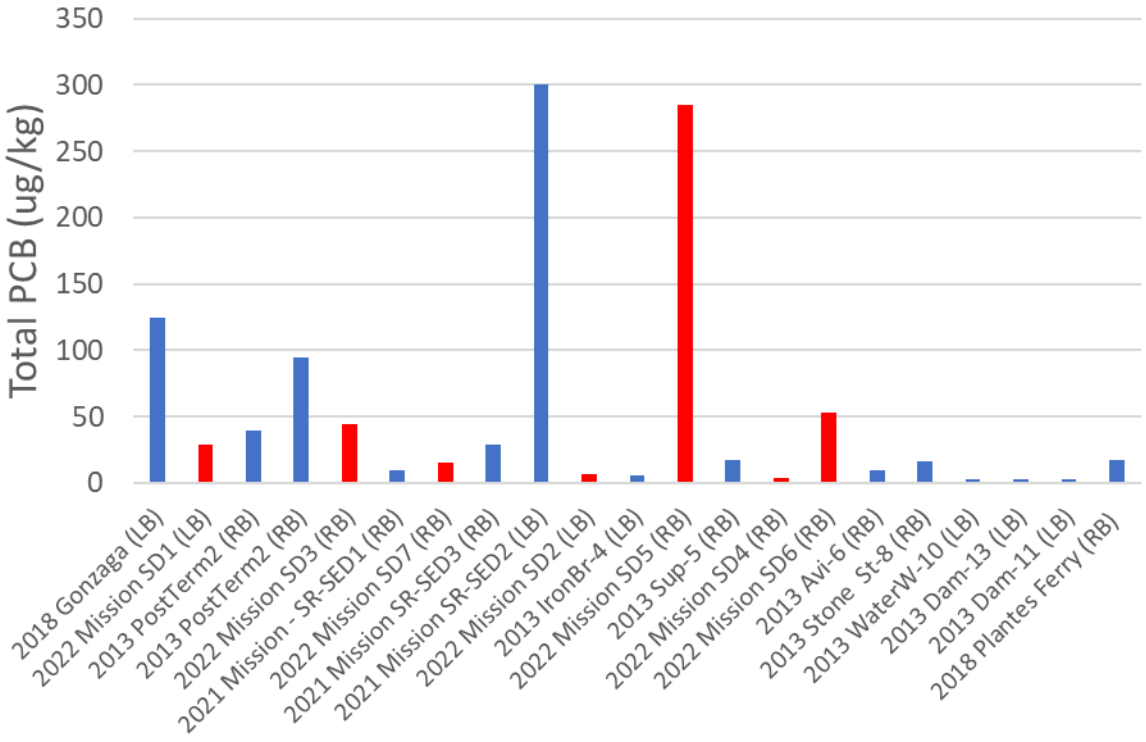

Figure 8. Comparison of Sediment PCB Concentrations Observed in this Study to Recent Task Force and Ecology Data (2022 Results in Red). LB denotes sampling locations along the left bank, and RB denotes sampling locations along the right bank.

5.1.2 Location of Unidentified Sources

The patchy and temporally inconsistent nature of the Mission Reach sediment PCB data make it difficult to draw strong conclusions regarding the location of unidentified sources. One finding of note, however, is the presence of elevated sediment PCB concentrations at station SD5. This station was selected for monitoring in 2020 due to the presence of magnetic anomalies identified during the object detection. While this single elevated sediment PCB concentration does not provide conclusive evidence of a source of PCBs buried in the river bed, it does merit further investigation. It is also noted that the historical source assessment (LimnoTech, 2022a) identified two sites possessing the potential for PCB release into the environment within close proximity to the SD5 elevated PCB sampling location:

- A metal fabricating facility operating since the 1950's, currently known as Krueger Sheet Metal Co.
- EZ Loader boat trailer manufacturing, located near station SD5 since the 1960s

5.1.3 Homolog Distributions

Sediment sampling in the Mission Reach in 2021 identified a high total PCB concentration at SR-SED2 (300 ug/kg). The homolog distributions of the SR-SED2 sample and the SD5 sample are compared in Figure 9.

SR-SED2 had high nona- and deca-chloro homologs which indicated a potential contribution from Aroclor 1268. The homolog distribution at SD5 does not resemble that of SR-SED2 and is dominated by penta- and hexa-chloro homologs. The homolog distribution of SD5 most closely resembles Aroclor 1254 (cosine similarity of 0.82). Therefore, both the location and the potential contributing Aroclors appear to differ between 2021 and 2022.

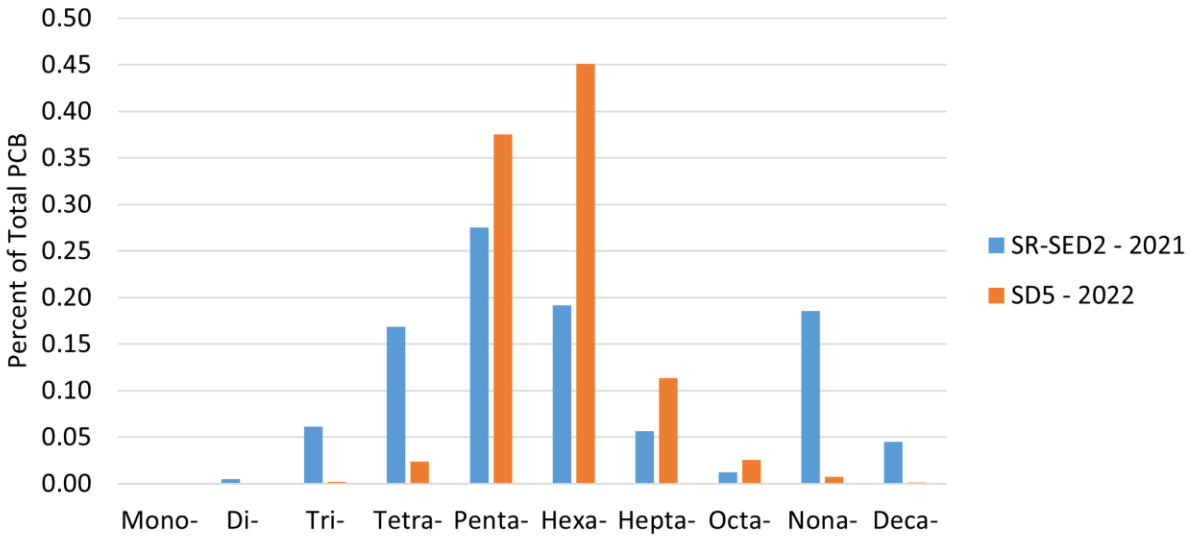

Figure 9. Homolog Comparison of Historic High Sediment Total PCB Samples.

5.2 Biofilm

5.2.1 Spatial Distribution

Figures 10 and 12 show the spatial distribution of biofilm PCB concentrations from both this study and Ecology (Era-Miller and Wong, 2022) for the left and right banks, respectively.

Concentrations are qualitatively similar between the 2018/2019 and 2022 surveys with the following items of note:

- The source of contamination at Ecology's ASFB station appears to originate several hundred feet upstream of that site, as the highest concentrations observed in 2022 were both located upstream of the original site.
- A very high (>600,000 pg/g) concentration was observed at SR3A on the left bank. Additionally, a high concentration was observed at SR3A on the right bank in 2018/2019. 2022 sampling found elevated concentrations surrounding SR3A on both the left and right bank but not to the magnitude observed in 2018/2019.

Geostatistical analysis of the biofilm data indicates the following:

- Strong spatial correlation exists, with contamination occurring over broad areas as opposed to discrete locations.
- Inputs fluctuate along the length of these areas, with several locations where concentrations rise then fall over a short distance.
- Peak concentrations generally occur in the middle of the contaminated zone rather than in an upstream location, potentially indicative of a diffuse source such as via groundwater.

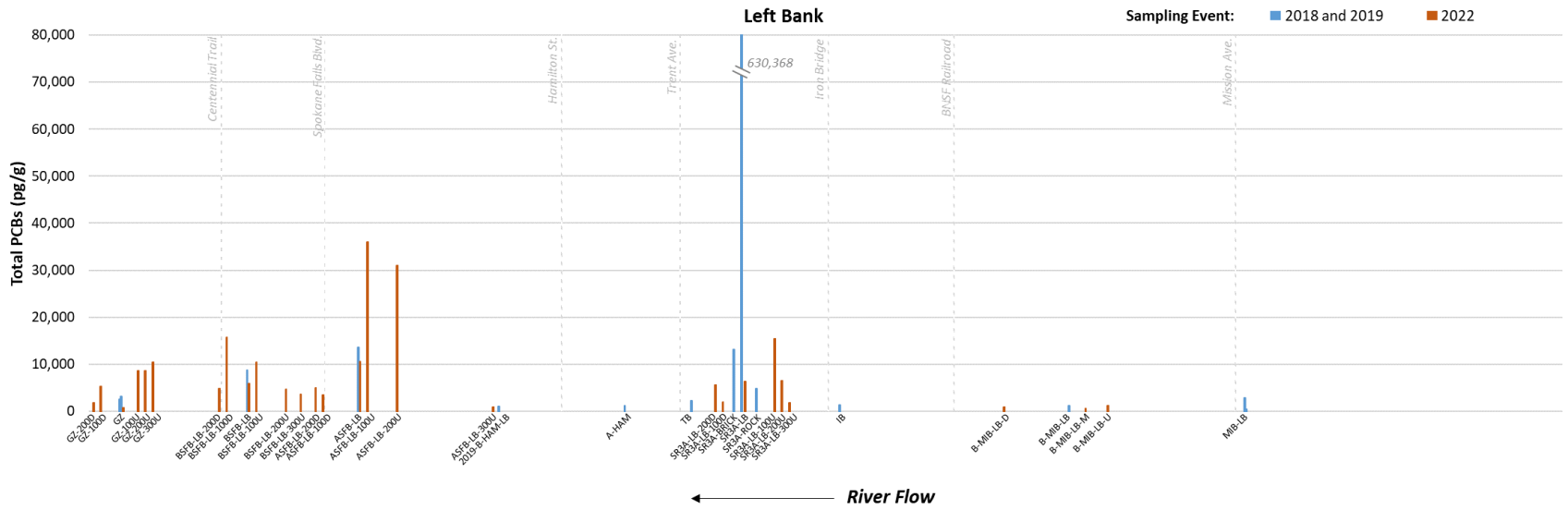

Figure 10. Combined 2018, 2019, and 2022 Biofilm PCB Data for Spokane River Left Bank

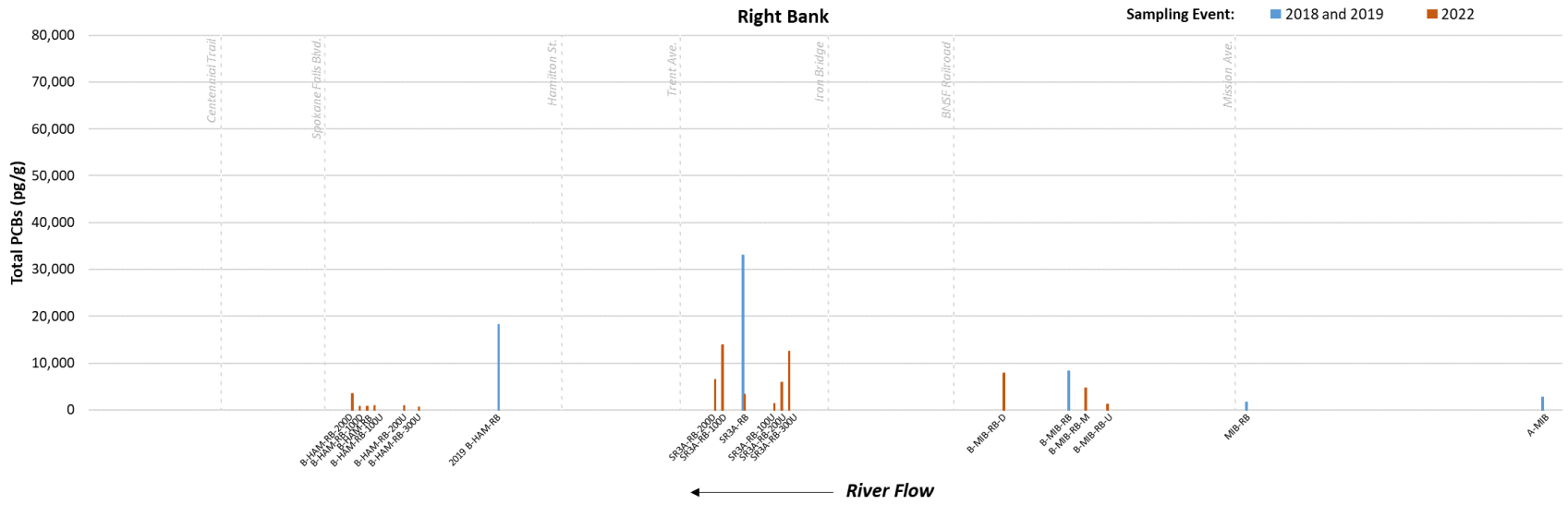

Figure 11. Combined 2018, 2019, and 2022 Biofilm PCB Data for Spokane River Right Bank

5.2.2 Homolog Patterns

The homolog patterns at the elevated 2022 locations compare as follows to those observed by Ecology in their 2018 and 2019 monitoring:

- Concentrations at GZ, BSFB, SR3A-RB, ASFB, and B-MID-RB-D observed by Ecology were dominated first by penta- then by hexa-chloro. This homolog distribution parallels that of most of the elevated 2022 locations. Exceptions include:
    - 2022 sampling location SR3A-LB-200D was dominated by tetra- then penta-chloro which differs from what was observed by Ecology at the SR3A locations.
    - 2022 sampling location ASFB-LB-100U was dominated by penta- then tetra-chloro which differs from what was observed by Ecology.
- Ecology reported that homolog patterns at SR3A-RB, ASFB, BSFB, and GZ were similar to that of Aroclor 1254. This observation continues to be true in the 2022 sampling.
    - This indicates that the sources identified at the ASFB upstream stations may be Aroclor 1254.
- Ecology reported that the homolog patterns of SR3A, SR3A-BRICK, and SR3A-ROCK were similar to that of Aroclor 1260 which is dominated by hexa- and hepta-chlorinated homologs. Ecology observed that SR3A-RB was similar to Aroclor 1268 which is dominated by nona- and deca-chlorinated homologs.
    - 2022 elevated SR3A stations did not resemble either Aroclor 1260 or Aroclor 1268.

6 Next Steps

The results of the 2022 sediment and biofilm sampling provide additional insight into the nature and distribution of PCB contamination in Mission Reach, but do not definitively identify the contributing sources. The following activities could further support source identification:

- The largest sediment PCB concentration was observed at the location of a previously identified magnetic anomaly. Future study to identify the nature of this magnetic anomaly would be worthwhile to better determine its potential for being a PCB source (e.g., a generator or drum.). The options for this next step include visual inspection of the surface of the riverbed via a diver or remotely operated vehicle. If the object is not visible at the surface, next steps could include more detailed geophysical investigations such as the deployment of ground penetrating radar.
- The comparison of 2022 data with historic data indicated that high sediment PCB concentrations show high variability in terms of location and homolog distribution. Continued sampling of sediment PCBs would provide a better indication of whether observed elevated concentrations represent: 1) the location of unidentified PCB sources in the Mission Reach, or 2) the transport of transport upstream sources that settle in the Mission Reach.
- The 2022 biofilm sampling found elevated concentrations on the left bank near E. Spokane Falls Blvd. downstream of the artesian well. The 2020 water column mass balance was inconclusive regarding the presence of an unknown PCB load in this portion of the river. Additional water column and/or biofilm sampling directly downstream of the artesian well would help determine whether the elevated biofilm PCBs in this area are caused by the artesian well or some other source (e.g., groundwater.)

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7 References

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Appendix A: Quality Assurance Project Plan

Provided separately as an electronic document

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Appendix B: Laboratory Results

Provided separately as electronic spreadsheets

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