Monitoring to Assist in Defining the Sources of PCB Contamination in the Spokane River Mission Reach

Prepared for:
Spokane River Regional Toxics Task Force

March 10, 2022
TTWG Review DRAFT

LimnoTech
Water Environment | Scientists Engineers

Blank Page

LimnoTech
Water | Scientists
Environment | Engineers

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

Monitoring to Assist in Defining the Sources of PCB Contamination in the Spokane River Mission Reach

Prepared for:
Spokane River Regional Toxics Task Force

TTWG Review Draft
March 10, 2022

Blank page

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Blank page

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 concentrations of polychlorinated biphenyls (PCBs) in fish tissue. To address these impairments, the Washington State Department of Ecology (Ecology) is pursuing a toxics reduction strategy that included the establishment of a Spokane River Regional Toxics Task Force to identify and reduce PCBs at their source in the watershed. Sampling conducted by Ecology's Environmental Assessment Program in 2018 and 2019 showed elevated PCB concentrations in biofilm in the section of the Spokane River downstream of the E. Mission Avenue bridge in Spokane (termed the Mission Reach). Initial forensic analyses conducted for the Task Force could not positively identify the source of these elevated PCB concentrations

This project consisted of conducting monitoring across a range of media to help better define the source(s) of observed PCB contamination in the Mission Reach. Key findings of this monitoring are:

- The PCB concentration in an artesian well discharging into the downstream portion of the Mission Reach was greater than 2000 ug/l. This suggests that contaminated groundwater could be contributing to the elevated Mission Reach PCB concentrations.
- Water column grab sampling showed no spatial pattern indicative of an external source of PCBs to the water column within the Mission Reach. One elevated PCB concentration of 574 ug/l was observed at E. Mission Ave. This location represents the upstream boundary of the Mission Reach, so this elevated concentration would be indicative of a PCB source upstream of the Mission Reach.
- Sampling of PCBs in bottom sediments at three Mission Reach locations showed one site with elevated concentrations (300 ppb) and two sites with concentrations consistent with those observed elsewhere in the Spokane River. Further investigation is needed to determine the source of this elevated concentration.
- A sub-bottom object detection survey identified the presence of magnetic anomalies buried in the stream bed at two locations, potentially representing PCB-containing objects. Further investigation is needed to determine the nature of the magnetic anomalies.
- A PCB-detection dog identified potential PCB sources in riverbank areas along select areas of the Mission Reach, including the area around an un-monitored stormwater outfall.
- A scoping analysis demonstrated that drive point piezometers could be installed to monitor groundwater quality at two out of three locations directly adjacent to the Mission Reach. This technology merits future consideration for measuring groundwater PCB concentrations, after it has been established that appreciable amounts of groundwater enter the river in the Mission Reach.

Blank page

1 Introduction

Sections of the Spokane River and Lake Spokane have been placed on the State of Washington's 303(d) list of impaired waters because of concentrations of polychlorinated biphenyls (PCBs) that exceed water quality standards. To address these impairments, the Department of Ecology (Ecology) is 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. Ecology's Environmental Assessment Program conducted spatial surveys of the Spokane River using biofilms In August of 2018 and 2019 to assess possible suspected and unknown sources of PCBs to the river (Wong and Era-Miller 2019). The goals of the sampling were to collect and analyze PCB concentrations in biofilm, sediment, and macroinvertebrates in the river, and to assess the presence of unidentified sources of PCBs to the river. Both sampling events identified one segment of the river where biofilm PCB concentrations were particularly high, located between the Mission Avenue Bridge and the Spokane Falls Boulevard Bridge. This segment is commonly referred to as the Mission Reach.

Initial forensic analyses conducted by the Task Force could not positively identify the source of PCBs causing these elevated biofilm concentrations (LimnoTech, 2020). Initial forensic analyses conducted for the Task Force could not positively identify the source of these elevated PCB concentrations, but did identify several potential categories of sources, i.e., groundwater contamination from upland sources, PCB-containing objects buried in the riverbed, contaminated artificial bottom fill material, legacy contamination in naturally occurring bottom sediments, and contaminated stormwater runoff. This project consisted of conducting monitoring across a range of media to help better define the source(s) of observed PCB contamination in the Mission Reach.

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

- Water and sediment monitoring
- PCB-detection dog
- Sub-bottom object detection
- Drive-point piezometer feasibility assessment

Blank Page

2
Water and Sediment Monitoring

The field monitoring program for PCBs in water and sediment consisted of a two-day sampling event throughout the Mission Reach and select downstream Spokane River locations. Sampling activities and results are described below, divided into sections corresponding to:

- Study components
- Sampling locations
- Monitoring date
- Field sampling activities
- Quality assurance
- Analytical Results

2.1 Study Components

The water and sediment monitoring consisted of three separate components, each with different objectives:

- Water column: Water column PCB concentrations were measured at fifteen locations in order to define the spatial distribution of the elevated water column concentrations in the Mission Reach and downstream in the Spokane River.
- Bed sediments: Bed sediment PCB concentrations were measured at three locations in the Mission Reach in order to supplement the single Mission Reach sediment sample collected in 2018 and provide insight into the importance of legacy sediment PCB contamination as a source of Mission Reach contamination.
- Artesian well discharge: The PCB concentration associated with an artesian well observed discharging to the Mission Reach was measured to provide an indication of the potential for contaminated groundwater to be the cause of elevated PCB concentrations in Mission Reach.

2.2 Sampling Locations

Sampling locations for all three media are described in Table 1 and shown in Figure 1.

Table 1. Sampling Area Descriptions and Locations (RB= Right Bank, Mid = Mid-Channel, LB = Left Bank)

Medium	Station ID	Location Descriptor	Latitude	Longitude
Sediment	SR-SED1	Near Springfield Outfall	47.6631133˚N	-117.3932816˚W
Sediment	SR-SED2	North of Trent Bridge EB	47.664612˚ N	-117.3911889˚W
Sediment	SR-SED3	Trent Bridge WB	47.6644451˚N	-117.3927918˚W
Water Column	SR-1	USGS Gage	47.659803˚N	-117.399263˚W
Water Column	SR-2	Monroe Street	47.656727˚N	-117.452221˚W
Water Column	SR-3	Division Street	47.660233˚N	-117.427165˚W
Water Column	SR-4a	E. Spokane Falls Blvd. RB	47.663152˚N	-117.410719˚W
Water Column	SR-4b	E. Spokane Falls Blvd. Mid	47.662073˚N	-117.400736˚W
Water Column	SR-4c	E. Spokane Falls Blvd. LB	47.662058˚N	-117.401206˚W
Water Column	SR-5a	WA 290 RB	47.662066˚N	-117.401767˚W
Water Column	SR-5b	WA 290 Mid	47.660217˚N	-117.396374˚W
Water Column	SR-5c	WA 290 LB	47.659962˚N	-117.396207˚W
Water Column	SR-6a	East Trent Ave RB	47.659594˚N	-117.396147˚W
Water Column	SR-6b	East Trent Ave. Mid	47.662047˚N	-117.393947˚W
Water Column	SR-6c	East Trent Ave. LB	47.662036˚N	-117.393438˚W
Water Column	SR-7a	E. Mission Ave RB	47.662052˚N	-117.392786˚W
Water Column	SR-7b	E. Mission Ave Mid	47.671658˚N	-117.388187˚W
Water Column	SR-7c	E. Mission Ave LB	47.671629˚N	-117.387705˚W
Well Discharge	AW-1	Artesian Well	47.659803˚N	-117.399263˚W

2.3 Monitoring Dates

All sampling was conducted on September 8 and 9, 2021.

2.4 Field Sampling Activities

The field sampling activities as planned and implemented are detailed in the project QAPP (LimnoTech, 2021a). This section summarizes those activities. Water samples were collected by wading into the main channel flow. River samples were collected by direct immersion of the sample bottle into the river as a surface grab at a depth of 0.15 m below the water surface.

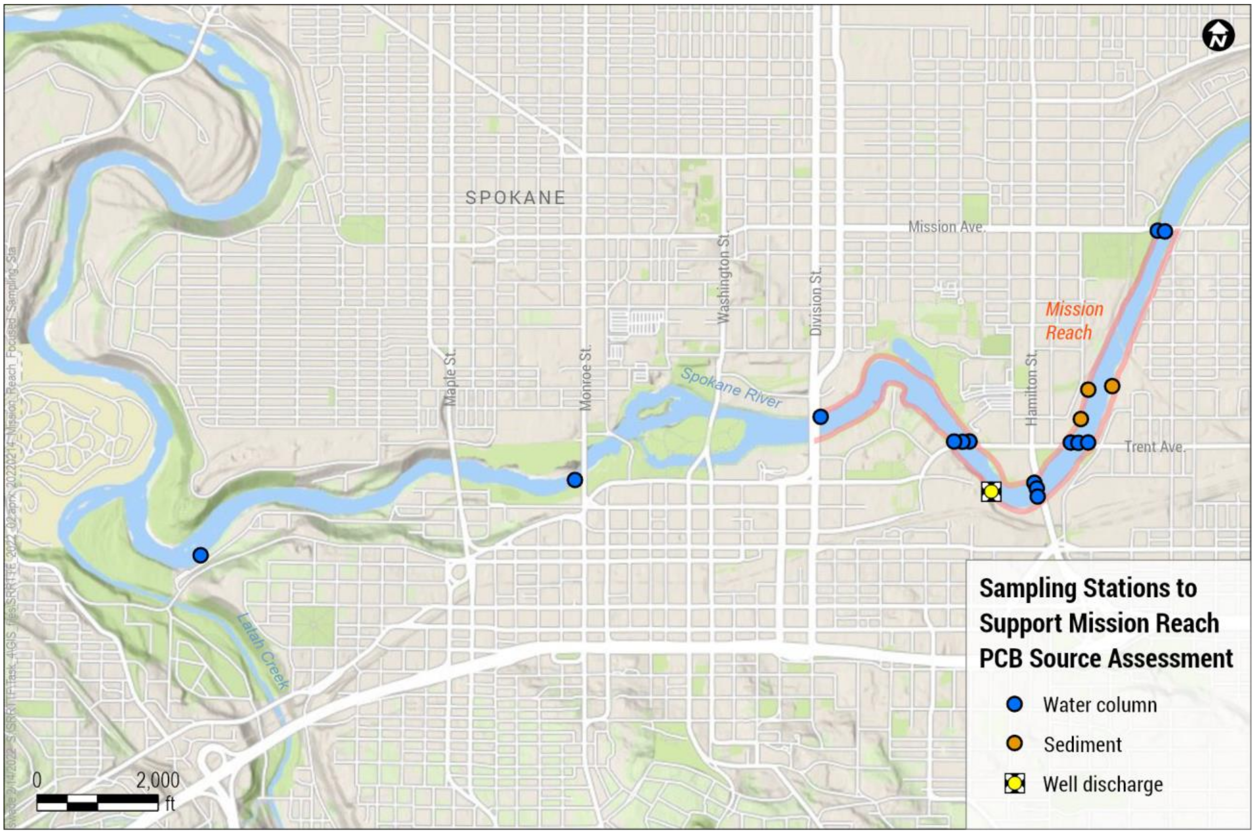

Figure 1. Map of Sampling Area Locations

Surface sediment samples were collected using a decontaminated Power Grab ST following SOP SW-19: Surface Sediment Sampling with Grab Sampler (Gravity, 2018). A watercraft was used to access the site to collect the grab sample. Any excess water from the grab was siphoned off. The top two centimeters of sediment from the grab was 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. Samples were stored in a cooler on ice until further processing.

The artesian well sample was collected by direct submersion of water containers in the retaining area of the well.

2.5 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. Separate samples were provided to SVL Laboratories in Kellogg, Idaho for measurement of conventional parameters. The conventional parameters consisted of total organic carbon, dissolved organic carbon, and total suspended solids for the water column and artesian well samples. Sediment samples were analyzed for grain size distribution and organic carbon content.

2.5.1 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:

- Several congeners and the total PCB concentration were flagged as failing the duplicate sample relative percent differences (RPDs) for the sediment sample.
- Select congeners for thirteen water column samples, three sediment samples and the artesian well sample were flagged as having low sample and method blank surrogate recovery.

There are no changes to PCB result values as a result of this assessment, although data qualifiers were added to select samples subject to high relative percent difference, and sample and method blank surrogate %R evaluation as described above.

2.5.2 Blank Censoring

Total PCB concentrations were censored 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.

2.6 Analytical Results

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

2.6.1 Total PCBs

Total PCB concentrations for the water column and artesian well sampling are provided in Table 2 with water column data plotted in in Figure 2. River PCB concentrations throughout the Mission Reach and downstream generally fall in 170 to 270 pg/l range with no obvious spatial pattern to indicate the presence of a water column PCB source within Mission Reach. The concentration observed at the left bank at E Mission Ave. (574 pg/l) was well above this range. This elevated concentration is not assumed to reflect a PCB source within Mission Reach, because this location is defined as the upstream boundary of Mission Reach. To the extent that this elevated concentration reflects an unknown source, that source would be located upstream of Mission Reach.

The artesian well discharge had a total PCB concentration of 2150 ug/l, roughly ten times greater than the average river concentration. This indicates that groundwater loading could be an important contributor to the Mission Reach contamination, to the extent that: 1) this concentration is representative of the local groundwater, and 2) an appreciable amount of groundwater flow enters the river in the Mission Reach. The Spokane Aquifer Joint Board's Spokane Valley-Rathdrum Prairie Aquifer Atlas (MacInnis et al., 2004) indicates that net water flow is from the Mission Reach to the aquifer (i.e., a losing reach), but this does not preclude groundwater flow entering the Mission Reach at select times and locations.

Table 2. Water Column and Artesian Well Total PCB Concentrations (pg/l)

Station ID	Location Descriptor	Total PCB (pg/l)
AW-1	Artesian Well	2150
SR-1	USGS Gage	273
SR-2	Monroe Street	176
SR-3	Division Street	327
SR-4a	E. Spokane Falls Blvd. RB	181
SR-4b	E. Spokane Falls Blvd. Mid	179
SR-4c	E. Spokane Falls Blvd. LB	200
SR-5a	WA 290 RB	158
SR-5b	WA 290 Mid	165
SR-5c	WA 290 LB	219
SR-6a	East Trent Ave RB	195
SR-6b	East Trent Ave. Mid	182
SR-6c	East Trent Ave. LB	181
SR-7a	E. Mission Ave RB	299
SR-7b	E. Mission Ave Mid	183
SR-7c	E. Mission Ave LB	574

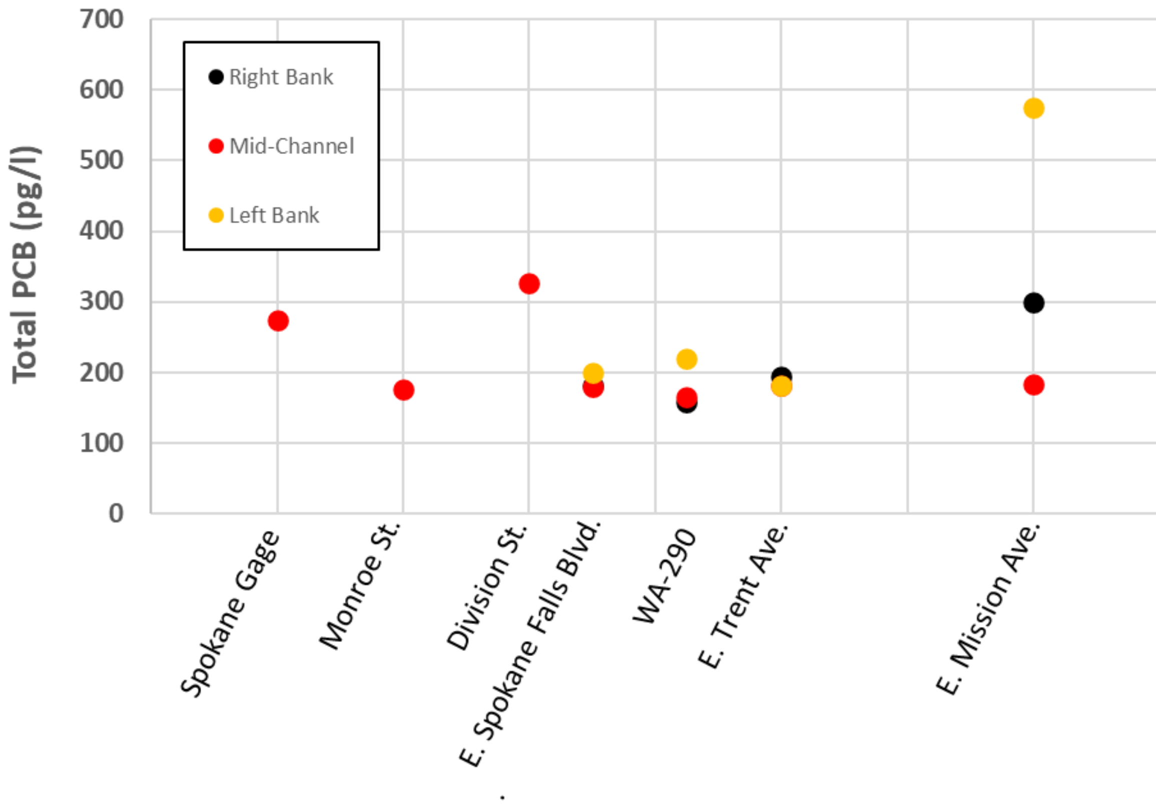

Figure 2. Water Column Total PCB Concentrations (pg/l)

Total PCB concentrations for the sediment sampling are provided in Table 3. Sediment PCB concentrations show large variability, with concentrations less than 30 ug/kg at Stations SR-SED1 and SR-SED3 and greater than 300,000 ug/kg at Station SR-SED2. Organic carbon-normalized PCB concentrations ranged from 592 ug/kg OC at Station SR-SED1 to 20,000 ug/kg OC at Station SR-SED2. Sediment grain size analysis showed all three samples were primarily sands. Stations SR-SED1 and SED-2 were both 98.6% sand and 1.4% silt. Station SR-SED3 was 90.4% sand, 7.6% silt, and 2% clay.

Table 3. Sediment Total PCB Concentrations (ug/kg)

Station ID	Location Descriptor	Total PCB (ug/kg)	Total PCB (ug/kg OC)
SR-SED1	Near Springfield Avenue	10.1	592
SR-SED2	North of Trent Bridge EB	300	20,000
SR-SED3	Trent Bridge WB	28.8	1,600

2.7 Homolog Distributions

Homolog distributions for river water column samples are provided in Figures 3 through 9. These data are provided in tabular format for each individual sample in Appendix A. The tetra-chloro homolog was the most prevalent at the majority of locations, with tri- and penta-chloro homologs the next most abundant. Two locations exhibited congener distribution distinct from the above pattern. The E. Mission Ave Bridge and Spokane Gage stations had a relatively higher percentage of penta- and hexa-chloro homologs.

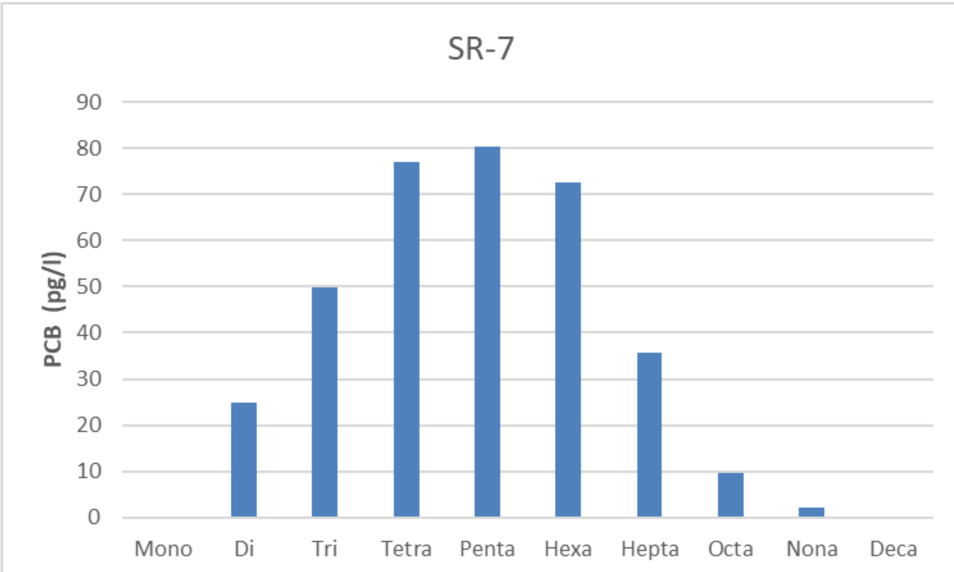

Figure 3. Average Blank-Corrected Homolog Concentrations for E. Mission Avenue Water Column Samples.

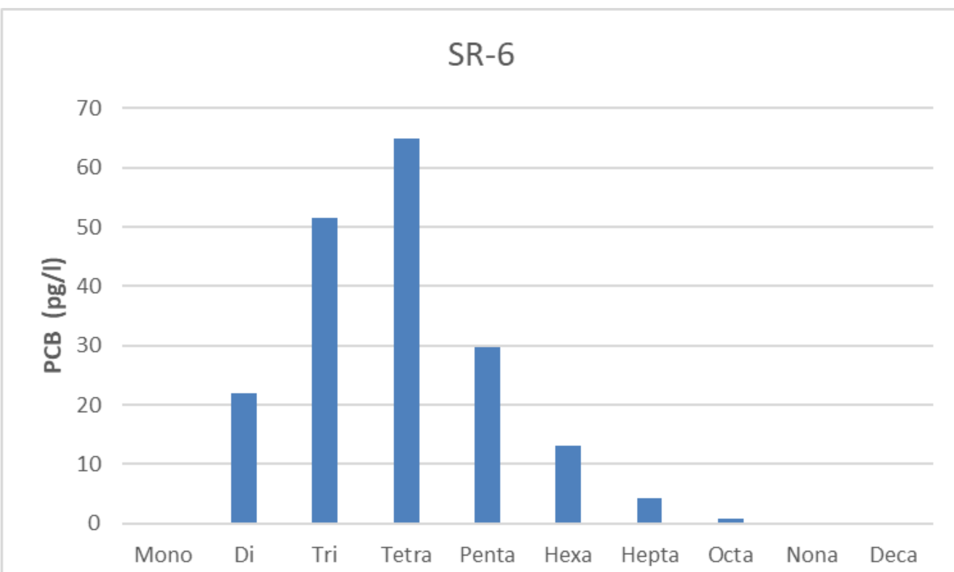

Figure 4. Average Blank-Corrected Homolog Concentrations for E. Trent Avenue Water Column Samples.

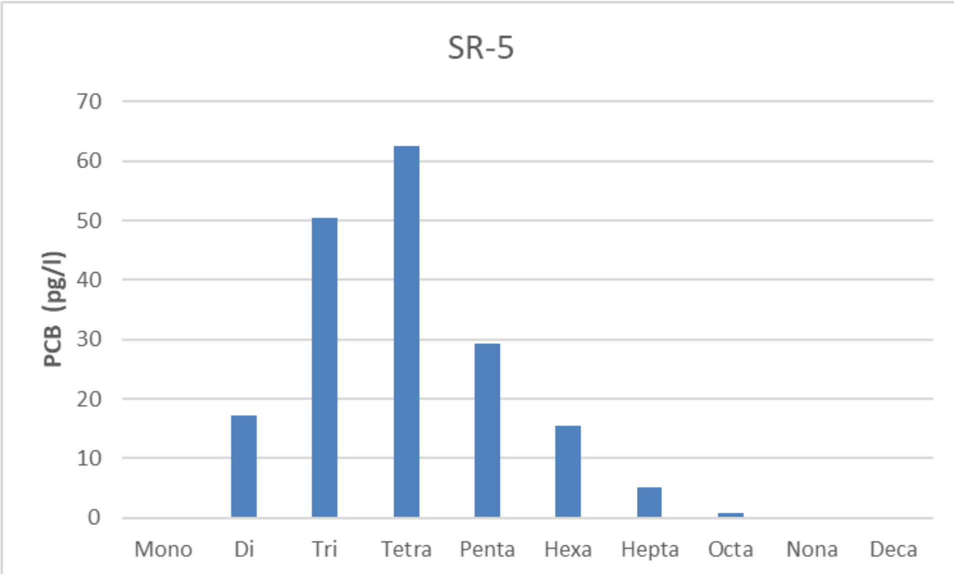

Figure 5. Average Blank-Corrected Homolog Concentrations for WA-290 Water Column Samples.

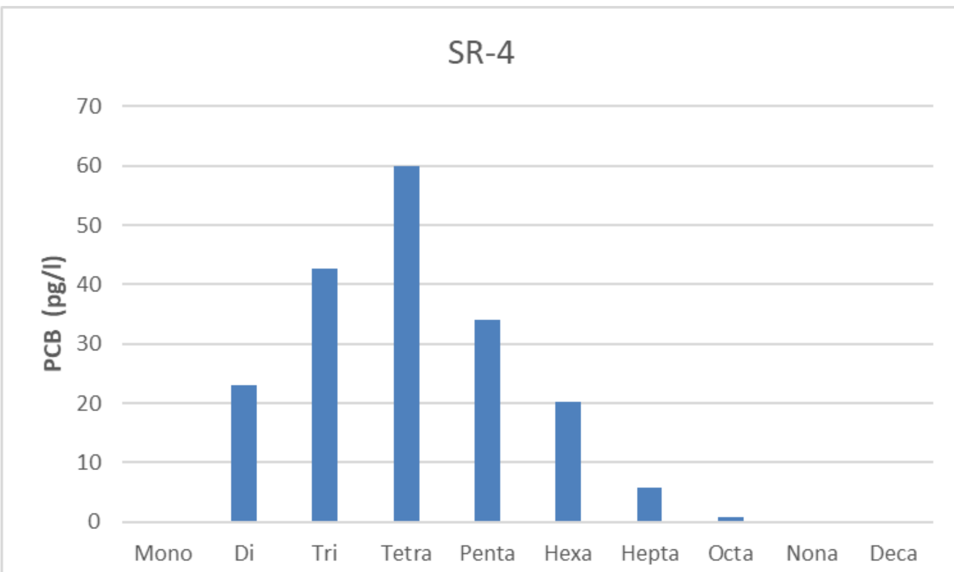

Figure 6. Average Blank-Corrected Homolog Concentrations for E. Spokane Falls Blvd. Water Column Samples

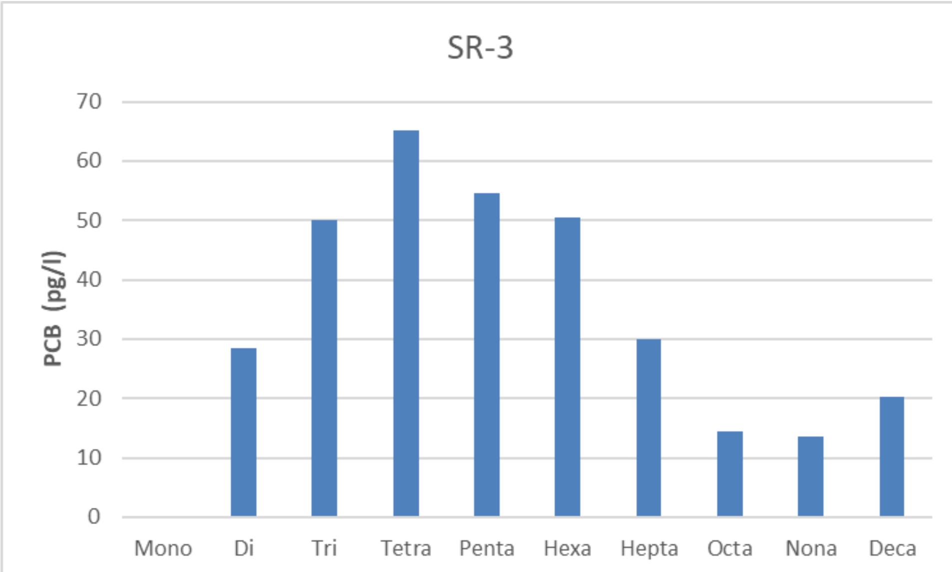

Figure 7. Blank-Corrected Homolog Concentrations for Division St. Water Column Sample

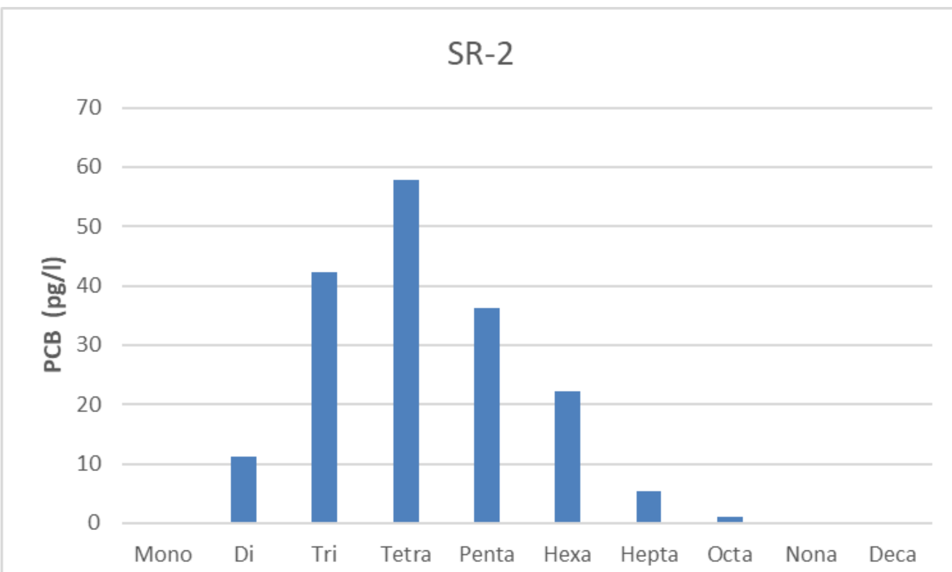

Figure 8. Blank-Corrected Homolog Concentrations for Monroe St. Water Column Sample

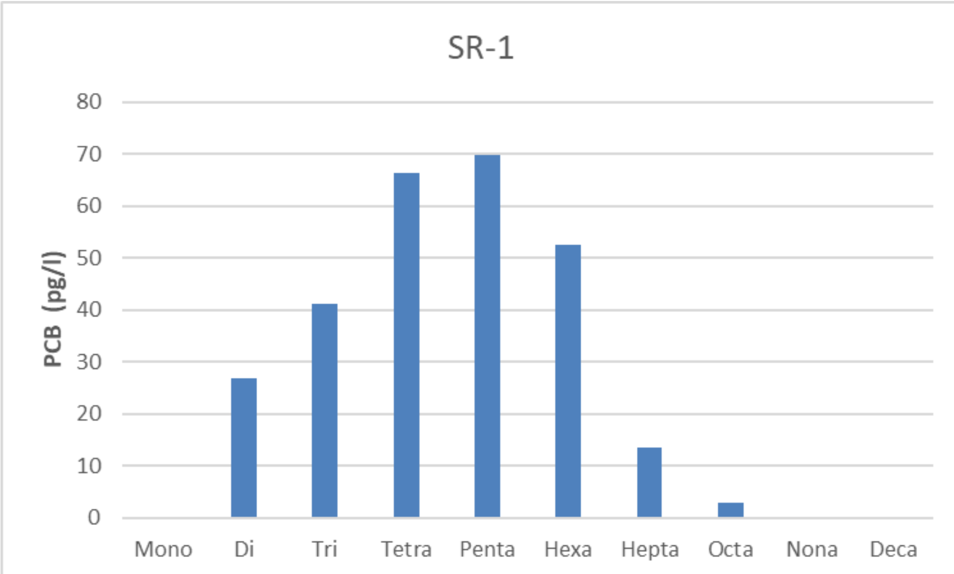

Figure 9. Blank-Corrected Homolog Concentrations for Spokane USGS Gage Water Column Sample

Figure 10 shows the homolog distribution for the artesian well sample. These data are provided in tabular format in Appendix A. The tri- and tetra-chloro homologs dominate the total concentration, potentially indicative of an Aroclor 1242 source.

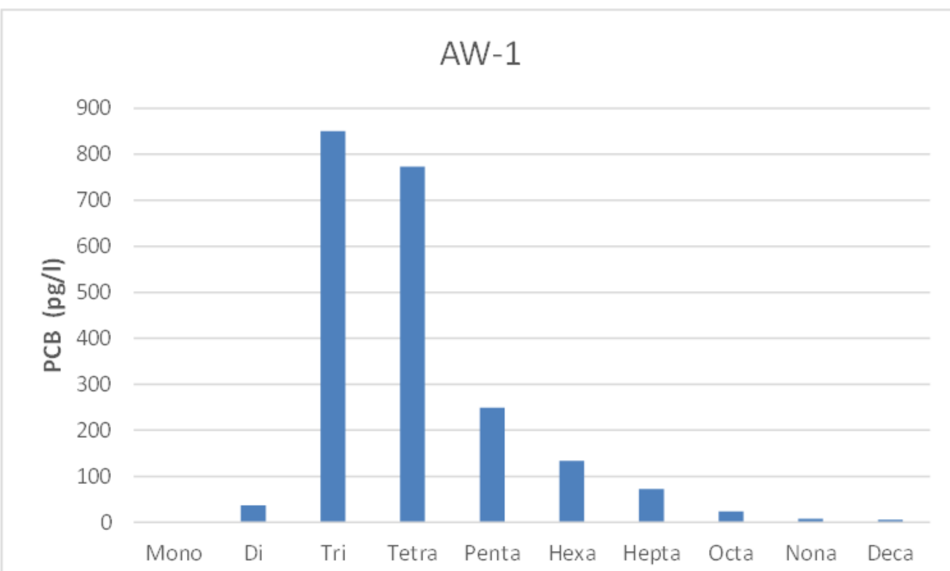

Figure 10. Blank-Corrected Homolog Concentrations for Artesian Well Sample

Figures 11 through 13 show the homolog distribution for each of the sediment sampling locations. These data are provided in tabular format for each individual sample in Appendix A. The penta-chloro homolog was the most prevalent at each location, with tetra- and hexa-chloro homologs the next most abundant,

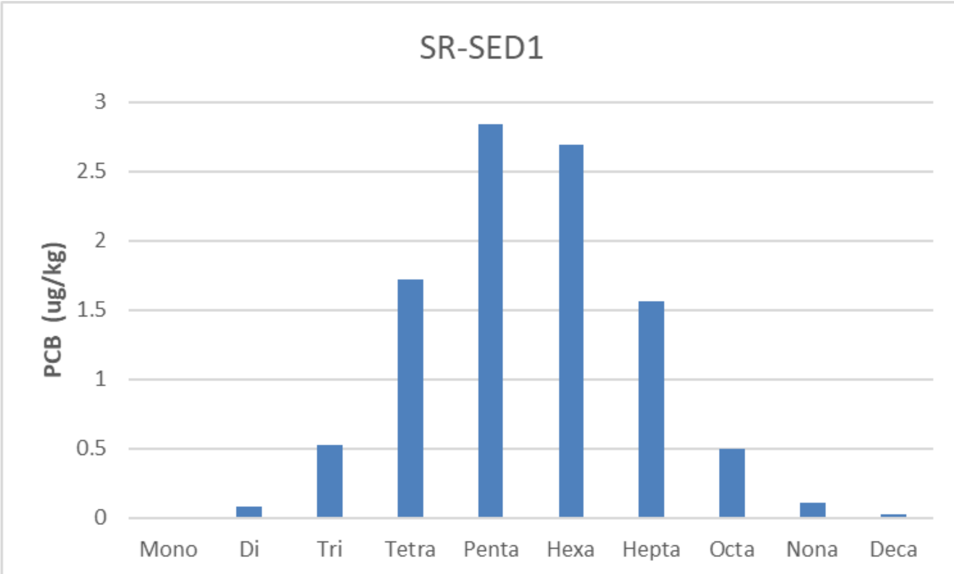

Figure 11. Blank-Corrected Homolog Concentrations for Station SR-SED1 near Springfield Avenue

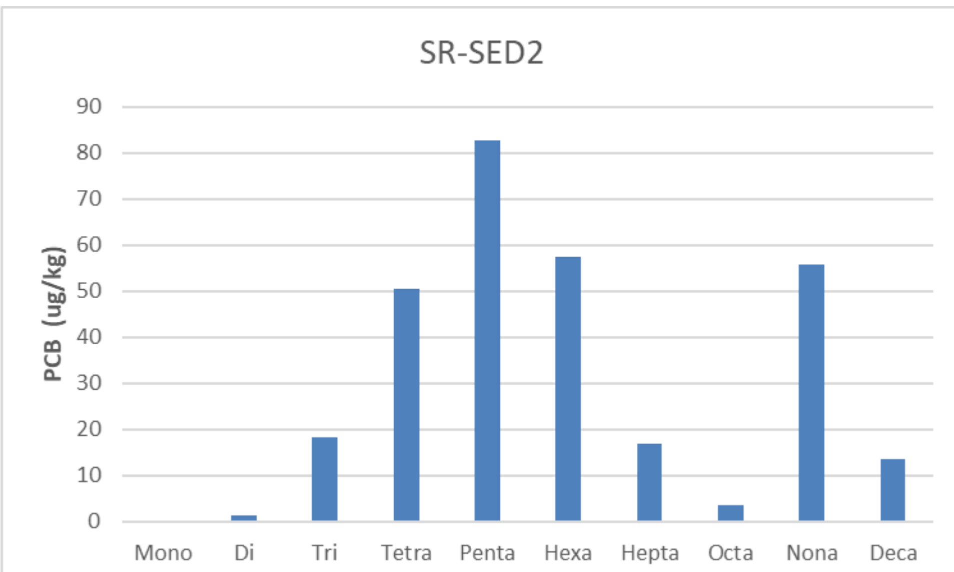

Figure 12. Blank-Corrected Homolog Concentrations for Station SR-SED2 north of Trent Bridge East Bank

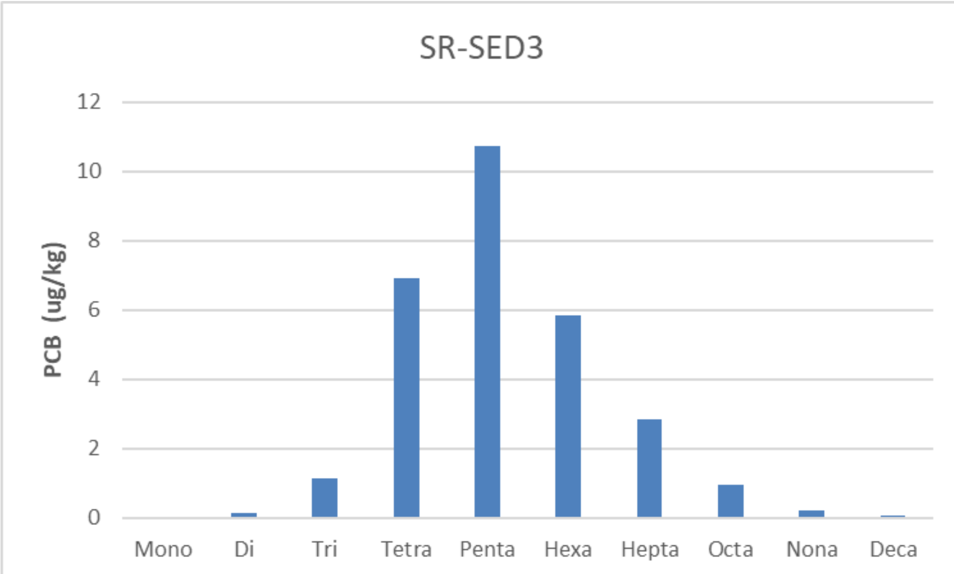

Figure 13 Blank-Corrected Homolog Concentrations for Station SR-SED3 Trent Bridge West Bank

2.8 Data Interpretation

2.8.1 Water Column

Water column grab sampling in the Mission Reach and downstream areas showed no spatial pattern indicative of an external source of PCBs to the water column. One elevated concentration of 574 ug/l was observed at E. Mission Ave. This location represents the upstream boundary of the Mission Reach so this elevated concentration represents a PCB source upstream of the Mission Reach. The tetra-chloro homolog was the most prevalent at the majority of locations, with tri- and penta-chloro homologs the next most abundant, potentially indicating a mixture of Aroclors 1242 and 1254. The E. Mission Ave Bridge and Spokane Gage stations had a relatively higher percentage of penta- and hexa-chloro homologs, potentially indicating a larger proportion of Aroclor 1254.

2.8.2 Artesian Well

The PCB concentration in an artesian well discharging into the downstream section of the Mission Reach was greater than 2000 ug/l. This suggests that contaminated groundwater could be contributing to the elevated Mission Reach PCB concentrations. The tri- and tetra-chloro homologs dominate the total concentration, potentially indicative of an Aroclor 1242 source.

2.8.3 Bottom Sediments

Sampling of PCBs in bottom sediments at three Mission Reach locations showed one site with elevated concentrations (300 ug/kg) and two sites with concentrations consistent with those observed elsewhere in the Spokane River. Figure 14 compares observed sediment concentrations from this study with prior Task Force (LimnoTech, 2021b) and Ecology (Era-Miller, 2020; Era-Miller, 2015) sediment PCB concentration observed within and upstream of the Mission

Reach. PCB concentrations in this study are consistent with those 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.

All three locations had highest concentrations in the penta-chloro homolog, with station SR-SED2 showing high concentration in the nona-chloro homolog. Further investigation is needed to determine the source of this elevated concentration.

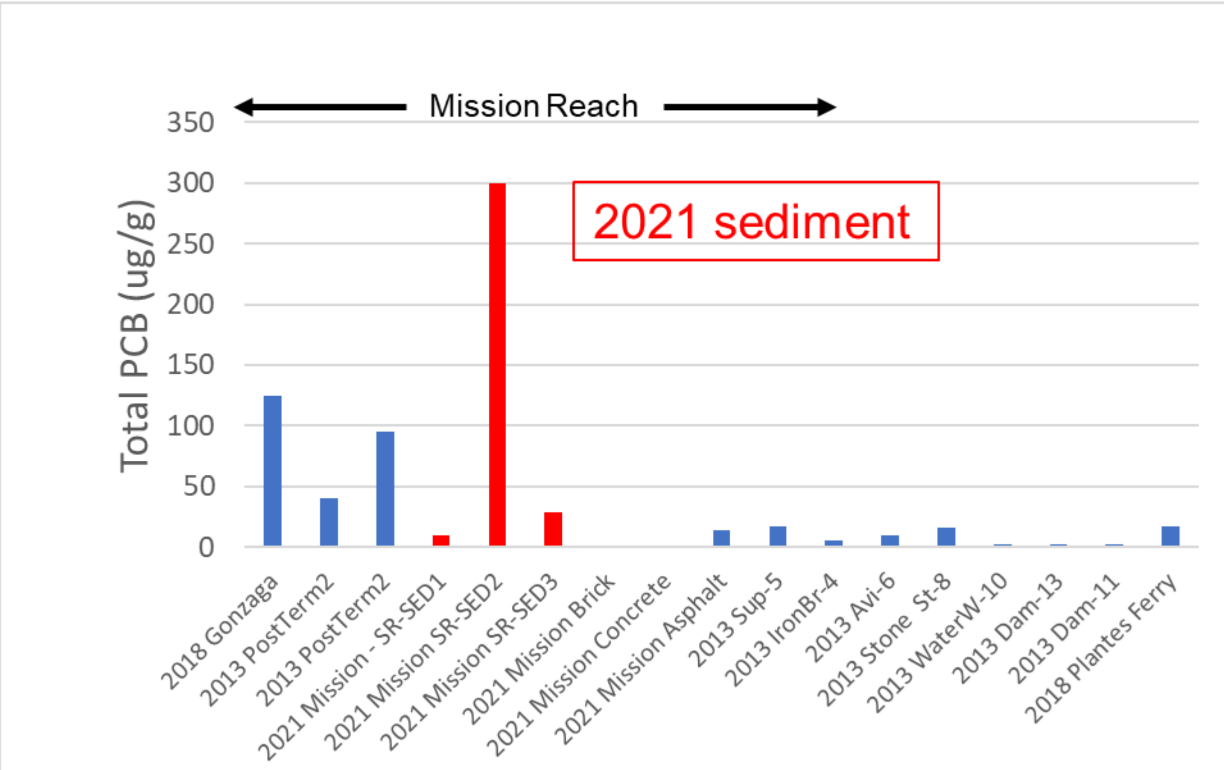

Figure 14. Comparison of Sediment PCB Concentrations Observed in this Study to Recent Task Force and Ecology Data

Blank Page

3 PCB-Detection Dog

3.1 Introduction

A PCB-detection dog was deployed to identify potential areas of PCB contamination in riparian areas of the Mission Reach. A complete write-up of this study, including links to GIS coordinates and filed videos, are provided in Appendix D.

3.2 Methods

Canine surveys took place on August 29-31st 2021. The survey area was prioritized to the area between North Columbia Street (western perimeter) and Iron Bridge Court (eastern perimeter), the Iron Bridge (northern perimeter) and Trent Avenue (southern perimeter). The canine team was granted access to search the Riverwalk building on the right bank and properties owned by MGD LLC. (Figure 15). Canine and handler surveyed the priority area by searching both sides of the riverbank and by walking the perimeter of buildings and property lines within designated areas. Due to canine interest, surveys were extended westward to East Hamilton Street and north to East Cataldo Avenue Survey. Coverage was recorded using GPS track logger (Figure 16).

Figure 15. Target Area and Permissions

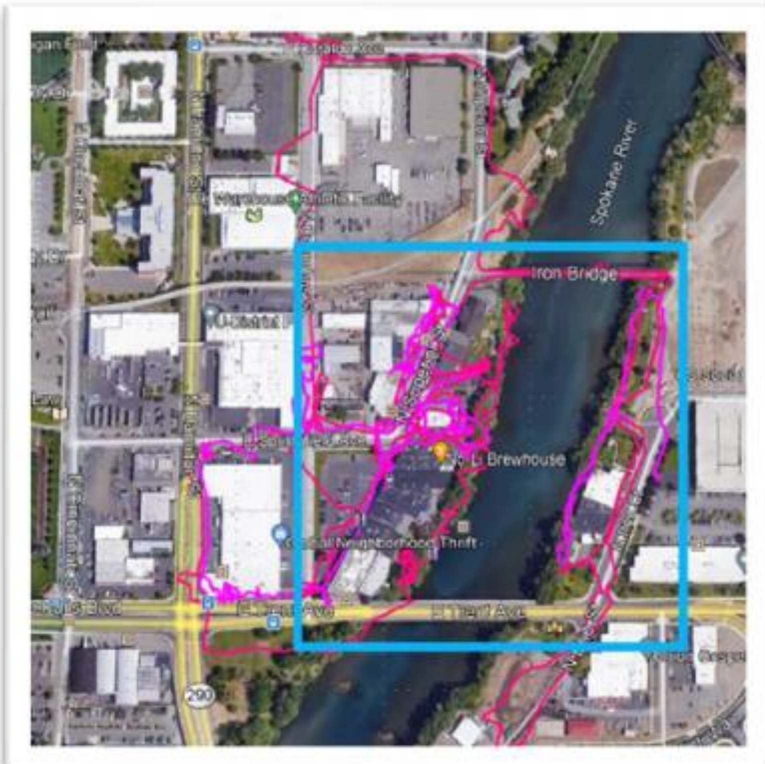

Figure 16. PCB Detection Study Area and Tracklog Coverage

The detection team also traveled the river by longboard to provide an additional perspective and better access to areas of the riverbank that were obstructed by vegetation. The detection dog had a change of behavior near a submerged stormwater outfall. The outfall is difficult to see from the bank due to heavy shrubs and is just upstream from the SR3A-RB sample site. Several other submerged pipes and wreckage were observed and recorded during the float survey and documented in the full report provided in Appendix C).

Canine detections were reported as "high" "medium" or "low" confidence. The degree of confidence is determined by the handler who specializes in reading and interpreting the changes of behavior exhibited by the dog when working into an odor. The detection dog, named Jasper, is trained to sit when he has located a target odor. Areas with positive detections were surveyed multiple times to compare changes of behavior and determine confidence levels for each detection made by Jasper.

3.3 Findings

While there were no definitive sources of PCBs detected along the right or left banks of the river, several buildings in the stormwater drainage area were detected by the dog and in a few instances the odor was also detectable by the handler. Other detections occurred at stormwater catch basin sites, drywell sites, and soil on the riverbank or next to buildings. GPS coordinates and descriptions of 19 detection areas were recorded during surveys. Links to video footage of canine detections can be found in Appendix C.

The most significant finding was an active outfall, less than 10 meters upriver from the SR3A-RB PCB hotspot (Figure 17). This outfall discharges stormwater from the area where PCB-contaminated buildings were detected.

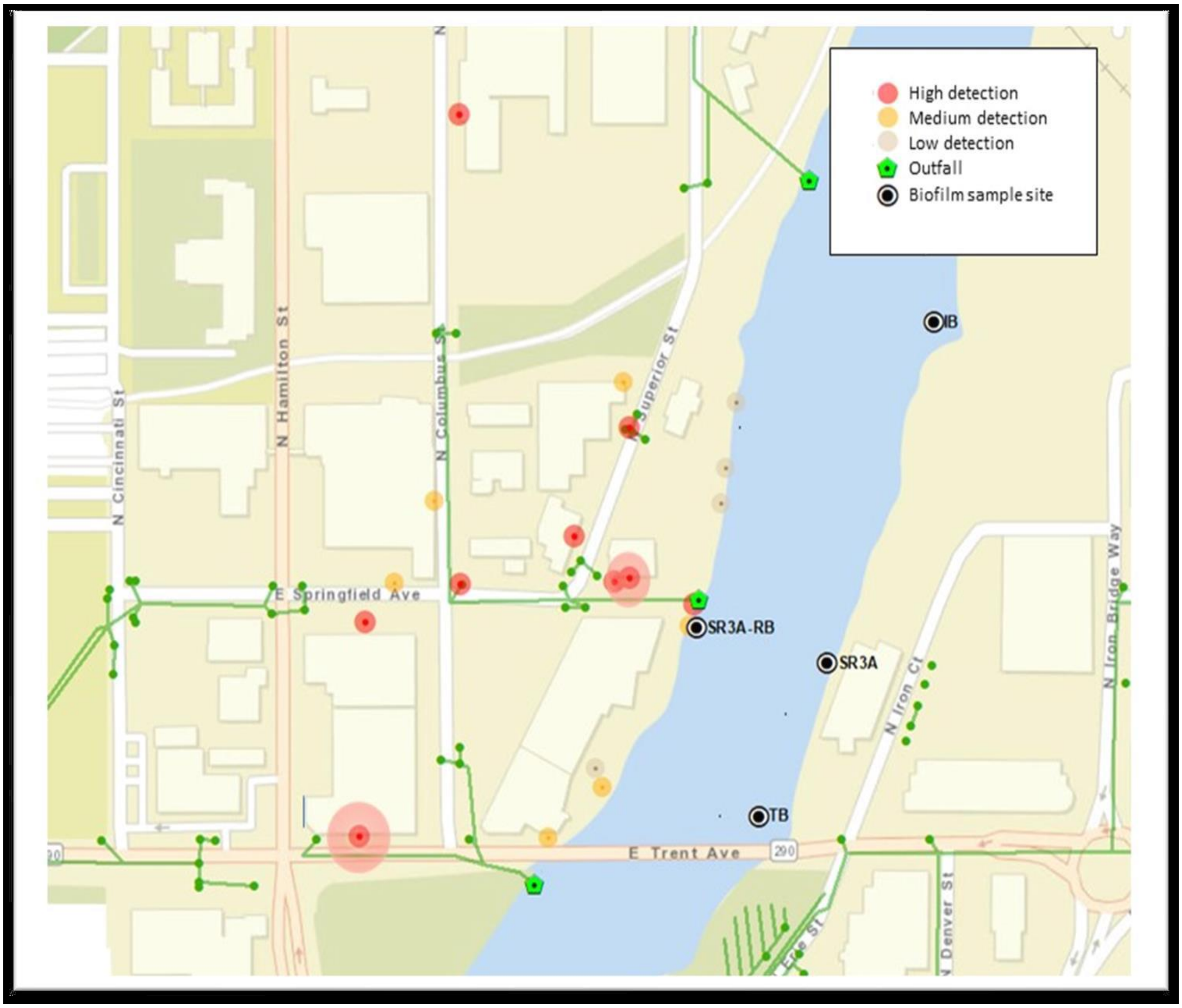

Figure 17. Map showing canine detections, outfalls and biofilm sample locations.

3.4 Conclusions

Based on the PCB detections made in this area, the canine detection team concluded that the source of PCBs is likely from buildings and contaminated soil within the Springfield stormwater basin which discharges to an outfall near the SR3A-RB PCB hotspot. The number of buildings positive for PCB in the survey zone suggests that there may be higher levels of PCBs in three stormwater basins that serve this area: Springfield, Trent Bridge and Spokane Falls. Testing the level of PCBs in biofilm at each outfall and testing catch basins in these mainlines could help determine if the PCB hotspot is caused by building materials and historic operations that took place here, or if the source is underground and not detectable by a detection dog.

There were 10 areas of high interest to the detection dog. Figure 18 above shows a summary of these 10 sites and the underlying stormwater system that drains directly into the Spokane River..

Figure 17 show the sites are numbered 1-10 based on probable relevance to the SR3A-RB PCB hotspot. The following section provides a more detailed description for each site.

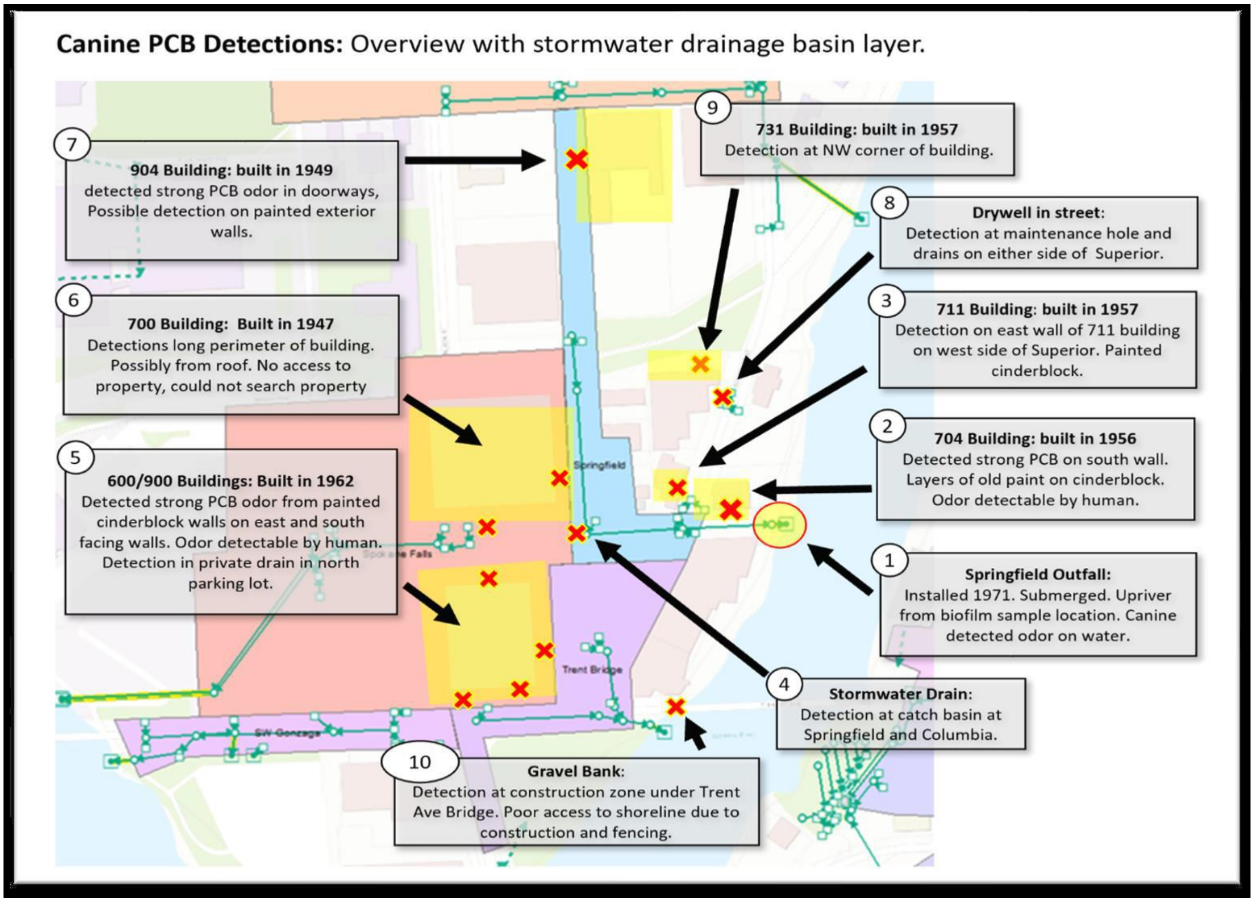

Figure 18. Overview of PCB Detection Sites.

4
Object Detection Survey

4.1 Introduction

Gravity Marine Consulting, LLC (Gravity) was contracted by the Task Force to conduct an object detection survey in the Mission Reach of the Spokane River. The survey area ranged between the Mission Avenue Bridge and Trent Street Bridge on the Spokane River. The objective of the survey was to detect any anomalous objects on or beneath the river bottom as a potential source for PCB contamination detected in previous sampling efforts. The survey was designed in a two-step process to help identify the position, size, and type of object. Phase one of the survey included a towed side scan sonar (SSS) survey of surface debris. This phase of the survey helps identify objects laying on the river bottom. The second phase of the survey program was a towed magnetometer survey to identify if observed debris contained ferrous material (i.e., steel vs. other material). Both survey methodologies were correlated to understand the extent and identity of targets.

This section summarizes the survey and results found, with the complete survey report provided in Appendix E.

4.2 Side Scan Hydrographic Survey

The survey was conducted from a shallow portable vessel, given the shallow water depths and limited access to this reach of the Spokane river. The vessel was equipped with a Trimble SPS461 L1/L2 GPS receiver for real time vessel heading and position data. The sonar used was a Starfish 990F side scan sonar. The SSS is capable of collecting high-resolution imagery of bottom targets within the thresholds of the transducers.

The survey was conducted within the Mission Reach of the Spokane River between the Mission Avenue bridge and E. Trent Avenue bridge. Due to ongoing in-water construction near Trent St, the survey did not extend all the way down river to the E. Trent Avenue bridge.

The SSS sonar system collected full swath hydrographic data of the river bottom where accessible. Given the angle of transducers, the sonar is capable of collecting swath data approximately 4-5 times the water depth, per transducer. Given the shallow water depth of the survey area (from 10 feet to less than 6 inches), some of the coverage area was impacted by very shallow depths. Data were collected as close to shore as possible, given depth constraints..

4.2.1 Side Scan Imagery Processing

Side scan imagery processing was conducted using the HYSCAN module of the HYPACK 2020 software platform. The targeting and mosaicking tool was used to process all side scan imagery. Side scan imagery was conducted in a three-phase processing strategy. Phase 1 of data processing views all raw acoustic imagery. Phase 2 of data processing is the review of each scan in a typically “waterfall” configuration, which stack individual scans to get a complete picture of each scan. In this stage edits are made to the gain settings for each file as well as the colorization options. Also, this stage is when targets are identified on each file and saved to a target data base for further processing. Phase 3 creates a single mosaic of all side scan files to create a single image of all the side scan data. The individual files are stitched together and filtered to create a complete picture of the survey area. This product is used for overlaying on final drawings and help with orientation of identified targets.

4.2.2 Side Scan Survey Results

A total of 63 targets and/or grouping of targets were identified from the survey. These don't typically denote an observed source of pollution, rather an object on the river bottom that was significant enough to identify in the post processing of SSS data. It would be reasonable to assume that many of these targets are larger rocks/boulders as well as logs and debris as well some anthropogenic items. The targets were somewhat evenly distributed along the reach, with a notable clustering near the down-river extent of the reach near Trent Street. Most of the targets appeared to be near shore rather than in the middle of the river. Two large objects were detected mid-reach and appeared to be larger wooden rectangular objects filled with river rock. These data were used for further analysis as to which targets to investigate further.

4.3 Magnetometer Geophysical Survey

A magnetometer survey was conducted in project area to identify if any of the observed targets were comprised of ferrous material (i.e. steel). A Marine Magnetics SeaSpy magnetometer (SBP) was used to conduct the survey and collect magnetic total field data in the project area. Data acquisition for the magnetometer survey was done through Hypack 2020 SURVEY platform. The software has a driver that interfaces directly with the magnetometer and collects raw total field data as well as all positioning information. Total field data were compiled in HYPACK native .RAW file, where the total field data were written as a special instrument field with the header SMI. Data were extracted from the raw data files for post processing.

Magnetometer data was processed using the Magnetometer Editing toolbox of HYPACK 2020. This data editing package allows the removal of erroneous data values, anomaly calculations, target identification and field interpolation. Magnetometer data were processed in several steps.

Initially all raw data were loaded into the data editor to remove obvious erroneous data. Total field data were then processed through the IGRF algorithm to derive a raw anomaly value in nT based on the fluctuations in the total magnetic field gamma values from shore-based measurements. Additionally, a time differential analysis was performed on gamma values to look at the value and direction of the magnetic gradient between each time step differential nT (dnT/dT). The processed data were used to make Total Field and delta-T interpolated field maps. These maps were used in correlation with side scan target locations to help identify the material composition of the targets.

4.4 Magnetometer Results

Given the close proximity of the survey areas to substantial amount of steel objects (e.g., steel bridges, bridge pilings, reinforced concrete) the total field was most likely significantly manipulated in the areas of the survey. Nonetheless, the magnetic data does show some good correlation with known targets as well as identifies areas of high magnetic value.

A few interesting clusters of correlated magnetic anomalies and SSS targets reside in the downstream extent of the reach. Figure 19 depicts the magnetic time series results for the entire surveyed area, with objects of interest appearing in red. Three areas of interest exist in the lower portion of the surveys area, shown in greater spatial detail in Figure 20. While the imagery cannot depict exactly what these objects are, these areas identify potential ferrous objects for further investigation via video or diver survey.

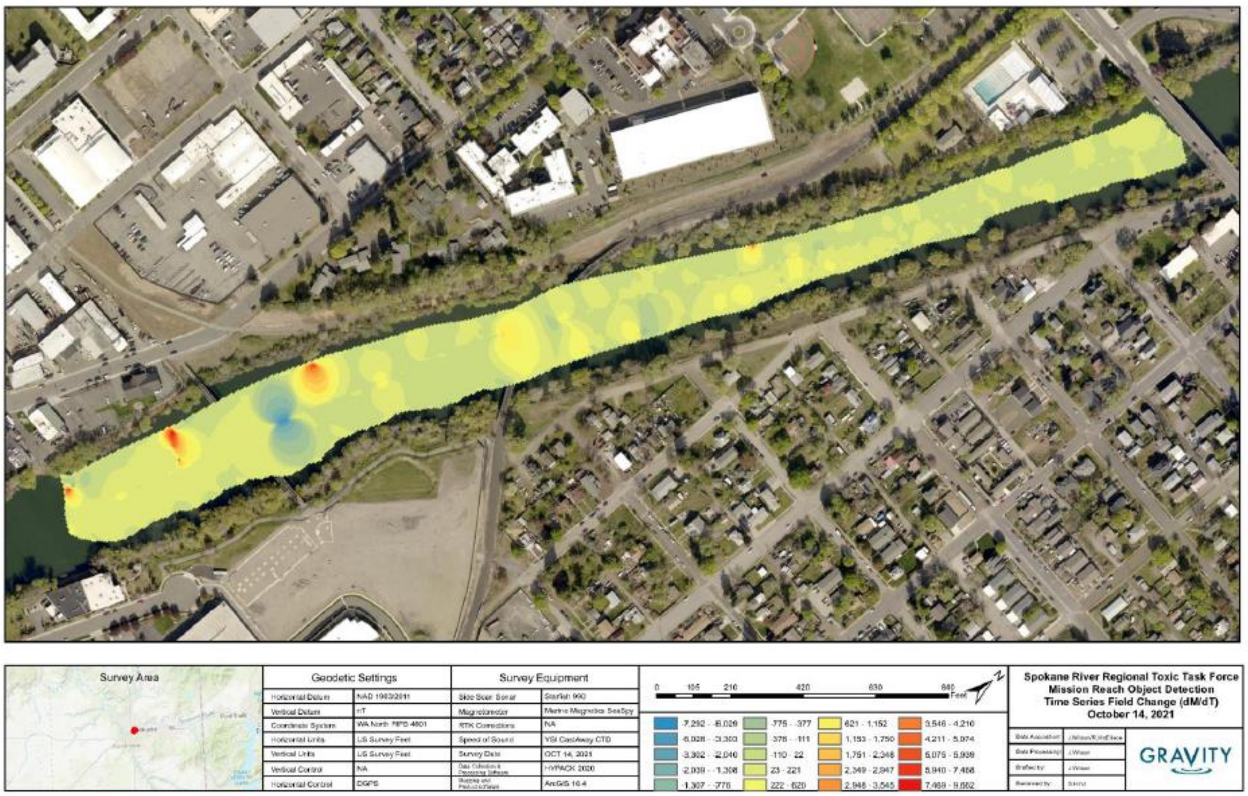

Figure 19. Magnetic Time Series for Entire Mission Reach Study Area.

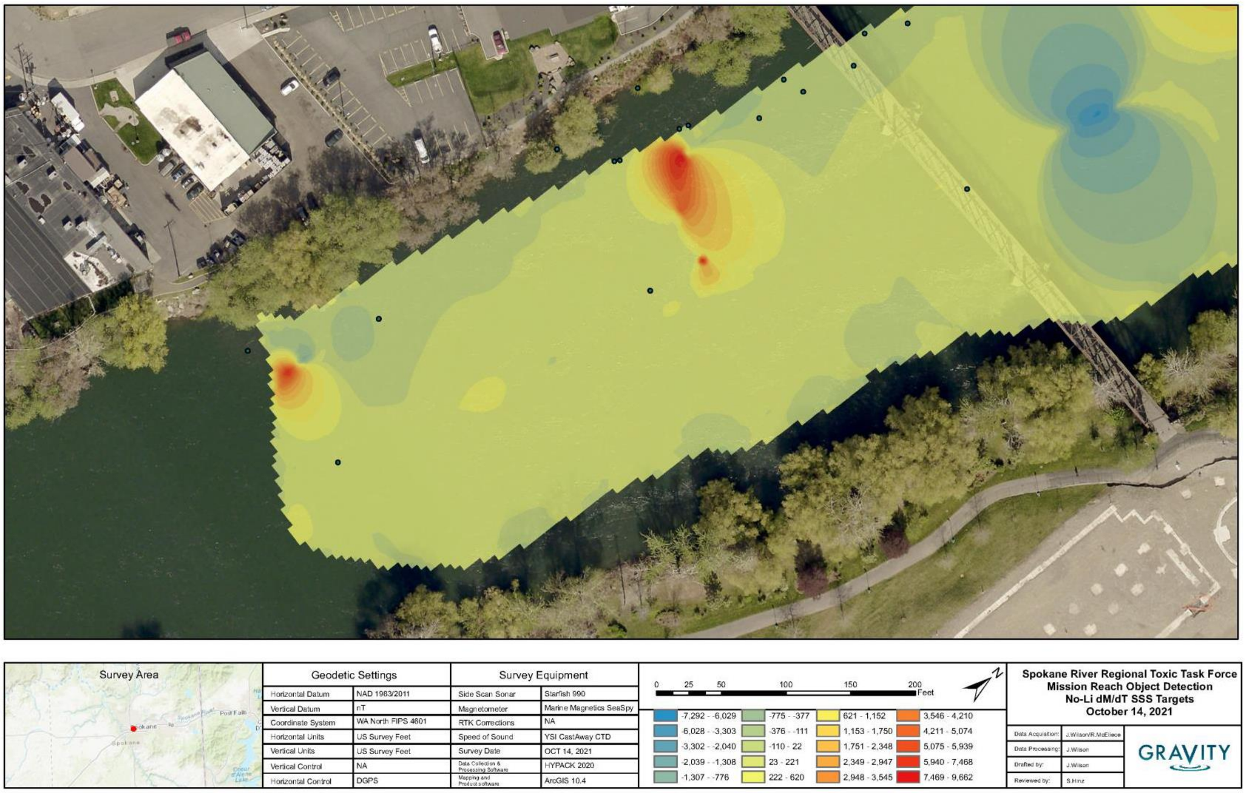

Figure 20. Magnetic Time Series Focused on Lower Portion of the Study Area.

5
Scoping Analysis of Drive Point Piezometers

LimnoTech (2020) identified contaminated groundwater as one potential cause of elevated PCB concentrations in the Mission Reach. The objective of this sampling component was to test deployment of temporary drive point piezometers via a limited field verification study to assess their suitability for assessing groundwater PCB contribution to the Mission Reach. The piezometer feasibility assessment was designed to determine whether: 1) public access to install piezometers could be obtained, and 2) it was feasible to install piezometers in the Mission Reach and measure conductivity in the transition zone between groundwater and the river.

5.1 Methods

Gravity Marine Consulting, LLC (Gravity) was contracted by the Task Force to conduct the feasibility assessment. Three sites were selected for this assessment, consisting of the near-shore area adjacent to the sediment sampling sites described previously in Table 1 of this report. Field methods were performed to be consistent with Standard Operating Procedure EAP061, Version 2.1: Installing, Monitoring, and Decommissioning Hand-driven In-water Piezometers (Sinclair and Pitz, 2018). Water collected from the piezometer were analyzed for temperature and specific conductivity. Concurrent sampling of temperature and specific conductivity were made of water in the Spokane River at each site. Figure 21 shows an example of an installed piezometer and YSI flow-through cell used to measure water quality.

Figure 21. Installed piezometer system

5.2 Results

Piezometers were successfully deployed at two of the three test sites, SR-SED1 and SR-SED3. The piezometer installed at site SR-SED2 was not able to collect a sufficient sample to allow water quality analysis. Table 4 shows the temperature and specific conductivity measured in both the surface water (i.e., river) and transition zone water for the remaining stations. Obvious differences in temperature and specific conductivity are observed between the surface water and transition zone water. These differences suggest that the water quality of the transition zone is influenced by more than just the surface water, indicating that groundwater may be flowing into the Mission Reach.

Table 4. Temperature and specific conductivity between surface water and transition zone water.

Parameter	SR-SED1		SR-SED3	
	Surface Water	Transition Zone Water	Surface Water	Transition Zone Water
Temperature (°C)	13.869	18.989	14.28	21.46
Specific Conductivity us/cm	261.1	310.3	273.4	317.5

6 References

EPA, 2011. Standard Operating Procedure for Sampling Porous Surfaces for Polychlorinated Biphenyls (PCBs). Office of Environmental Measurement and Evaluation EPA Region 1. https://www3.epa.gov/region9/pcbs/disposal/cleanharbors/pdfs/application/2011-appendix-k-epa-guidance.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

Era-Miller, 2015. Urban Waters Sediment and Groundwater Seep Data. Presentation to Spokane River Regional Toxics Task Force, October 26, 2015.

LimnoTech, 2021a. Addendum 2 to Quality Assurance Project Plan Measuring PCBs in Biofilm, Sediment, and Invertebrates in the Spokane River: Screening Study. Prepared for Spokane River Regional Toxics Task Force. March 3, 2021.

LimnoTech, 2021b. Spokane River Regional Toxics Task Force Evaluation of PCBs in Spokane River Artificial Bottom Fill Material. Prepared for Spokane River Regional Toxics Task Force. July 2021.

LimnoTech, 2020.: Follow-up Investigations from Spokane River Multi-media Data Collection. Prepared for Spokane River Regional Toxics Task Force. August 18, 2020 draft.

MacInnis, J.D., Lackaff, B.B., Buchanan, J.P., Boese, R.M., McHugh, J., Harvey, G., Higdem, R., and Stevens, G., 2004, The Spokane Valley-Rathdrum Prairie aquifer atlas 2004 update: Spokane, Spokane Aquifer Joint Board, 26 p.

Sinclair, K. and C. Pitz, 2018. Standard Operating Procedure EAP061, Version 2.1: Installing, Monitoring, and Decommissioning Hand-driven In-water Piezometers. Publication No. 18-03-216. Washington State Department of Ecology, Olympia. May 2018

Wong, S. and B. Era-Miller. 2019. Quality Assurance Project Plan: Measuring PCBs in Biofilm, Sediment, and Invertebrates in the Spokane River: Screening Study. Publication No. 19-03-103. Washington State Department of Ecology, Olympia. https://fortress.wa.gov/ecy/publications/SummaryPages/1903103.html

Blank page

Appendix A: Water and Sediment Results - PCBs by Homolog

Blank Page

Table A-1: Blank-Corrected Homolog Results for E. Mission Ave.			
	SR-7a	SR-7b	SR-7c
Total PCBs (pg/l)	299	183	574
Total Monochloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Dichloro Biphenyls (pg/l)	31.8	27.3	15.4
Total Trichloro Biphenyls (pg/l)	52.4	43.2	54.0
Total Tetrachloro Biphenyls (pg/l)	73.4	60.0	97.4
Total Pentachloro Biphenyls (pg/l)	64.7	28.7	148.0
Total Hexachloro Biphenyls (pg/l)	49.7	18.2	150.1
Total Heptachloro Biphenyls (pg/l)	20.5	4.5	81.7
Total Octachloro Biphenyls (pg/l)	5.2	1.0	23.0
Total Nonachloro Biphenyls (pg/l)	1.4	0.0	4.6
Total Decachloro Biphenyls (pg/l)	0.0	0.0	0.0

Table A-2: Blank-Corrected Homolog Results for E. Trent Ave.			
	SR-6a	SR-6b	SR-6c
Total PCBs (pg/l)	195	182	181
Total Monochloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Dichloro Biphenyls (pg/l)	20.7	14.7	30.7
Total Trichloro Biphenyls (pg/l)	54.5	48.6	51.1
Total Tetrachloro Biphenyls (pg/l)	66.6	68.2	59.8
Total Pentachloro Biphenyls (pg/l)	31.5	34.5	23.4
Total Hexachloro Biphenyls (pg/l)	16.8	11.3	11.1
Total Heptachloro Biphenyls (pg/l)	4.4	4.2	4.4
Total Octachloro Biphenyls (pg/l)	0.7	0.6	0.8
Total Nonachloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Decachloro Biphenyls (pg/l)	0.0	0.0	0.0

Table A-3: Blank-Corrected Homolog Results for WA 290			
	SR-5a	SR-5b	SR-5c
Total PCBs (pg/l)	158	165	219
Total Monochloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Dichloro Biphenyls (pg/l)	15.0	14.8	22.0
Total Trichloro Biphenyls (pg/l)	47.5	49.0	55.1
Total Tetrachloro Biphenyls (pg/l)	58.5	60.3	68.8
Total Pentachloro Biphenyls (pg/l)	22.4	24.0	41.3
Total Hexachloro Biphenyls (pg/l)	10.3	11.9	24.4
Total Heptachloro Biphenyls (pg/l)	4.1	4.8	6.1
Total Octachloro Biphenyls (pg/l)	0.5	0.5	1.2
Total Nonachloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Decachloro Biphenyls (pg/l)	0.0	0.0	0.0

Table A-4: Blank-Corrected Homolog Results for E. Spokane Falls Blvd.			
	SR-4a	SR-4b	SR-4c
Total PCBs (pg/l)	181	179	200
Total Monochloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Dichloro Biphenyls (pg/l)	30.0	27.8	11.2
Total Trichloro Biphenyls (pg/l)	41.3	41.1	45.6
Total Tetrachloro Biphenyls (pg/l)	57.7	56.9	65.1
Total Pentachloro Biphenyls (pg/l)	29.8	29.6	42.6
Total Hexachloro Biphenyls (pg/l)	16.4	17.3	27.1
Total Heptachloro Biphenyls (pg/l)	4.7	5.4	7.4
Total Octachloro Biphenyls (pg/l)	0.9	1.0	0.8
Total Nonachloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Decachloro Biphenyls (pg/l)	0.0	0.0	0.0

Table A-5: Blank-Corrected Homolog Results for Division St., Monroe St, and USGS Gage			
	SR-1	SR-2	SR-3
Total PCBs (pg/l)	273	176	327
Total Monochloro Biphenyls (pg/l)	0.0	0.0	0.0
Total Dichloro Biphenyls (pg/l)	26.8	11.3	28.4
Total Trichloro Biphenyls (pg/l)	41.1	42.3	50.1
Total Tetrachloro Biphenyls (pg/l)	66.2	57.8	65.2
Total Pentachloro Biphenyls (pg/l)	69.8	36.2	54.5
Total Hexachloro Biphenyls (pg/l)	52.5	22.1	50.5
Total Heptachloro Biphenyls (pg/l)	13.6	5.3	30.1
Total Octachloro Biphenyls (pg/l)	2.9	1.0	14.5
Total Nonachloro Biphenyls (pg/l)	0.3	0.0	13.6
Total Decachloro Biphenyls (pg/l)	0.0	0.0	20.2

Table A-6: Blank-Corrected Homolog Results for Artesian Well	
	AW-1
Total PCBs (pg/l)	2150
Total Monochloro Biphenyls (pg/l)	0.0
Total Dichloro Biphenyls (pg/l)	36.4
Total Trichloro Biphenyls (pg/l)	850.0
Total Tetrachloro Biphenyls (pg/l)	772.9
Total Pentachloro Biphenyls (pg/l)	248.9
Total Hexachloro Biphenyls (pg/l)	133.9
Total Heptachloro Biphenyls (pg/l)	72.6
Total Octachloro Biphenyls (pg/l)	23.2
Total Nonachloro Biphenyls (pg/l)	7.5
Total Decachloro Biphenyls (pg/l)	5.0

Table A-7: Blank-Corrected Homolog Results for Sediment Samples

	SR-SED1	SR-SED1-DUP	SR-SED2	SR-SED3
Total PCBs (ug/kg)	10.061	49.499	300.242	28.834
Total Monochloro Biphenyls (ug/kg)	0.005	0.004	0.007	0.009
Total Dichloro Biphenyls (ug/kg)	0.082	0.073	1.395	0.141
Total Trichloro Biphenyls (ug/kg)	0.529	0.484	18.392	1.127
Total Tetrachloro Biphenyls (ug/kg)	1.722	2.922	50.557	6.927
Total Pentachloro Biphenyls (ug/kg)	2.834	14.082	82.674	10.707
Total Hexachloro Biphenyls (ug/kg)	2.692	20.486	57.448	5.830
Total Heptachloro Biphenyls (ug/kg)	1.562	8.580	16.989	2.855
Total Octachloro Biphenyls (ug/kg)	0.500	2.447	3.580	0.961
Total Nonachloro Biphenyls (ug/kg)	0.106	0.380	55.700	0.210
Total Decachloro Biphenyls (ug/kg)	0.028	0.041	13.500	0.069
Organic Carbon (%)	1.7	-	1.5	1.8
% Sand	98.6	-	98.6	90.4
% Silt	1.6	-	1.6	7.6
% Clay	<0.2	-	<0.2	2.0

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

Appendix D:
PCB-Detection Dog Report

Provided separately as electronic document

Blank Page

Appendix E:
Object Detection Survey Report

Provided separately as electronic document

Blank Page