Spokane River Regional Toxics Task Force
2016 Monthly Monitoring Report

Prepared for:
Spokane River Regional
Toxics Task Force

May 24, 2017
DRAFT

LimnoTech
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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) 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.

The Work Plan developed by the Task Force (SRRTTF, 2012) included collection of data to characterize PCB sources. Prior Task Force technical activities carried out synoptic surveys to assess groundwater PCB sources to the Spokane River during summer flow conditions. The Task Force subsequently desired an understanding of the seasonal variability in PCB concentrations in the river, and sponsored the study described in this report. River sampling was conducted at five Spokane River locations and at the mouth of Latah Creek in each of the months of March, April, May, June, October, and December of 2016. Survey activities were conducted in accordance with the Quality Assurance Project Plan (LimnoTech, 2016) developed for this phase of the project.

The following conclusions can be gathered from the data collected:

- River PCB concentrations remain less than 40 pg/l during all months at the outlet of Lake Coeur d'Alene, with only one exception.
- PCB concentrations tend to increase downstream as the river passes through the Spokane metropolitan area. The amount of increase varies seasonally in response to river flow, with lower river flows generally leading to larger increases in concentration.
- October river concentrations near Spokane were slightly higher than in other months, in conjunction with wet weather conditions. Data collected by the City of Spokane during this event suggest that the City's stormwater contributes approximately 5% of these increased concentrations, while historical combined sewer overflow (CSO) data suggest that CSO loads are of a magnitude consistent with the observed increase in concentration.
- An observed PCB concentration greater than 1000 pg/l at the mouth of Hangman (Latah) Creek during wet weather indicates the potential presence of a PCB loading source to this watershed. While this load is sufficient to cause high concentration in the Creek, its effect on the Spokane River was small due to the small amount flow in the Creek at the time the sample was taken.
- While this study provides valuable information on seasonal variability in PCB concentrations, it is only a relatively brief snapshot of one sample per month at six stations for six months, Additional monitoring would be required to provide a deeper understanding of seasonal variability of concentrations and/or loading contributions for periods beyond those previously covered in previous synoptic surveys.

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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 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. 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. The stated objective of the Task Force is "to work collaboratively to characterize the sources of toxics in the Spokane River and identify and implement appropriate actions needed to make measurable progress towards meeting applicable water quality standards." The Work Plan developed by the Task Force (SRRTTF, 2012) identified four phases of work:

- Phase 1: Review of existing data and reports, and development of a data gaps assessment with recommendations for additional sampling
- Phase 2: Collection of additional data
- Phase 3: Analysis of data to characterize and quantify PCB sources
- Phase 4: Assessment of potential control actions and development of a Comprehensive Plan

The majority of Phase 1 activities were completed in 2013, and are documented separately in LimnoTech (2013a, 2013b, 2013c, and 2013d). Phase 2 technical activities originally focused on assessing the presence of groundwater sources of PCBs to the Spokane River during summer low flow conditions. Synoptic surveys were conducted in this regard in August, 2014 and August, 2015. The Task Force subsequently desired an understanding of the seasonal variability in PCB concentrations in the river, and sponsored the study described in this report. River sampling was conducted at five Spokane River locations and the mouth of Latah Creek in each of the months of March, April, May, June, October, and December of 2016. Survey activities were conducted in accordance with the Quality Assurance Project Plan (LimnoTech, 2016) developed for this phase of the project and included as an Appendix to this report.

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

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2
Sampling Activities

The field monitoring program consisted of six one-day sampling events at five Spokane River locations and the mouth of Hangman (Latah) Creek. In addition, individual Task Force members collected PCB data under separate monitoring efforts that provide data useful for this assessment. Sampling activities are described below, divided into sections corresponding to:

- Monitoring locations
- Monitoring dates
- Field sampling activities
- Non-SRRTTF sampling activities

2.1 Monitoring Locations

Sampling locations (Figure 1) included five Spokane River stations, as well as at the mouth of Hangman (Latah) Creek. The stations were at the following locations (with latitudes and longitudes specified):

- Lake Coeur d'Alene Outlet (-116.7989162, 47.6816274)
- Spokane River below Trent Ave. Bridge near Plante's Ferry (-117.2418, 47.69708)
- Spokane River below Greene St. Bridge (-117.3628, 47.67808)
- Spokane River at Spokane USGS Gage (-117.4497, 47.65888)
- Spokane River Gage Station below Ninemile Dam (-117.5397324, 47.21437906)
- Latah (Hangman) Creek Gage Station (-117.44986, 47.6528668)

The Lake Coeur d'Alene Outlet station will represent the contribution of PCBs from the entire watershed contributing to the lake. The remaining four Spokane River stations (Trent Bridge, Greene Street, USGS Gage, and below Nine Mile Dam) were selected to determine the extent that concentrations increase as the river passes through the City of Spokane. The primary reason for these locations was to obtain measurements at a range of (relatively) evenly spaced locations; secondary considerations included consistency with prior water column and fish tissue sampling locations, ease of access, and presence of flow gaging stations. The final station, at the mouth of Latah Creek, was selected to represent the PCB concentrations entering the river from the Latah Creek watershed, as one sample during the 2014 synoptic sampling showed elevated PCB concentration in response to a localized rain storm.

2.2 Monitoring Dates

The project study plan defined monitoring dates conditionally, based upon seasonal weather conditions and the quality of information gained during the initial months of sampling. The study plan called for monthly monitoring from March through May of 2016, to be followed by a review of current information on snow pack, river flows, and weather forecasts to make a determination as to whether sampling in June of 2016 would be worthwhile. LimnoTech conducted this review and presented findings at the May Task Force meeting. The decision of the Task Force was that June sampling would provide worthwhile information on seasonal variability in concentrations, even though the snowpack had been largely depleted.

In addition, the study plan called for LimnoTech to conduct a mid-project assessment after spring 2016 laboratory results became available, to determine if the data that had been collected were providing valuable information. The results of this assessment were to be provided to the Task Force prior to conducting fall sampling, with the option to either: 1) Continue fall sampling as planned, 2) Make modifications to the sampling plan, or 3) Terminate all remaining sampling. Spring monitoring results were presented at the September Task Force meeting, with the Task Force recommending to continue fall sampling as planned.

As a result of the above decision process, a total of six monitoring events were conducted on the following dates:

- March 24, 2016
- April 19, 2016
- May 24, 2016
- June 16, 2016
- October 26, 2016
- December 13, 2016

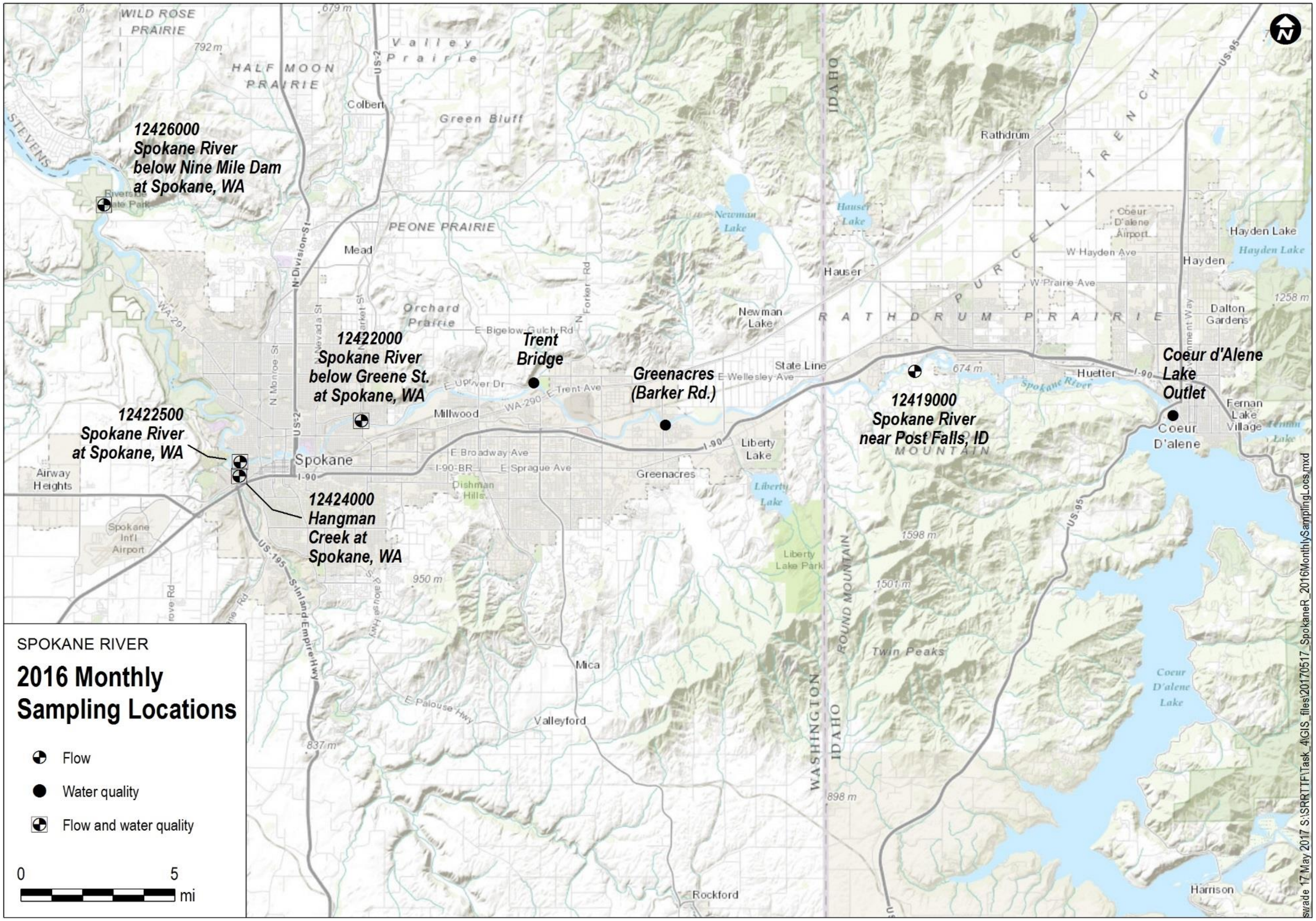

Figure 1. Sampling Locations for 2016 Monthly Sampling

2.3 Field Sampling Activities

The field sampling activities as planned and implemented are detailed in the project QAPP (LimnoTech, 2016), and Gravity (2017) field report, both of which are included as appendices to this report. This section summarizes those activities. Environmental specialists from Gravity Consulting conducted the sampling events. Grab samples were collected by hand using "clean hands" and "dirty hands" methodology combined with direct immersion techniques at the prescribed locations. These methods reduce the likelihood of any cross-contamination from direct (e.g., handling dirty equipment) or indirect (e.g., dust or air transport) sources.

2.4 Quality Assurance

Field samples were shipped to AXYS Analytical Laboratories, Ltd. in Sidney, British Columbia, for analysis of PCB concentrations. PCB concentrations for individual congeners were blank-corrected following the process defined in the QAPP (LimnoTech, 2016). A separate set of samples were taken to SVL Analytical, Inc. in Coeur d'Alene, ID for analysis of total dissolved solids, total suspended solids, total organic carbon, dissolved organic carbon. These additional parameters can be used to inform future studies related to PCB partitioning, fate and transport, and/or bioaccumulation.

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)
- Method blank concentrations
- Completeness

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

- One surrogate recovery result was low for 3 samples. The out of control surrogate results are below the associated criteria range (25%-125%) for percent recovery specified in the QAPP. Sample results associated with the low surrogate recoveries are qualified as estimated using J/UJ data flags for positive/negative result values.
- Three duplicate sample pairs had a high relative percent difference (RPD) for individual congeners or congener groups (two pairs for congener PCB-001; one pair for congener groups PCB-044/047/065, PCB-045/051, and PCB-068.) The duplicate pair RPD results are above the QAPP-specified criteria (0-50% for congeners >10 times the detection limit).

Duplicate pair results associated with the high RPDs are qualified as estimated using the J data flag.

- A number of December field samples were not reviewed because of unacceptably high PCB contamination in the laboratory method blank. The original laboratory analysis of all December samples was rejected due to laboratory blank contamination, and new analyses were conducted using archive samples from the December monitoring event. The archive samples were split among three separate laboratory batches each of which contained some degree of blank contamination issues:
    1. The batch consisting of the Spokane Gage duplicate sample had a total PCB concentration of 128 pg/l in the blank, which narrowly exceeded the quality objective of 127 pg/l. This value is included below in the data assessment, but is flagged as not fully meeting specifications.
    2. The batch containing samples for Trent Ave., Greene St., Latah Creek and Nine Mile met the SRRTTF QAPP data specifications, but exceeded the laboratory method specification for blank contamination in the PCB 11 congener. These results are included below in the data assessment, but also flagged as not fully meeting specifications.
    3. The batch containing the Lake Coeur d'Alene outlet station and one of the duplicate samples for the Spokane USGS gage had unacceptably high method blank contamination, and was rejected from consideration. As a result, no December 2016 data are available for the Lake Coeur d'Alene outlet station. These were the only two samples for the year that were lost, such that the QAPP completeness criterion of obtaining validated results for 95% of all samples was satisfied.

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

Data quality indicators evaluated for conventional parameters included the following:

- Bias (laboratory control samples, matrix spikes, and blanks)
- Precision (RPD of matrix spikes and replicate samples)
- Completeness

All reviewed QC results for conventional parameters complied with QAPP data quality indicators.

2.4.2 Blank Correction

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.

Method blank concentrations associated with all 2016 results are provided below in Table 1. Method blanks were run in triplicate for the March, April, and May events.

Table 1. Method Blank PCB Concentrations Associated with 2106 Monthly Sampling)

Month	Stations	Method Blank PCB Concentration (pg/l)
March	All	25, 22, 24
April	All	16, 18, 11
May	All	28, 32, 39
June	All	66
October	All	57
December	Trent Ave., Greene St., Latah Creek, Nine Mile	96
December	Spokane USGS Gage	128

No blank corrections were conducted on conventional parameters, as all blank samples for all conventional parameters were below the relevant detection limit.

2.5 Non-Task Force Sampling Activities

Two other monitoring activities occurred during 2016 which, although not directly sponsored by the Task Force, were conducted by individual Task Force members and provided valuable information towards the goals of this assessment:

- March 2016 Stormwater Loading Assessment by City of Spokane
- March and October Spokane River sampling by Idaho municipalities

Each is described below. The PCB concentrations for individual congeners, homologs, and total PCBs collected by these agencies were blank-corrected for this work following the process defined in the project QAPP (LimnoTech, 2016) and described above in Section 2.4.2. All other aspects of quality assurance for these non–Task Force activities were described in their own respective Quality Assurance Plans, These plans consist of the City of Spokane's Quality Assurance Project Plan for Cochran Basin Stormwater Sampling (City of Spokane Wastewater Management, 2016) and NPDES Quality Assurance Plans corresponding to each of the Idaho entities (Post Falls, HARSB, Coeur d'Alene).

2.5.1 October 2016 Stormwater Loading Assessment by City of Spokane

In concurrence with the SRRTTF October river sampling, the City of Spokane measured the PCB concentration representing discharge from their Cochran stormwater basin. An automatic sampler began taking samples at 03:03 on October 26 and finished at 15:04 on the same day. These samples were sent to Pacific Rim Laboratories in Surrey, British Columbia, for analysis of PCB concentrations.

During the October Cochran basin sample event, flow measurements were recorded simultaneously to sample collection providing for an estimate of stormwater PCB loading during the monitoring event. The ISCO sampler used for sample collection is flow-paced. Stormwater flow was continuously monitored but only recorded at a 5-minute interval. Furthermore, flow monitors have an accuracy of ±20%. . Discharge flow was also measured for combined sewer overflows (CSOs) using the same methodology described above, although no CSO concentration measurements were made.

2.5.2 March and October Spokane River Sampling by Idaho Municipalities

As part of their NPDES permit requirements, the Idaho municipalities discharging to the Spokane River (i.e. Coeur d'Alene, Post Falls, and Hayden) conduct in-river monitoring of PCB concentrations twice per year. In 2016, this monitoring occurred on May 25 and October 27, each within one day of the SRRTTF monitoring dates. Samples were taken by Gravity Consulting at the following locations:

- Lake Coeur d'Alene outlet (-116.801974, 47.677349)
- Downstream of Coeur d'Alene (-116.820113, 47.696459)
- Downstream of Hayden/Upstream of Post Falls (-116.94737, 47.70338)
- Downstream of Post Falls (-117.037256, 47.694016)

These samples were sent to AXYS Analytical Laboratories, Ltd. in Sidney, British Columbia, for analysis of PCB concentrations.

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3
Results

This section presents the results of the 2016 monitoring, in terms of concentrations of total PCBs and individual homologs. Furthermore, a detailed listing of PCB concentrations and conventional parameters for each date at each sampling location is provided in Appendix A, and full laboratory data sheets are provided in Appendix D.

3.1 Total PCBs

Total PCB concentrations across all months sampled are shown below for the Spokane River stations in Figure 2 and for all stations in Table 2. PCB concentrations are generally less than 40 pg/l leaving Lake Coeur d'Alene and throughout the Idaho sampling locations, and increase as the river passes through the Spokane metropolitan area. Additional interpretation of these data are provided subsequently in Section 4 of this report.

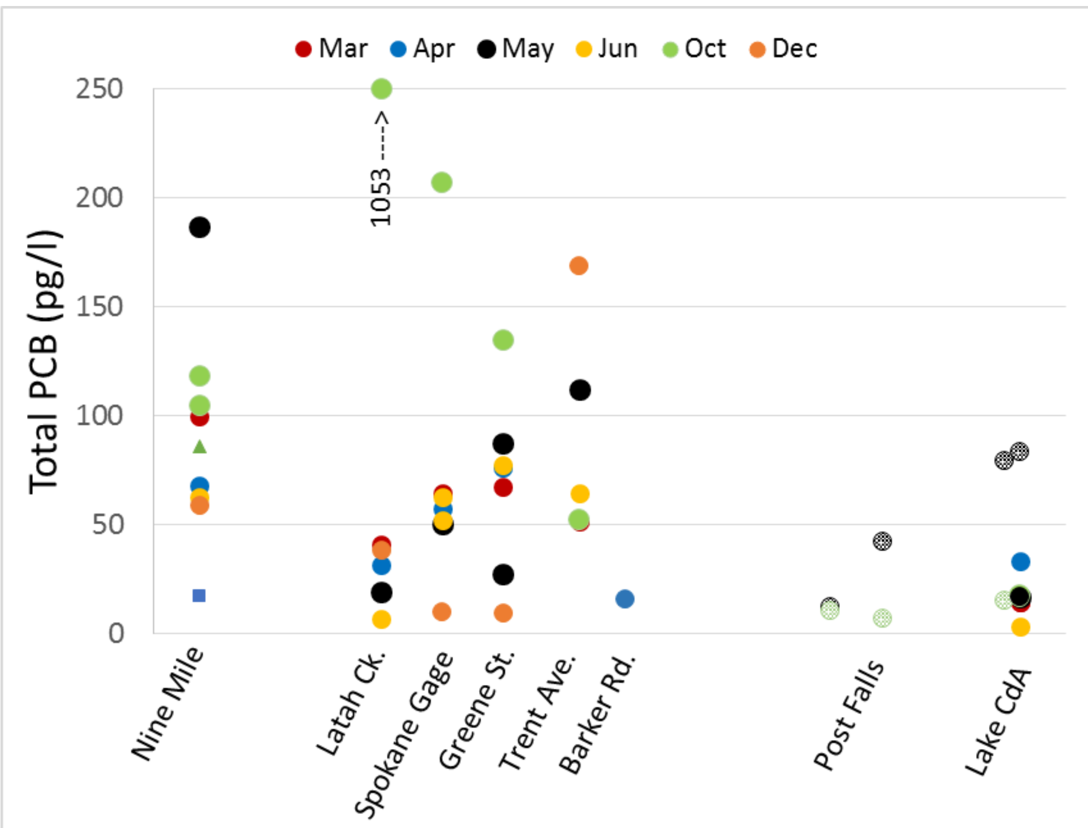

Figure 2. Spokane River Total PCB Concentrations Measured during 2016 Monthly Surveys (Measurements for Idaho Municipalities Shown as Hatched)

Table 2. Spokane River Total PCB Concentrations Measured during Monthly Surveys (Duplicate Samples in Parentheses)

Task Force Sampling	March	April	May	June	October	December
Lake Coeur d'Alene Outlet	14 (14)	33	17	3	18	
Trent Ave.	51		112	64	52	169
Barker Rd.		16 (17)				
Greene St.	67	76	87 (27)	78	135	9
Spokane Gage	64	57	50	63 (52)	207	10
Hangman (Latah) Creek	41	31	19	7	1053	38
Nine Mile	100	68	187	62	105 (118)	59
Idaho Sampling						
Lake Coeur d'Alene Outlet			84		16	
Downstream of Coeur d'Alene			79		15	
Upstream of Post Falls			42		7	
Downstream of Post Falls			12		10	
Cochran Basin Stormwater					5198 (5744)	

3.2 Homolog Distributions

Homolog distributions for all sampling events are shown in Figures 3 through 8, with the data provided in tabular format in Appendix A. Interpretation of these data are provided subsequently in Section 4 of this report. The occurrence in these Figures of two results for a single station in a given month (e.g. Lake Coeur d'Alene outlet in Figure 3) correspond to duplicate field samples.

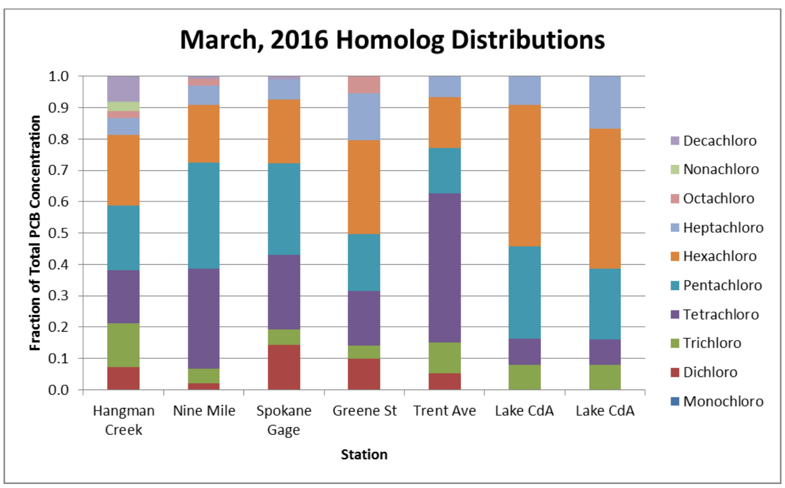

Figure 3. Blank-Corrected Homolog Distributions for March, 2016 Sampling Event

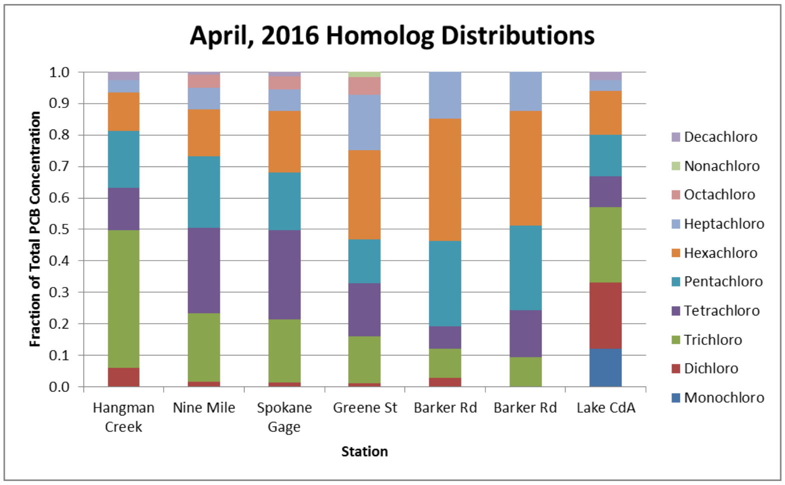

Figure 4. Blank-Corrected Homolog Distributions for April, 2016 Sampling Event

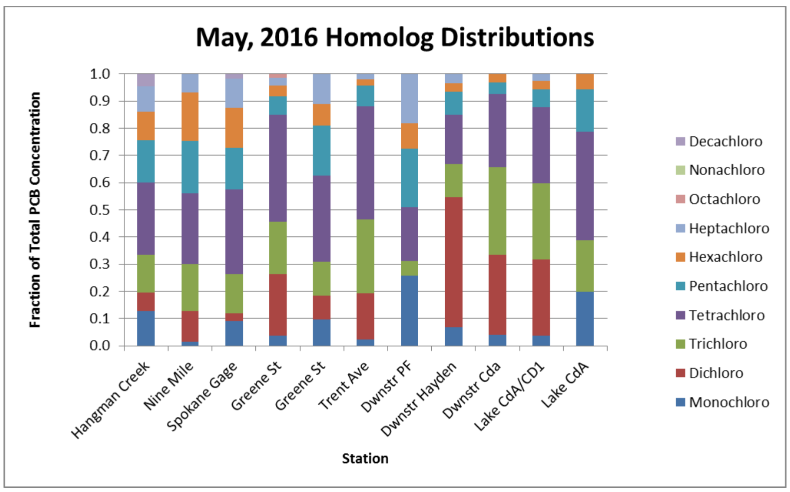

Figure 5. Blank-Corrected Homolog Distributions for May, 2016 Sampling Event

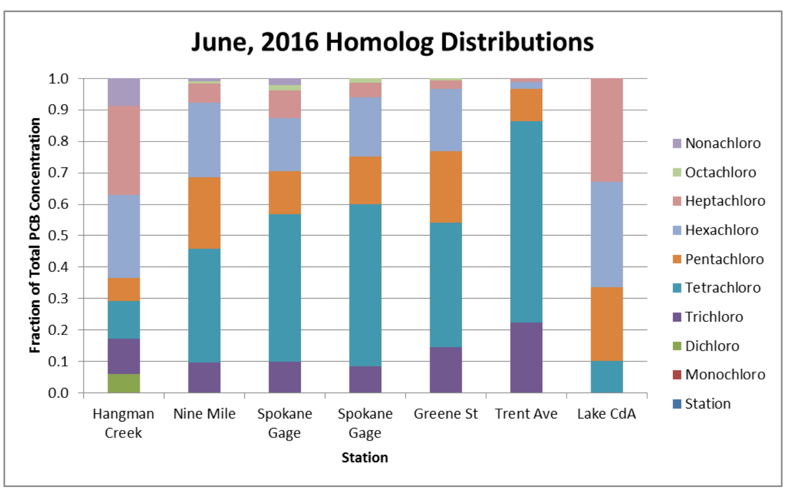

Figure 6. Blank-Corrected Homolog Distributions for June, 2016 Sampling Event

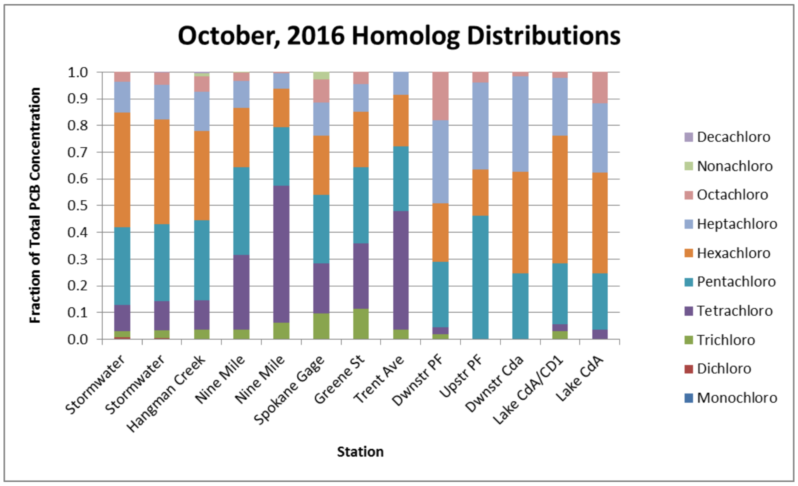

Figure 7. Blank-Corrected River Homolog Distributions for October, 2016 Sampling Event

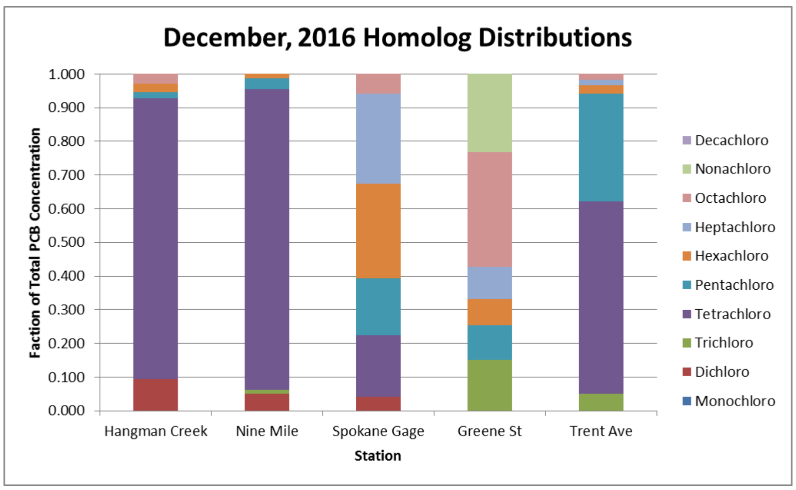

Figure 8. Blank-Corrected Homolog Concentrations for December, 2016 Sampling Event

4 Data Interpretation

The objective of the monthly water quality sampling, as stated in the Quality Assurance Project Plan (LimnoTech, 2016), is to determine the seasonal variability in PCB concentrations in the Spokane River. The concentrations are also reviewed in conjunction with available data on river flow to support a semi-quantitative assessment of PCB loading along the length of the River. This section provides an interpretation of the PCB results provided in Section 3 in term of:

- Seasonal variability
- Loading contributions

4.1 Seasonal variability

The seasonal variability of PCB concentrations are assessed, as well as the relationship of observed concentrations to river flow and wet weather conditions. The seasonal variation in homolog distributions is also discussed.

4.1.1 Total PCBs

In terms of total PCBs, concentrations leaving Lake Coeur d'Alene generally remained below 40 pg/l across all months. For purposes of comparison, confidence testing conducted as part of early Task Force monitoring efforts concluded that concentrations less than 30 pg/l could not be measured with accuracy due to unavoidable laboratory blank contamination (LimnoTech, 2014). The only concentrations above 40 pg/l occurred during the monitoring conducted in May for the Idaho municipalities, where concentrations leaving the lake and immediately downstream of Coeur d'Alene were measured at 79 and 84 pg/l, respectively. These two concentrations may not be fully representative, as three other measured concentrations from similar times and locations (two locations from the same date taken downstream during the Idaho monitoring, and a sample from the same location taken one day earlier from the SRRTTF sampling) were all less than 20 pg/l.

Total PCB concentrations in Washington vary slightly across seasons, and show a weak negative correlation (Figure 9) to observed river flows (Table 2). No seasonal variation was seen in Idaho, as concentration were uniformly low across all months. This negative correlation in Washington is not unexpected, as the river receives many continuous PCB loads, such that higher river flow means more dilution by cleaner upstream water. It is noted that October had the highest observed average PCB concentration, and that October sampling occurred during a period of rainfall. In addition, the PCB concentration in Latah (Hangman) Creek of 1053 pg/l was more than an order of magnitude greater than any other concentration measured at that site during the remaining months. The Latah (Hangman) Creek concentrations show an interesting response to rainfall and flow. The March survey reflected antecedent wet weather conditions in the watershed, with 0.7 inches of rainfall occurring two days prior to the date of sampling. Creek flows were at 1680 cfs for this event, which was roughly an order of magnitude larger than the flows during other sampling events, yet PCB concentrations were only 41 pg/l. In October, where a total of 0.6 inches of rain fell in the day prior and during the event, Creek concentrations were 1053 pg/l, yet Creek flows were only 58 cfs.

The significance of wet weather loading is discussed further in Section 4.2.

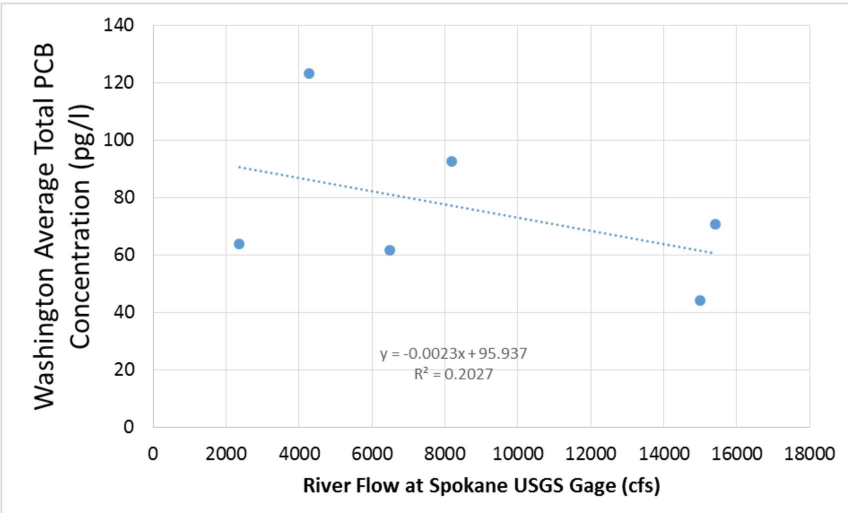

Figure 9. Average Total PCB Concentrations in Washington at Different River Flows

Table 3. Spokane River and Latah Creek Flows (cfs) Observed during 2016 Monthly Monitoring

	3/24	4/19	5/24	6/16	10/26	12/13
Spokane USGS Gage	15400	15000	8180	2360	4280	6480
Latah Creek	1680	178	91	21	58	NA

4.1.2 Homolog Distributions

Some seasonal variability in homolog distributions were observed (shown previously in Figures 3 through 8). March PCB concentrations are dominated by the tetra- through hexa-chloro homologs, while April also shows an equal amount of tri-chloro homologs starting at Greene St. May distributions are dominated by tri- and tetra- chloro homologs, with di-chloro homologs showing a greater presence than any other month. The tetra-chloro homolog dominates in June. October concentrations are mostly comprised of tetra- through hexa-chloro homologs, while December is dominated by the tetra-chloro homolog at three of the five stations sampled. The near absence of the tetra-chloro homolog at the Greene St. and Spokane Gage stations in December, given its preponderance at Trent Ave. and Nine Mile Dam, calls into question the overall representativeness of the December data.

4.2 Loading contributions

4.2.1 Total PCBs

The observed PCB concentrations were combined with available stream flow information to generate instream total PCB loads for each month sampled. The stream flow information used for the loading assessment consisted of both direct flow measurements at the sampling stations and estimation from other USGS gages. The USGS gaging station at the Lake Coeur d'Alene outlet is being replaced, such that direct measurement of flow out of the lake was not available. The USGS measured flows in the Spokane River at Post Falls closely match historically measured flows at the Lake Coeur d'Alene outlet (Figure 10), For this reason, Post Falls flows are used to represent flows out of Lake Coeur d'Alene outlet for purposes of the loading assessment.

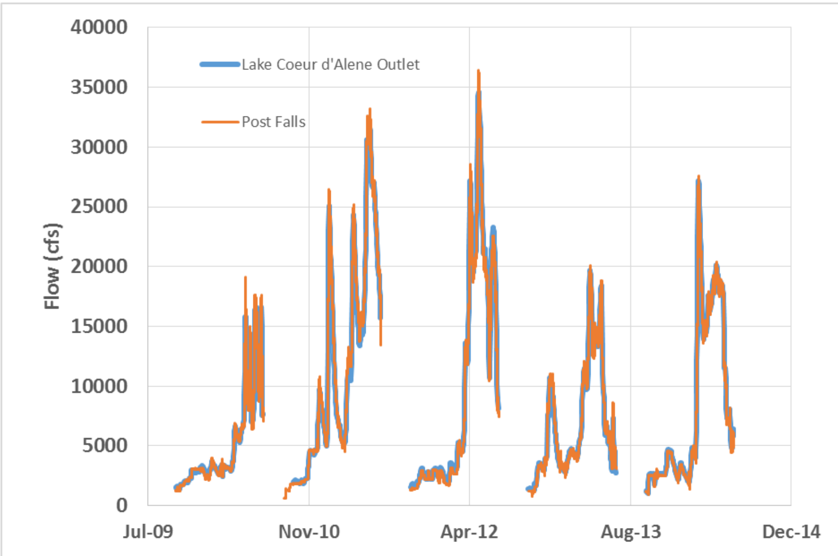

Figure 10. Comparison of Historically Observed October – June Spokane River Flows at Lake Coeur d'Alene Outlet and Post Falls

Similarly, Spokane River flows at Nine Mile Dam were not measured by USGS until July of 2016. Flows have been historically measured by USGS both at the Spokane gage and at the mouth of Latah Creek, and Figure 11 demonstrates that the sum of these two flows closely approximate the flow at Nine Mile Dam for those periods of time when data from all gages are available. As such, the Spokane gage and Latah Creek flows are used to estimate flows at Nine Mile Dam for the monitoring events conducted prior to July.

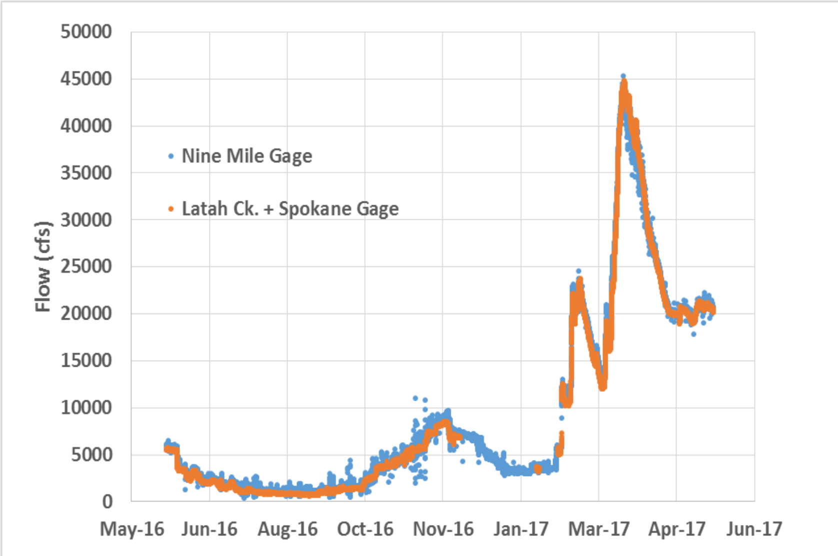

Figure 11. Observed Spokane River Flows at Nine Mile Dam Compared to Sum of Observed Latah Creek and Spokane Gage Flows

The flows used in the mass loading calculations for each month are provided in Table 4.

Table 4. Spokane River and Latah Creek Flows (cfs) Used for Loading Assessment

	3/24	4/19	5/24	6/16	10/26	12/13
Lake Coeur d'Alene	15700*	15100*	8540*	1830*	4340*	NA
Greene St.	15530	15050	8325	2703	4437	6581
Spokane USGS Gage	15400	15000	8180	2360	4280	6480
Latah Creek	1680	178	91	21	58	NA
Nine Mile	17080*	15178*	8271*	2632	4525	7024

*Direct flow measurement not available, estimated from other USGS gages as described above

Graphs showing instream total PCB loads for each month sampled are shown in Figures 12 through 17 below. It should be noted that inference of external loading sources using these observed river loads (as was done for the 2014 and 2015 synoptic surveys) is speculative at best. An accurate mass balance assessment, which estimates loading sources to a river segment as the difference between observed river loads at the downstream and upstream ends of the segment, requires relatively stable flows. In addition, collection of multiple concentration samples are needed to dampen the uncertainty in individual laboratory measurements. These requirements were met during the prior synoptic surveys by conducting the assessment during stable low flows and collecting multiple PCB samples over several days to reduce measurement variability. Given the observed variability in stream flow during the monthly surveys, and collection of a single sample per station, results from any mass balance assessment should be viewed with caution.

Total PCB loads for March (Figure 12) were 500 mg/day leaving Lake Coeur d'Alene, increasing to 2,500 mg/day at Greene St. the Spokane Gage, and further increasing to 4,000 mg/day at Nine Mile Dam. Hangman Creek was a minor contributor (i.e. <5%) to the overall load, despite Creek flows during this event being an order of magnitude larger than the flows in the Creek for any other event.

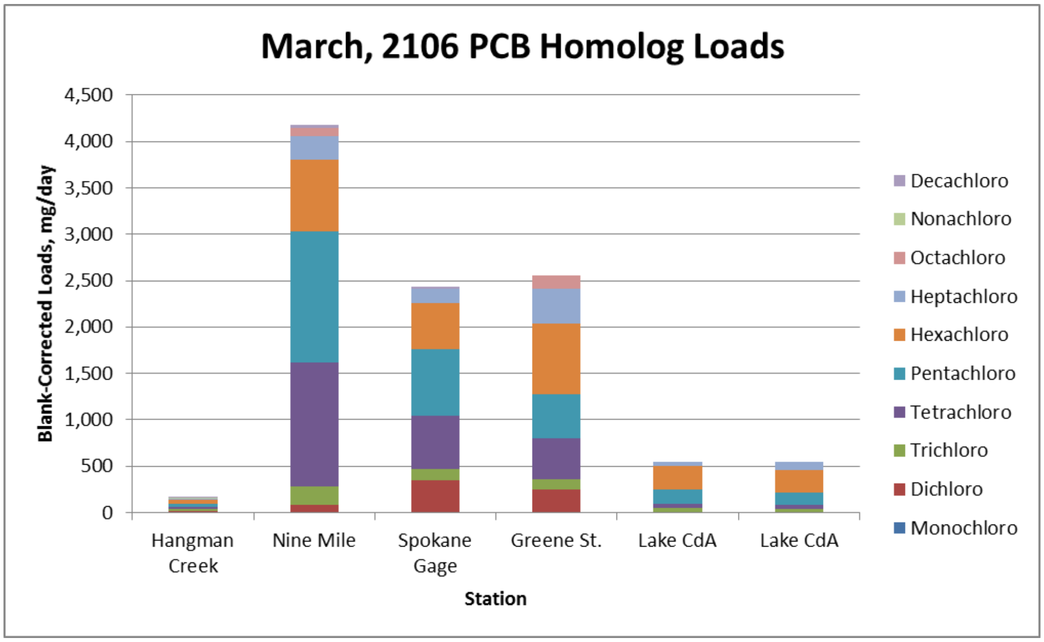

Figure 12. Blank-Corrected Homolog Loads for March, 2016 Sampling Event

Total PCB loads for April (Figure 13) were 1200 mg/day leaving Lake Coeur d'Alene, increasing to 2,100 to 2,700 mg/day at the Greene St., Spokane Gage, and Nine Mile Dam stations. Hangman Creek was again a minor contributor to the overall load.

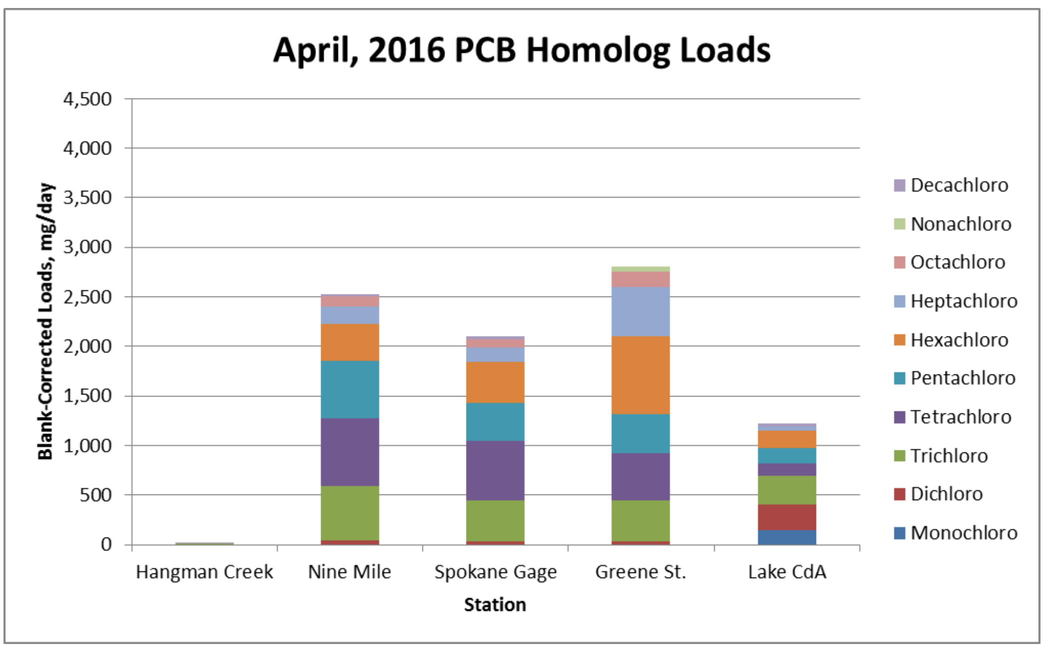

Figure 13. Blank-Corrected Homolog Loads for April, 2016 Sampling Event

Total PCB loads for May (Figure 14) were 400 mg/day leaving Lake Coeur d'Alene, increasing to approximately 1,000 mg/day at Greene St. and the Spokane Gage, and further increasing to 3,700 mg/day at Nine Mile Dam. The Lake Coeur d'Alene load is much less than in prior months, due to a lesser volume of flow leaving the lake. The large load at Nine Mile Dam was due to a measured PCB concentration of 187 pg/l, and it is noted that a single sample may not adequately characterize actual concentrations. Hangman Creek was again a minor contributor to the overall load.

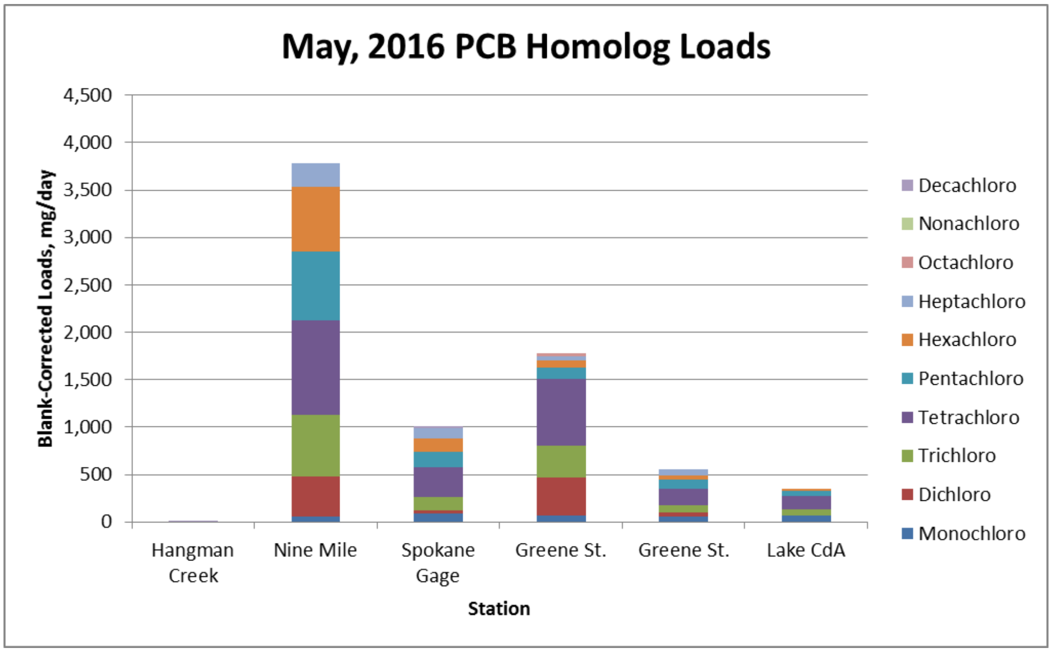

Figure 14 Blank-Corrected Homolog Loads for May, 2016 Sampling Event

Total PCB loads for June (Figure 15) were 20 mg/day leaving Lake Coeur d'Alene, increasing to 300 to 500 mg/day at the Greene St., Spokane Gage, and Nine Mile Dam locations. The load leaving Lake Coeur d'Alene continued its seasonal decline, in response to a continued decrease in the volume of water leaving the lake.

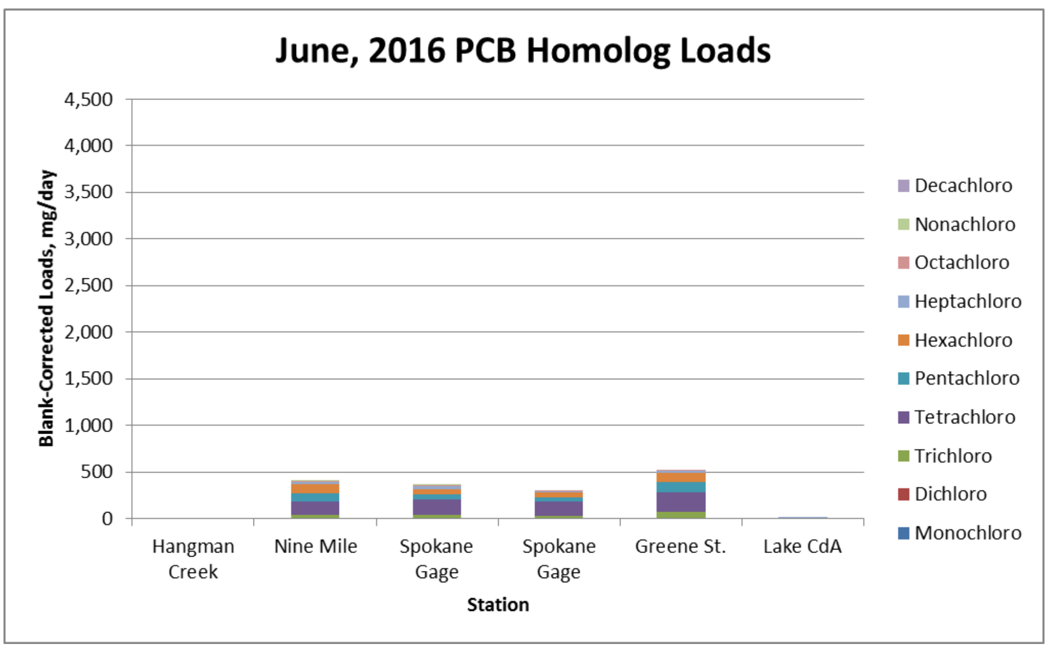

Figure 15. Blank-Corrected Homolog Loads for June, 2016 Sampling Event

Total PCB loads for October (Figure 16) were 200 mg/day leaving Lake Coeur d'Alene, increasing to 1500 mg day at Greene St. and 2,200 mg/day at the Spokane Gage, and decreasing to 1,100 to 1,300 mg/day at Nine Mile Dam. Stormwater loads were calculated using observed concentrations from the Cochran basin, and an estimated total stormwater flow calculated from observed Cochran flow times the ratio of total impervious cover to impervious cover in the Cochran basin. Loads from both stormwater and Hangman Creek are seen to be relatively minor contributors to the overall load. The City of Spokane also measured combined sewer overflow (CSO) discharge volume during the October event. This CSO volume, when combined with historically observed CSO PCB concentrations, results in a loading estimate of 1160 mg/day. The estimated amount of wet weather loading is roughly consistent with the observed increase in instream loads. It is noted that, while a CSO outfall exists in the Hangman Creek basin, flow monitoring conducted by the City of Spokane indicated that the CSO did not discharge during the event.

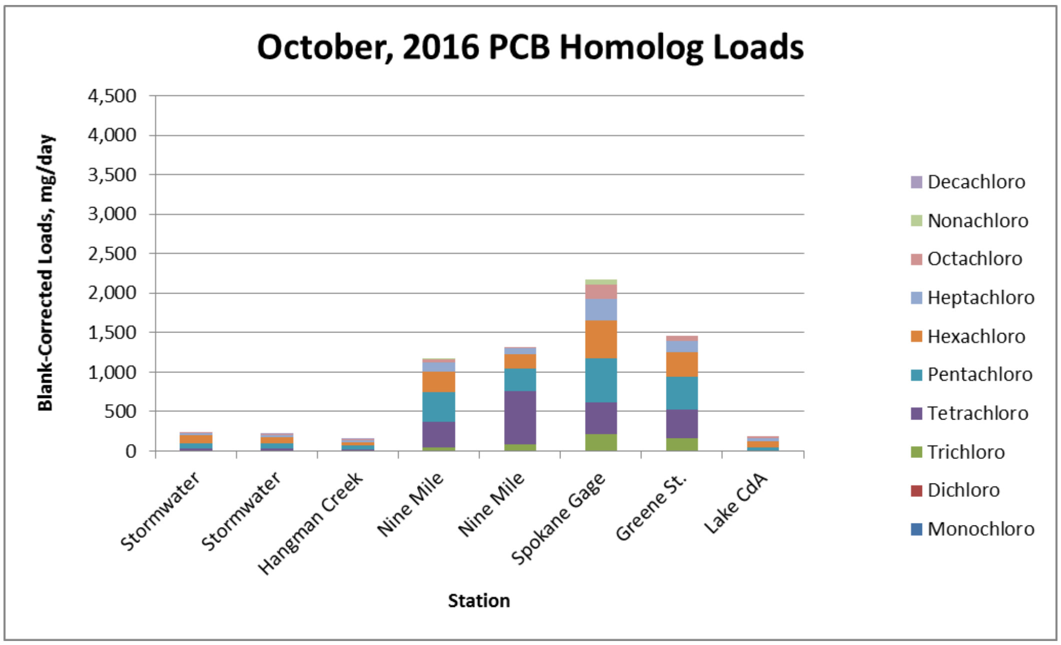

Figure 16. Blank-Corrected Homolog Loads for October, 2016 Sampling Event

Total PCB loads for December (Figure 17) were 150 mg/day at the Greene St. and Spokane Gage stations increasing to 900 mg/day at Nine Mile Dam. This is a much lower load than seen in any other month at these stations, corresponding to the extremely low measured PCB concentrations (9 and 10 pg/l). Given the previously discussed difficulty in measuring concentrations below 30 pg/l, these loads may not be representative. The total PCB estimate at Nine Mile Dam is much more strongly influenced by the tetrachloro homolog than any previous Nine Mile Dam sample, and also may not be representative. No concentration data were available for Lake Coeur d'Alene in December, nor was flow information available for Hangman Creek.

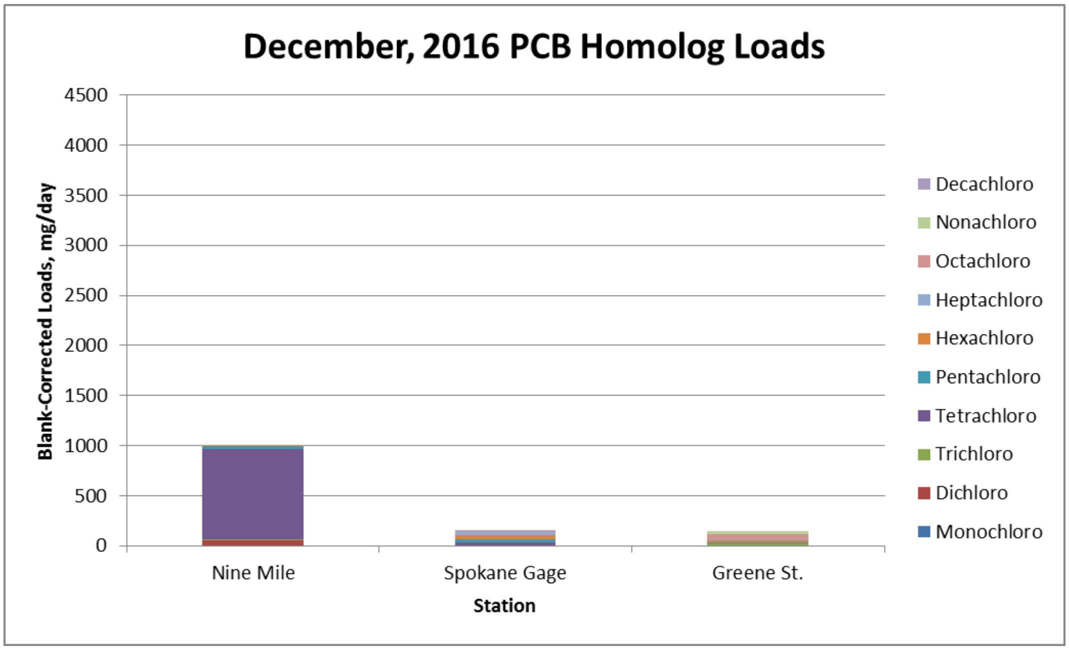

Figure 17. Blank-Corrected Homolog Loads for December, 2016 Sampling Event

4.2.2 Homologs

The observed PCB homolog distributions were combined with available USGS stream flow information to generate graphs of homolog loads for each month sampled, shown previously in Figures 12 through 17. Similar to the caveat given above in Section 4.2.1 for total PCBs, the inference of external homolog loading sources using these observed river loads is speculative at best.

In March and April, the increase in loads between Lake Coeur d'Alene and the Spokane Gage were primarily in the form of tetra- and penta-chloro homologs. In May, June, and October, tri- and hexa-chloro homologs also showed a noticeable increase in addition to the increases in tetra- and penta-chloro homologs. Little information can be gained from December results, given the absence of a Lake Coeur d'Alene sample and dominance of the tetrachloro homolog at Nine Mile dam.

The homolog distribution for the elevated October, 2016 Latah Creek PCB concentration was compared to homolog distributions for the October, 2016 stormwater sample, as well as to homolog distributions for the most for the most commonly produced Aroclor mixtures. A strong similarity is seen between the Latah Creek and stormwater homolog distributions (Figure 18), implying that stormwater may be the source of the elevated concentration in Latah Creek. No strong similarity was seen between stormwater and any individual Aroclor, with the homolog distributions for Latah Creek and stormwater being the most similar to an even mix of Aroclors 1254 and 1260.

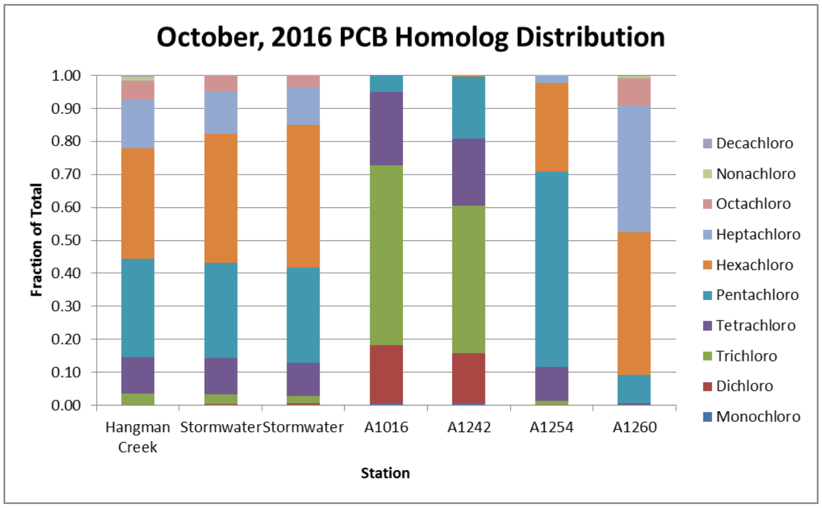

Figure 18. Homolog Distributions for Hangman Creek and Stormwater for October, 2016 Sampling Event, Compared to Distributions for Most Commonly Produced Aroclors.

4.2.3 Conclusions and Recommended Next Steps

The following conclusions can be gathered from the data collected and analyses conducted:

- River PCB concentrations remain less than 40 pg/l during all months at the outlet of Lake Coeur d'Alene, with only one exception. Despite these relatively low concentrations, the resulting load leaving the lake can exceed 1000 mg/day during peak spring flows.
- PCB concentrations tend to increase downstream as the river passes through the Spokane metropolitan area. The amount of increase varies seasonally in response to river flow, with lower river flows generally leading to larger increases in concentration.
- October river concentrations near Spokane were slightly higher than in other months, in conjunction with wet weather conditions. Data collected by the City of Spokane during this event suggest that the City's stormwater is a relatively small contributor to these increased concentrations, while historical combined sewer overflow (CSO) data suggest that CSO loads are of a magnitude consistent with the observed increase in concentration.
- An observed PCB concentration greater than 1000 pg/l at the mouth of Hangman (Latah) Creek during wet weather indicates the potential presence of a PCB loading source to this watershed. The homolog pattern for this sample closely matched the homolog pattern seen in Cochran Basin stormwater. While this load is sufficient to cause high concentration in the Creek, its effect on the Spokane River was small due to the small amount flow in the Creek at the time the sample was taken.

Recommended next steps should consider the fact that this study provides only a relatively brief snapshot of one sample per month at six stations for six months, Additional monitoring would be required, should the Task Force desire a deeper understanding of the following issues:

- <u>Seasonal variability of concentrations leaving Lake Coeur d'Alene.</u> Two December samples collected in December, 2016 near Coeur d'Alene showed total PCB concentrations on the order of 80 pg/l. An insufficient number of samples exist to determine whether these samples reflect actual higher concentrations occasionally leaving the lake, or whether they are measurement anomalies.

- River mass balance assessments to infer external loads. The loading assessments provided in this report are characterized as "speculative at best", due to the limited amount of data available relative to what is needed to characterize loads with any degree of confidence.

It should be noted the above issues are not easily addressed. Given the existing monitoring and analytical protocol, it will be difficult to define the variability in concentrations leaving Lake Coeur d'Alene when they are 30 pg/l or less. With respect to mass loading assessments, a prohibitively large number of samples may be required to estimate loads for conditions other than summer low flows. Decisions to conduct additional monitoring should, as always, weigh the information to be gained from such monitoring against the cost of the monitoring.

5 References

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Appendix A: Synoptic Survey Results - PCBs by Homolog and Conventional Parameters

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Table A-1: Blank-Corrected Analytical Results for Lake Coeur d'Alene Outlet							
Station SR15	March		April	May	June	October	December
Total PCBs (pg/l)	14.279	14.213	32.978	16.818	3.029	17.783	na
Total Monochloro Biphenyls (pg/l)	0	0	4.01	3.318	0	0	na
Total Dichloro Biphenyls (pg/l)	0	0	6.95	0	0	0	na
Total Trichloro Biphenyls (pg/l)	1.153	1.142	7.857	3.196	0	0	na
Total Tetrachloro Biphenyls (pg/l)	1.168	1.15	3.271	6.744	0.31	0.653	na
Total Pentachloro Biphenyls (pg/l)	4.228	3.196	4.286	2.597	0.711	3.734	na
Total Hexachloro Biphenyls (pg/l)	6.42	6.333	4.613	0.963	1.015	6.72	na
Total Heptachloro Biphenyls	1.31	2.392	1.13	0	0.993	4.584	na
Total Octachloro Biphenyls (pg/l)	0	0	0	0	0	2.092	na
Total Nonachloro Biphenyls (pg/l)	0	0	0	0	0	0	na
Total Decachloro Biphenyls (pg/l)	0	0	0.861	0	0	0	na
Total Dissolved Solids (mg/l)	56	47	32	31	40	26	47
Total Suspended Solids (mg/l)	<5	<5	<5	<5	<5	<5	<5
Total Organic Carbon (mg/l)	2	1.8	2.02	1.7	1.44	1.62	1.69
Dissolved Organic Carbon (mg/l)	1.89	1.9	1.94	2.31	1.46	1.53	2.1

Table A-2: Blank-Corrected Analytical Results for Spokane River Below Trent Bridge							
Station SR7	March	April*		May	June	October	December
Total PCBs (pg/l)	51.458	15.796	16.926	111.832	64.498	52.29	168.778
Total Monochloro Biphenyls (pg/l)	0	0	0	2.634	0	0	0
Total Dichloro Biphenyls (pg/l)	2.654	0.437	0	18.834	0	0	0
Total Trichloro Biphenyls (pg/l)	5.159	1.466	1.601	30.411	14.43	1.835	8.724
Total Tetrachloro Biphenyls (pg/l)	24.382	1.118	2.499	46.448	41.222	23.211	96.386
Total Pentachloro Biphenyls (pg/l)	7.509	4.282	4.572	8.615	6.705	12.688	53.648
Total Hexachloro Biphenyls (pg/l)	8.301	6.15	6.17	2.65	1.377	10.142	4.333
Total Heptachloro Biphenyls (pg/l)	3.453	2.343	2.084	2.24	0.764	4.414	2.786
Total Octachloro Biphenyls (pg/l)	0	0	0	0	0	0	2.901
Total Nonachloro Biphenyls (pg/l)	0	0	0	0	0	0	0
Total Decachloro Biphenyls (pg/l)	0	0	0	0	0	0	0
Total Dissolved Solids (mg/l)	51	34	32	39	88	44	53
Total Suspended Solids (mg/l)	<5	<5	<5	<5	<5	<5	<5
Total Organic Carbon (mg/l)	1.87	2.22	2.16	1.66	1.06	1.54	1.53

Table A-2: Blank-Corrected Analytical Results for Spokane River Below Trent Bridge							
Station SR7	March	April*		May	June	October	December
Dissolved Organic Carbon (mg/l)	1.86	2.1	1.93	1.8	1.13	1.3	1.84

* April samples for station SR7 actually taken at Barker Rd.

Table A-3: Blank-Corrected Analytical Results for Spokane River Below Greene Street							
Station SR4	March	April	May		June	October	December
Total PCBs (pg/l)	67.107	75.974	87.119	27.278	77.583	134.73	9.13
Total Monochloro Biphenyls (pg/l)	0	0	3.101	2.643	0	0	0
Total Dichloro Biphenyls (pg/l)	6.614	0.806	19.8	2.355	0	0.363	0
Total Trichloro Biphenyls (pg/l)	2.894	11.3	16.7	3.437	11.318	14.862	1.37
Total Tetrachloro Biphenyls (pg/l)	11.596	12.96	34.472	8.65	30.668	32.953	0
Total Pentachloro Biphenyls (pg/l)	12.296	10.56	5.936	4.994	17.715	38.407	0.943
Total Hexachloro Biphenyls (pg/l)	20.036	21.471	3.35	2.199	15.218	28.279	0.725
Total Heptachloro Biphenyls (pg/l)	9.999	13.377	2.55	3	2.218	13.934	0.862
Total Octachloro Biphenyls (pg/l)	3.672	4.18	1.21	0	0.446	5.929	3.11
Total Nonachloro Biphenyls (pg/l)	0	1.32	0	0	0	0	2.12
Total Decachloro Biphenyls (pg/l)	0	0	0	0	0	0	0
Total Dissolved Solids (mg/l)	53	44	41	49	94	48	58
Total Suspended Solids (mg/l)	<5	<5	<5	<5	<5	<5	<5
Total Organic Carbon (mg/l)	1.84	2.11	1.61	1.71	1.2	1.54	1.86
Dissolved Organic Carbon (mg/l)	2.01	1.94	1.7	1.67	1.28	1.53	1.86

Table A-4: Blank-Corrected Analytical Results for Spokane River USGS Gage at Spokane							
Station SR3	March	April	May	June		October	December
Total PCBs (pg/l)	64.498	57.244	50.441	62.561	51.993	206.85	10.056
Total Monochloro Biphenyls (pg/l)	0	0	4.593	0	0	0	0
Total Dichloro Biphenyls (pg/l)	9.207	0.812	1.41	0	0	0	0.417
Total Trichloro Biphenyls (pg/l)	3.193	11.412	7.333	6.218	4.393	19.789	0
Total Tetrachloro Biphenyls (pg/l)	15.372	16.27	15.599	29.387	26.848	38.932	1.83
Total Pentachloro Biphenyls (pg/l)	18.888	10.454	7.821	8.527	7.885	53.043	1.706
Total Hexachloro Biphenyls (pg/l)	13.1	11.203	7.314	10.599	9.776	45.602	2.835
Total Heptachloro Biphenyls (pg/l)	4.103	3.874	5.445	5.499	2.429	25.964	2.683
Total Octachloro Biphenyls (pg/l)	0	2.454	0	0.961	0.662	17.588	0.585
Total Nonachloro Biphenyls (pg/l)	0	0	0	1.37	0	5.937	0
Total Decachloro Biphenyls (pg/l)	0.635	0.765	0.926	0	0	0	0
Total Dissolved Solids (mg/l)	55	41	46	103	92	52	57, 57
Total Suspended Solids (mg/l)	<5	<5	<5	<5	<5	<5	<5, <5
Total Organic Carbon (mg/l)	1.88	2.05	1.72	1.18	1.15	1.65	1.55, 1.58

Dissolved Organic Carbon (mg/l)	2	1.88	2.36	1.29	1.2	1.51	1.75, 1.95

Table A-5: Blank-Corrected Analytical Results for Hangman (Latah) Creek Mouth						
Station HC1	March	April	May	June	October	December
Total PCBs (pg/l)	41.005	31.361	18.836	6.747	1053.4	37.986
Total Monochloro Biphenyls (pg/l)	0	0	2.377	0	0	0
Total Dichloro Biphenyls (pg/l)	2.953	1.873	1.3	0.411	0.737	3.592
Total Trichloro Biphenyls (pg/l)	5.774	13.764	2.613	0.757	36.443	0
Total Tetrachloro Biphenyls (pg/l)	6.929	4.187	5.027	0.806	116.58	31.65
Total Pentachloro Biphenyls (pg/l)	8.421	5.697	2.93	0.485	314.05	0.662
Total Hexachloro Biphenyls (pg/l)	9.25	3.777	1.941	1.782	352.26	0.968
Total Heptachloro Biphenyls (pg/l)	2.255	1.227	1.798	1.924	156.95	0
Total Octachloro Biphenyls (pg/l)	0.853	0	0	0	59.03	1.114
Total Nonachloro Biphenyls (pg/l)	1.27	0	0	0.582	13.18	0
Total Decachloro Biphenyls (pg/l)	3.3	0.836	0.85	0	4.12	0
Total Dissolved Solids (mg/l)	165	145	183	212	201	167
Total Suspended Solids (mg/l)	59	<5	<5	<5	5	<5
Total Organic Carbon (mg/l)	6.83	5.8	4.24	3.94	8.44	5.23
Dissolved Organic Carbon (mg/l)	7.14	5.6	5.12	3.72	6.51	5.63

Table A-6: Blank-Corrected Analytical Results for Spokane River Below Nine Mile Dam							
Station SR1	March	April	May	June	October		December
Total PCBs (pg/l)	99.831	68.077	186.882	62.33	104.75	118.3	58.616
Total Monochloro Biphenyls (pg/l)	0	0	2.856	0	0	0	0
Total Dichloro Biphenyls (pg/l)	2.085	1.179	21.1	0	0	0	2.93
Total Trichloro Biphenyls (pg/l)	4.691	14.667	31.888	5.981	3.737	7.444	0.771
Total Tetrachloro Biphenyls (pg/l)	31.789	18.54	48.861	22.52	29.307	60.72	52.3
Total Pentachloro Biphenyls (pg/l)	33.9	15.437	36.125	14.247	34.461	25.89	1.82
Total Hexachloro Biphenyls (pg/l)	18.308	10.111	33.48	14.707	23.3	16.79	0.795
Total Heptachloro Biphenyls (pg/l)	6.127	4.671	12.572	3.814	10.315	6.958	0
Total Octachloro Biphenyls (pg/l)	2.077	2.82	0	0.491	3.36	0.481	0
Total Nonachloro Biphenyls (pg/l)	0	0	0	0.57	0.266	0	0
Total Decachloro Biphenyls (pg/l)	0.854	0.652	0	0	0	0	0
Total Dissolved Solids (mg/l)	69	42	49	112	63	83	53
Total Suspended Solids (mg/l)	6	<5	<5	<5	<5	<5	<5
Total Organic Carbon (mg/l)	2.16	2.04	1.69	1.36	1.54	1.54	1.54
Dissolved Organic Carbon (mg/l)	2.3	1.86	1.74	1.25	1.46	1.44	1.89

Table A-7: Blank-Corrected Analytical Results for Cochran Basin Stormwater		
	October	October
Total PCBs (pg/l)	5197.81	5744.02
Total Monochloro Biphenyls (pg/l)	10.12	11.51
Total Dichloro Biphenyls (pg/l)	12.1	22.4
Total Trichloro Biphenyls (pg/l)	145.79	132.51
Total Tetrachloro Biphenyls (pg/l)	580.84	576.98
Total Pentachloro Biphenyls (pg/l)	1492.6	1657.7
Total Hexachloro Biphenyls (pg/l)	2036.37	2475.1
Total Heptachloro Biphenyls (pg/l)	673.55	656.41
Total Octachloro Biphenyls (pg/l)	234.64	211.41
Total Nonachloro Biphenyls (pg/l)	0	0
Total Decachloro Biphenyls (pg/l)	11.8	0

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Appendix B:
Gravity Report

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Appendix C: Quality Assurance Project Plan

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Appendix D: Laboratory Results

Provided separately as electronic spreadsheets

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