Spokane River PCBs and Other Toxics at the Spokane Tribal Boundary

Recommendations for Developing a Long-Term Monitoring Plan

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Cover photo: Little Falls Pool looking upstream from the Union Gospel Mission dock. (Photo by Brandee Era-Miller).

Spokane River
PCBs and Other Toxics
at the Spokane Tribal Boundary

Recommendations for Developing a Long-Term Monitoring Plan

by

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Abstract

The Washington State Department of Ecology conducted seasonal monitoring for toxic contaminants in the Spokane River at the eastern Spokane Tribal boundary during 2015 – 2016. This monitoring area is downstream of all known sources of PBDEs, PCBs, and metals (cadmium, copper, lead, and zinc). Toxics monitoring was conducted to provide recommendations for establishing a long-term monitoring program for the site.

Surface water and suspended sediment samples were taken during the three major hydraulic river regimes: spring high flow, summer low flow, and winter moderate flow. The samples were analyzed for PCBs, PBDEs, dioxins/furans, and metals (cadmium, copper, lead, and zinc). Three collection and extraction techniques were used to ensure detection of PCBs and PBDEs in surface water: CLAM (Continuous Low-level Aqueous Monitoring device), XAD-2, and liquid-liquid extraction with two-liter composite samples. Suspended sediments were collected with sediment traps deployed for four months at a time.

Recommendations were made to continue long-term monitoring in the Spokane River at the eastern Spokane Tribal boundary site, with minor changes in collection techniques and toxic parameters to consider for analysis.

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Introduction

This study established recommendations for a long-term toxics monitoring station on the mainstem Spokane River at the eastern Spokane Tribal boundary. The monitored parameters were polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), dioxins/furans, and metals (cadmium, copper, lead, and zinc). Data from the study will be used to inform and design a long-term monitoring program for the upstream Spokane Tribal boundary site.

Specific objectives for this project include:

- Characterize toxic chemicals (toxics) in surface water and suspended sediments in the Spokane River at the Spokane Tribal boundary during the three hydrologic regimes: spring high flow, summer low flow and winter moderate flow.
- Use data from the study to support (1) development of standard operating procedures (SOPs) for use of the Continuous Low-level Aqueous Monitoring device (CLAM) and (2) another Washington State Department of Ecology (Ecology) study: *Assessment Methods for Sampling Low-Level Toxics in Surface Waters* (Hobbs and McCall, 2016). The goal of the low-level toxics study is to characterize the precision and accuracy of different high-volume collection methods for use with low-level analytical methods such as the EPA 1600 series methods, with special focus on PCBs.

Background

The federal Clean Water Act, adopted in 1972, has as its interim goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water" wherever attainable. Development and implementation of Washington State water quality standards is a key step in achieving this goal.

Multiple reaches of the Spokane River do not meet Washington State surface water quality standards. These reaches have been placed on the impaired waters 303(d) list for PCBs, dioxins/furans and metals (see Appendix A for all 303(d) listings for toxics parameters in the Spokane River). There are elevated levels of other toxics including PBDEs and metals. In 2009 the Washington State Department of Health (DOH) issued a fish consumption advisory, recommending limiting the amount of fish eaten from the river due to the levels of PCBs and PBDEs.

To address impairments for metals, a Total Maximum Daily Load (TMDL; water cleanup plan) was developed for dissolved cadmium, lead, and zinc in 1999 (Butkus and Merrill, 1999). The Spokane River Regional Toxics Task Force (SRRTTF) was created in 2012 to lead the effort to find and reduce PCBs in the Spokane River (http://srrttf.org/).

A number of studies and cleanup activities have occurred and are ongoing to address contamination in the Spokane River watershed (Serdar et al., 2011). The majority of these have focused on the upstream portion of the river, where known contamination exists. For the purposes of this document, "upstream Spokane River" refers to areas upstream of Lake Spokane.

The monitoring location for this study is located in Little Falls Pool, a 5-mile section of the Spokane River downstream of Lake Spokane between Long Lake Dam and Little Falls Dam (Figure 1). There is a lack of toxics monitoring data for this 5-mile section of the river. The Spokane Tribal water quality standards apply at the confluence with Chamokane Creek. The Spokane Tribal water quality standards differ from the Washington State's Human Health and Aquatic Life water quality criteria. For example, the total PCB criterion in water for the protection of Human Health for the Spokane Tribe of Indians is 1.3 pg/L while Washington's Human Health total PCB criterion is 7 pg/L.

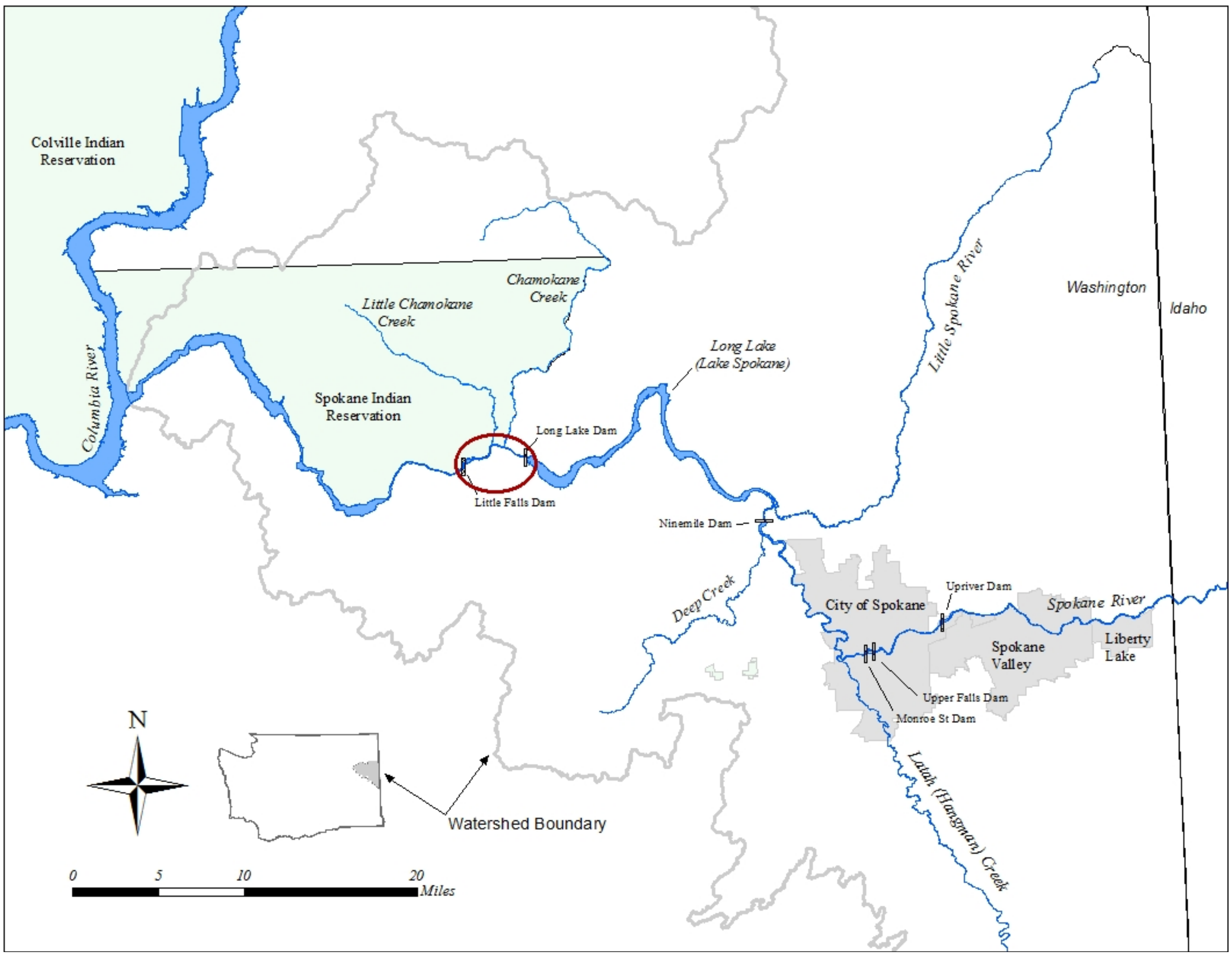


Figure 1. Spokane River Watershed within Washington State.
Little Falls Pool circled.

Results from Ecology's *Freshwater Fish Tissue Contaminant Monitoring Program* indicate that concentrations of PCBs and PBDEs in Spokane River fish from 2012 were much lower in Little Falls Pool compared to all other monitoring locations upstream (Seiders et al., 2014). Another Ecology study showed that surficial sediments collected in 2003-2004 in Little Falls Pool were lower for PCBs than upstream monitoring sites (Serdar et al., 2011). Figure 2 shows the surficial sediment organic carbon-normalized total PCB concentrations. Because of the lower PCBs in fish and sediments in Little Falls Pool, surface water concentrations for PCBs and other toxics in Little Falls Pool were unknown but expected to be lower than areas upstream.

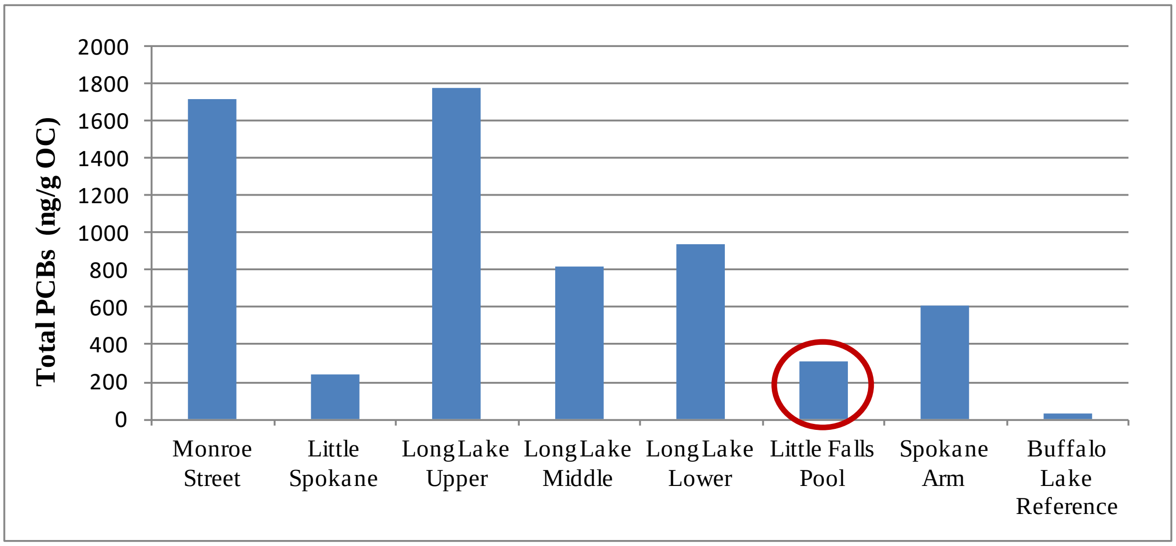


Figure 2. Organic Carbon Normalized Total PCBs in Spokane River Surficial Sediments.

Challenge of Measuring Low-Level Organics in Ambient Waters

PCBs are generally difficult to measure with certainty at the concentrations found in most ambient water bodies in Washington State. The Spokane River is no exception, especially in Little Falls Pool where surface water PCB concentrations are likely to be low relative to upstream.

Even when detected in surface water, PCBs are often detected in comparable concentrations in the laboratory method blanks and field blanks associated with the sampling event. Determining the environmental concentration above the sampling system noise (which includes both possible contamination from the analytical laboratory as well as from collection techniques) can prove challenging.

Results from the 2014 and 2015 Spokane River synoptic surveys and mass balance assessments conducted by Limnotech for SRRTTF were considered to be 'semi-quantitative' due to significant variability in the data resulting from low levels of PCB in the river and relatively high levels of PCBs found in the lab blanks and transfer blanks (Limnotech, 2014, 2015, 2016). The grab samples for the surveys were collected via direct immersion where the lid to the sample container is opened and the container filled under water to avoid contamination from contact with the ambient air.

Special collection methods such as CLAM and XAD-2 can be used to pre-concentrate PCBs and other organics by filtering high volumes of water (20 – 40 liters) through media that sorb both the particulate and dissolved fractions, effectively concentrating all of the organic chemical. If ambient concentrations of a chemical are low, concentrating the chemical can lead to more detections. However, similar to grab sample collection, pre-concentration collection methods can contribute contamination to samples. In some cases, the collection equipment can be a major source of contamination. A recent study conducted by King County found that the silicone tubing used for auto sampling contributed significant PCB contamination to surface water samples analyzed for PCBs (Williston et al., 2016).

In summary, unless a given sampling system has been thoroughly tested to show that it is contaminant free, the environmental results generated through the sampling system should be considered qualitative or semi-quantitative, but not quantitative.

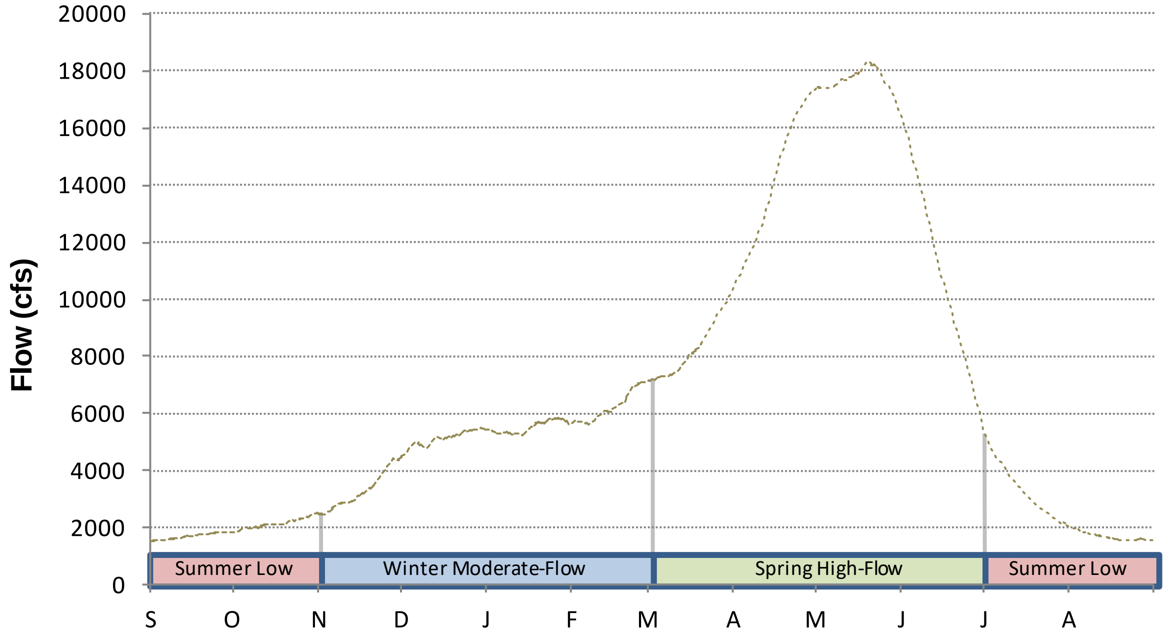
Study Area

The Spokane River begins in Idaho at the outlet of Lake Coeur d'Alene and flows west 112 miles to the Columbia River. The Spokane River watershed encompasses over 6,000 square miles in Washington and Idaho (Serdar et al., 2011). The river flows through the smaller cities of Post Falls and Coeur d'Alene in Idaho and through large urban and industrial areas in the Spokane Valley and the city of Spokane in Washington. The Spokane Tribe of Indians Reservation encompasses the north bank of the lower Spokane River from Chamokane Creek, below Long Lake Dam, downstream to the Columbia River confluence.

The Spokane River sits atop the western portion of the Spokane Valley-Rathdrum Prairie Aquifer. There is significant interchange between the river and the aquifer. The river is the largest contributor to the aquifer (49% of aquifer inflow) but is also the largest recipient of aquifer water at about 58% of aquifer outflow (MacInnis et al., 2009).

The Spokane River has seven major dams. From upstream to downstream, they are:
Post Falls Dam, Upriver Dam, Upper Falls Dam, Monroe Street Dam, Nine Mile Dam,
Long Lake Dam, and Little Falls Dam.

The Spokane River watershed is located in a transition area between the barren scablands of the Columbia Basin to the west, coniferous forests and mountainous regions to the north and east, and prairie lands to the south. Spokane receives 16.5 inches of rain annually on average. Spring snowmelt dominates flows in the Spokane River from April through June as shown in Figure 3.



Flows taken from USGS real-time water data station 12422500 Spokane River at Spokane(http://waterdata.usgs.gov/wa/nwis/rt). Data was calculated from 119 years of data (1890 - 2010).

Figure 3. Historical Average Annual Flow for the Spokane River near the City of Spokane.

Study Design and Methods

During 2015-2016 surface water and suspended sediments were collected from Little Falls Pool near the upstream boundary of the Spokane Tribe Reservation. The Tribe's water quality standards become applicable to the Spokane River at this site. Little Falls Pool is the 5-mile section of the Spokane River between Long Lake Dam and Little Falls Dam. Ecology collected surface water samples from the Union Gospel Mission (UGM) dock (right bank), and the sediment traps were placed just upstream along the left bank as shown in Figure 4.

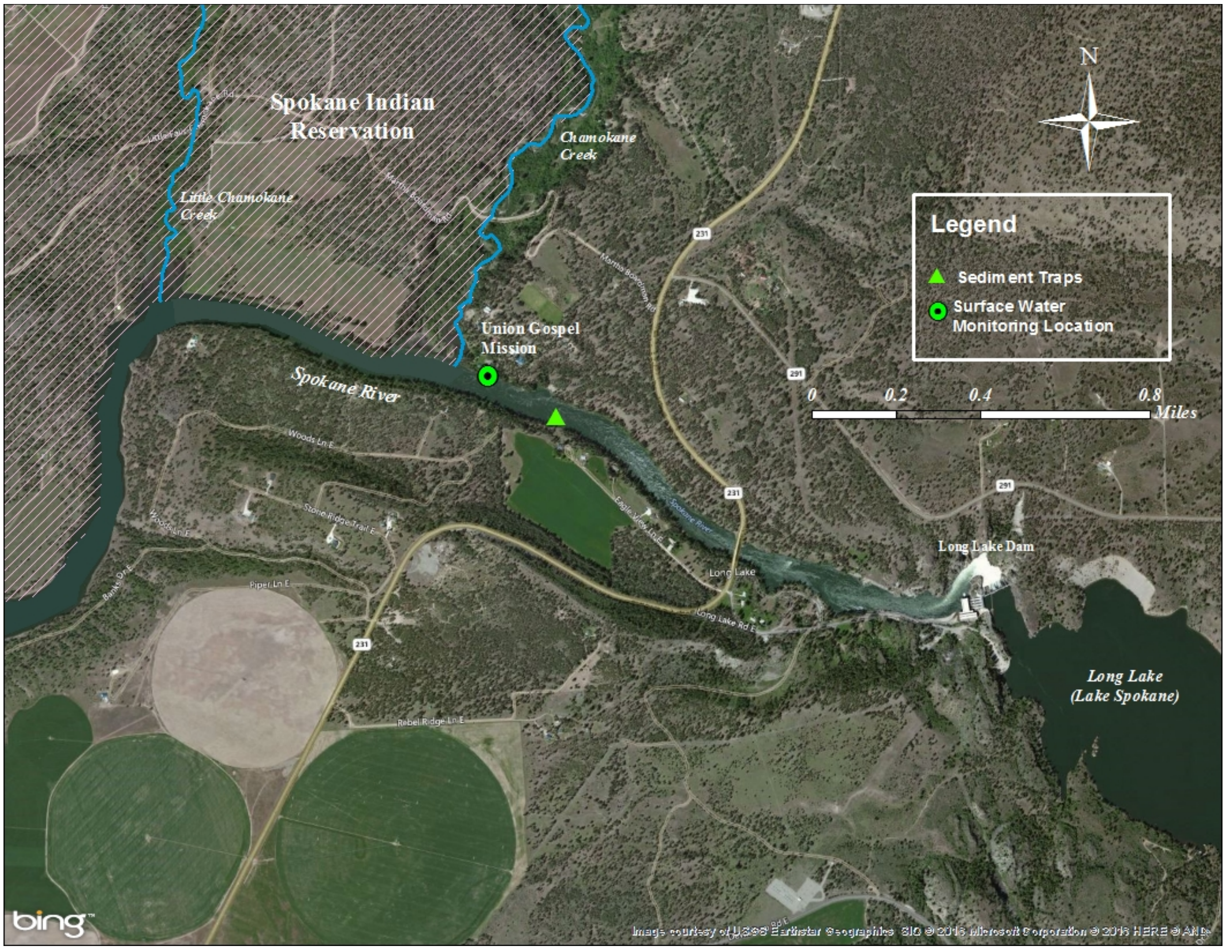


Figure 4. Monitoring Locations for the Study.

Surface water and suspended sediments were collected following the monitoring plan described in the Quality Assurance (QA) Project Plan for the study (Era-Miller, 2015). Samples were collected during three separate monitoring events in order to cover each of the three major flow regimes in the Spokane River: spring high flow, summer low flow, and winter moderate flow. Figure 5 shows the surface water monitoring events overlaid onto the sediment trap deployment periods. Sediment traps were deployed for about 4.5 months each from late spring 2015 through early summer 2016. Surface water samples were taken over a 24-hour period during each event and were comprised of both composite and grab samples.

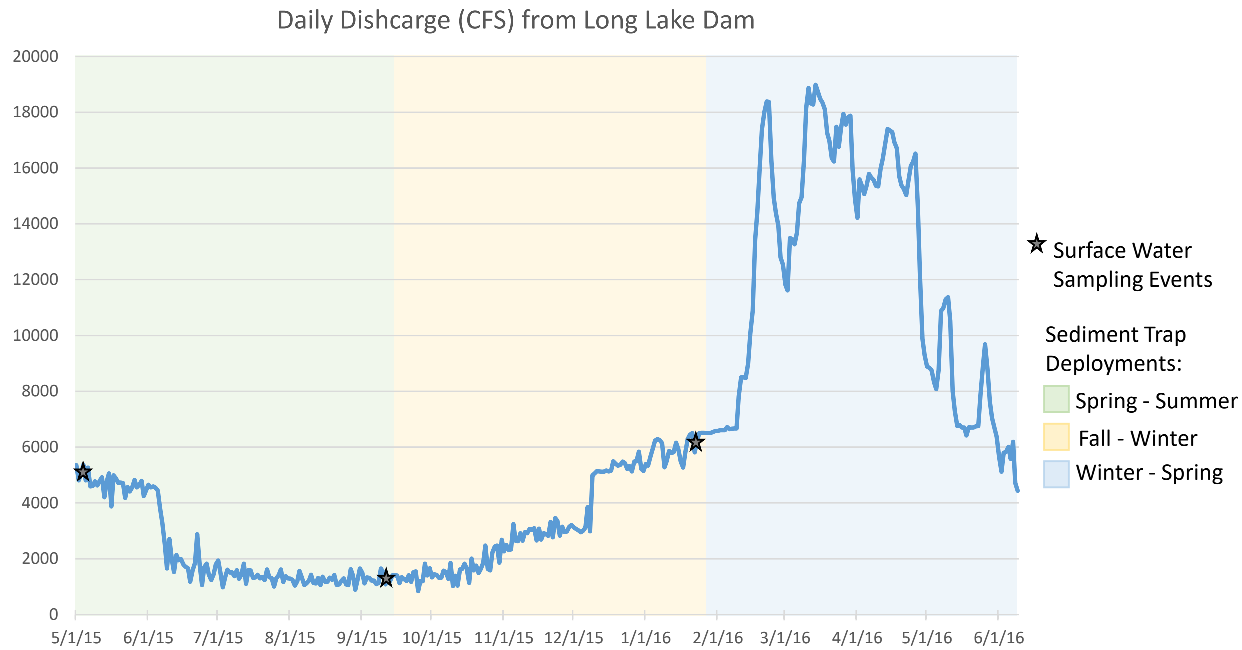


Figure 5. Sampling Events and Daily Discharge (cfs) in Little Falls Pool.
Discharge data obtained from Avista.

Field Procedures

Surface Water

Surface water samples were collected as composites with the exception of low-level metals which were collected as discreet grab samples. The primary method for collection and extraction of PCBs and PBDEs was through the use of active samplers called Continuous Low-level Aqueous Monitoring devices (CLAMs). The CLAM is submersible and extracts water on-site through a Solid Phase Extraction (SPE) disk at a flow rate of 5-75 ml per minute for up to 36 hours. More information on the CLAM can be found at the manufacturer's website: http://aqualytical.com/water-sampling-equipment/.

CLAMs were deployed in the river and also used in the laboratory to extract water samples that were collected and composited during the same sampling period.

Approximately 20 liters of water were collected for extraction with CLAM in the lab. Varied volumes of water were filtered through CLAMs in the field (15 – 40 liters). Filtering efficiency is affected by (1) battery life and the operating differences of each CLAM pump and (2) physical characteristics of the water sampled. For example, water with higher amounts of suspended particulates can clog the SPE disks inside the CLAM more quickly and slow down the filtering rate. Table 1 shows all the collection methods used to collect surface water for the study.

Table 1. Collection Methods for Toxics and Conventionals in Surface Water.

Parameters	Collection Method	Collection Period (24 hours)	Collection Event
PCBs & PBDEs	CLAM (Field)†	On-site Continuous	May and September 2015
	20 L (CLAM at lab)†	½ fill at deployment – ½ at retrieval	
PCBs	20 L (XAD-2 at lab)	½ fill at deployment – ½ at retrieval	January 2016
	2 Liter	½ fill at deployment – ½ at retrieval	
DOC, TOC, TSS, & TNVSS	Specific bottle	½ fill at deployment – ½ at retrieval	All 3
Hardness & metals	Grab	Sample 1 Sample 2	All 3

†All CLAM deployments had significant PCB contamination due to high-density polypropylene SPE disks.
DOC: Dissolved Organic Carbon
TOC: Total Organic Carbon.
TSS: Total Suspended Solids.
TNVSS: Total non-volatile suspended solids.
CLAM: Continuous Low Level Aqueous Monitoring device.
XAD-2: Sorption media for contaminant monitoring.

Results from the May and September 2015 sampling events revealed significant PCB and PBDE contamination from the high-density polypropylene SPE disk housing attached to the CLAMs. For the January 2016 sample event, the lab used XAD-2 instead of the CLAM for filtering the 20-liter composite samples. XAD-2 is a type of sorption media made up of small polymer resin beads. The SPE disks in the CLAM use a sorption media called HLB. Both media types are designed to sorb soluble organic chemicals. Additionally, 2-liter composite samples were collected in January and processed through liquid-liquid extraction instead of the CLAM or XAD-2 methods. Due to additional laboratory costs of setting up the XAD-2, only PCBs were analyzed for in January 2016.

At deployment and again at retrieval of the CLAM field samples, half the container volume of surface water was collected and transferred into appropriate sample containers for compositing (Table 1). Metals and hardness samples were collected as discreet grabs at the beginning and end of each 24 hour collection event. Collecting metals samples as discreet grabs as opposed to compositing, reduces the chance of background contamination that is often seen with low-level metals sampling.

Four surface water measurements were also taken at the beginning and end of each 24-hour collection event using a Hydrolab MiniSonde®:

- Temperature
- pH
- Conductivity
- Dissolved Oxygen

The following Environmental Assessment Program (EAP) Standard Operation Procedures (SOPs) were used for water sampling:

- *Sampling of Pesticides in Surface Waters, Version 2.1* (Anderson, 2015)
- *Collection and Field Processing of Metals Samples, Version 1.5* (Ward, 2015)
- *Standard Operating Procedures for Hydrolab® DataSonde® and HL4 Multiprobes, Version 2.1* (Anderson, 2016)

Sediment Traps

Suspended sediment traps were deployed in duplicate at the long-term monitoring site. Each duplicate trap sample was analyzed separately for toxics, except for the fall-winter period where one of the traps was lost and could not be retrieved. Duplicate traps were placed roughly 200 feet (61 meters) a part. Each trap holds 2 collection cylinders (each with a collection area of 78.5 cm^2 and a height-to-width ratio of 5) for a total of 4 cylinders for the monitoring site. After 4 months the accumulated sediment was collected and replaced with new cylinders, allowing sedimentation rates to be calculated for three separate 4-month collection periods.

The sediment traps were suspended in the water column with an anchor, snag line, and hardshell float. The hardshell float sits 6 feet below the water surface so that the trap can stay taut with fluctuating water levels and so it's not disturbed by vessel traffic or floating debris. The trap sits approximately 3 feet above the reservoir bottom. The trap is retrieved by dragging a hook to grab the snag line underwater. Additional information on the deployment and retrieval of the sediment traps is available in the QA Project Plan (Era-Miller, 2015).

Analysis of suspended sediments included the following parameters:

- Percent solids
- TOC
- Cadmium, copper, lead, and zinc
- PCB congeners
- PBDEs
- Dioxins and furans

Sediments were centrifuged to remove excess water and then frozen after each collection event such that all the samples could be analyzed together, thus minimizing batch-specific analytical variation.

Laboratory Procedures

Project samples were analyzed at Ecology's Manchester Environmental Laboratory (MEL) in Manchester, Washington and by AXYS Laboratories in Surrey, British Columbia. (Table 2). High resolution analytical methods were used for all PCB, PBDE, and dioxins/furan analyses.

Table 2. Parameters and Analytical Methods.

Parameter	Analytical Method	Laboratory
Surface Water (composites and grabs)		
TOC & DOC	SM 5310B	MEL
TSS	SM 2540D	
TNVSS	SM 2540B/E	
Hardness*	SM 2340B	
Cd, Cu, Pb, & Zn*	EPA 200.8	
PCBs	EPA 1668c	AXYS
PBDEs	EPA 1614	
Surface Water (CLAM and XAD-2)		
PCBs	EPA 1668c	AXYS
PBDEs	EPA 1614	
Suspended Sediments		
% Solids	SM 2540G	MEL
TOC	PSEP – TOC	
Cd, Cu, Pb, & Zn	EPA 200.7	
PCBs	EPA 1668c	AXYS
PBDEs	EPA 1614	
Dioxins/furans	EPA 1613	

* Hardness and metals collected as single discreet grab samples
Cd: cadmium; Cu: copper; Pb: lead; and Zn: zinc
AXYS: AXYS laboratory
CLAM: Continuous Low-Level Aquatic Monitoring device
DOC: dissolved organic carbon
EPA: U.S. Environmental Protection Agency
MEL: Ecology Manchester Environmental Laboratory
PSEP: Puget Sound Estuary Protocols
SM: Standard Methods
TNVSS: total non-volatile suspended solids
TOC: total organic carbon
TSS: total suspended solids

Data Quality

The study data were reviewed by the report authors, analytical chemists, and Manchester Environmental Laboratory (MEL). The majority of the study data were found to meet the laboratory measurement quality objectives (MQOs) outlined in the QA Project Plan (Era-Miller, 2015). See Appendix B, Table B-1, for a summary of how the project data compared to MQOs. Some of the project data have been qualified due to data quality concerns, but are acceptable as qualified and reported.

Due to significant PCB contamination from the CLAM sampling system (i.e., from the SPE disk housing), high levels of PCBs in the transfer blank for the XAD-2 samples and an unknown level of PCB contamination from the 2-liter composite samples, all surface water PCB data for the study should be considered semi-quantitative. CLAM PBDE data should also be considered semi-quantitative due to background contamination from both the laboratory and SPE disk housing.

Blank Censoring and Inclusion of Tentatively Identified Results

Results were censored against blanks on a congener-specific basis using the "3x rule" where if the sample result had less than 3 times the concentration detected in the blank, it was changed from a detection to a non-detected result, thus receiving a U, UJ, or NUJ qualifier. Data from all the samples extracted with CLAM were censored against the results from a blank SPE disk that was kept at the laboratory after disk preparation and conditioning, and later analyzed with the rest of the samples. This censoring method helped to account for the background contamination present in the SPE disk housing. Data from the samples extracted through XAD-2 and liquid-liquid methods were censored against the laboratory method blank that was run with each batch.

The "3x rule" was chosen for censoring to be consistent with recent surface water studies conducted by Limnotech for SRRTTF (Limnotech, 2015 and 2016). Limnotech conducted low-flow synoptic surveys in 2014 and 2015 to calculate a semi-quantitative mass-balance assessment for PCBs in the Spokane River between the Lake Coeur d'Alene outlet and Nine Mile Dam. The "3x rule" can allow for more false positives, causing calculations of total PCBs to sometimes be biased high. Use of the "3x rule" can also allow for the inclusion of more congeners to aid in source identification efforts. MEL recommends use of the "5x rule" for high resolution methods such as 1668c, while the "10x rule" is often used for low resolution methods.

Results qualified with NJ (tentatively identified estimate) were treated as estimated results in both the environmental samples and blanks and were used in the summation of result totals.

Data Availability

Copies of the original laboratory case narratives can be obtained from the lead study author.

The suspended sediment data are available electronically for download from Ecology's EIM database under Study ID BERA0012. EAP does not have a standard operating procedure (SOP) for sample collection methods using CLAM and XAD-2 and thus data from these methods are not currently entered into EIM. The CLAM and XAD-2 data are available in Appendix C, Tables C-1 and C-2.

Data for the surface samples collected in January 2016 as 2-liter composites and extracted through the liquid-liquid extraction process were entered into EIM. Liquid-liquid extraction is an accredited method. The 2-liter composite samples were censored using a "5x rule" for entry into EIM. The 2-liter data are also available in Appendix C, Table C-2, where it is censored using the "3x rule".

Surface Water

Field Measurements

Temperature, pH, conductivity, and dissolved oxygen were measured in the field using a Hydrolab MiniSonde®. The Hydrolab was calibrated before each of the three seasonal monitoring events. A post-calibration check was performed after the September 2015 event, and only conductivity appeared to be moderately out of range (calibration solution of 100 us/cm was measured at 121 us/cm).

PCBs and PBDEs

Contamination of PCBs and PBDEs in the CLAM high-density polypropylene SPE disk housing that holds the HLB sorption media was the biggest issue with the surface water samples. Due to the contamination, all the CLAM data were censored against a blank "clean" SPE disk that was extracted and analyzed along with each analytical batch. The 20-liter XAD and 2-liter sample results were censored against laboratory method blanks.

There were multiple types of CLAM blanks analyzed for PCBs and PBDEs during the study (Tables 3 and 4). There were similar concentrations of total PCBs and PBDE 47, 99, and 209 for the blanks within each sampling event, though the September sampling had less than half the concentrations of the May sampling. The contaminant levels in the CLAM blanks indicate a fairly constant background signal, especially for PCBs. Censoring all the CLAM data against the SPE lab disk blank run with each batch of samples helped to evenly account for contamination across the study. CLAMs were not used in January 2016 due to the SPE disk contamination issues.

Table 3. Total PCBs in CLAM Blanks.

CLAM Blank Type	**Total PCBs** (pg/disk)*	
	May 2015	Sept 2015
Lab SPE Disk	2593	1229
Field SPE Disk	2664	--
Trip Blank	2456	--
Transfer Blank	3258	867

* Concentrations are shown as total PCBs in picograms per disk.

Table 4. PBDEs in CLAM Blanks.

CLAM Blank Type	**PBDE 47** (pg/disk)*		**PBDE 99** (pg/disk)*		**PBDE 209** (pg/disk)*	
	May 2015	Sept 2015	May 2015	Sept 2015	May 2015	Sept 2015
Lab Disk	86	30	89	21	664	450 U
Field Disk	50	--	53	--	622	--
Trip Blank	57	--	45	--	585	--
Transfer Blank	80	59	68	45	848	560

* Concentrations are shown as picograms per disk.
-- Not analyzed. U: Not detected at the result value shown.

As part of the investigative work into how well CLAMs perform as an assessment tool for PCBs, PBDEs, and other low-level organic chemicals in surface water, an analysis of breakthrough was performed on two samples during the May 2015 sampling. The two samples had an additional disk used, so that the disks were attached in series on the CLAM. The first disk in series was spiked with a field spike solution containing PCB-31L, PCB-95L, PCB-153L, and PBDE-138L, while the second disk was not field spiked. All the field spiked disks recovered at 84 – 92% for the PCB surrogates and at 69 –77% for PBDE-138L. The second (non-spiked) disks recovered at 0 – 1%, suggesting that PCBs and PBDEs do not readily break through the CLAM SPE disks.

Metals

A transfer and filter blank was collected during each of the three surface water sampling events to account for any potential laboratory or sampling equipment contamination for the total and dissolved metals samples. There were no detections in any of the metals blanks except for one copper-total result of 0.14 ug/L taken during the May sampling. The associated sample result was 0.67 ug/L (Table 10 – *Results* section).

Suspended Sediments

Suspended sediments were analyzed for PCBs, PBDEs, dioxin/furans, and metals. There were fewer data quality issues overall with the suspended sediment samples compared to the surface water samples. This appeared to be associated with the sediments having higher concentrations relative to the laboratory method blanks. There were a few exceptions, noted as follows.

Dioxin/furans

Most of the dioxin/furan data were qualified as estimates due to chromatographic interferences, contamination in the blank, low labeled internal standard recoveries, and mass ion ratios outside the control limits.

Metals

Approximately 60% of the metals samples were beyond holding time limits at the time of analysis and were therefore “J” qualified as estimates by MEL. The project manager chose to freeze all samples and have them analyzed later in the same batch in order to minimize batch-specific analytical variability. More than half the samples were frozen for over a year prior to analysis.

Assessment Criteria

Table 5 shows the relevant Washington State and Spokane Tribal water quality and sediment criteria. The State criteria apply to surface water and suspended sediment above the confluence of Chamokane Creek with the Spokane River, and the Tribal criteria apply below the confluence. Both State and Tribal water quality criteria for the protection of human health for total PCBs are below the detection capabilities of current analytical technology at 7 and 1.3 pg/L (part per quadrillion), respectively.

The surface water criteria for PCBs shown in Table 5 are for informational purposes only. Surface water data (CLAM, XAD-2, and the 2-liter) are considered to be semi-quantitative and will not be used for formal assessment of attainment of State water quality standards.

Washington State and the Spokane Tribe of Indians have hardness-based acute and chronic criteria for the protection of aquatic life for cadmium, copper, lead and zinc. The hardness-based calculations are the same for both entities except the Tribe has slightly lower (more restrictive) criteria for copper.

Neither the State nor the Tribe has criteria for PBDEs, and there are no freshwater sediment cleanup screening thresholds for dioxin.

Table 5. Applicable Freshwater Criteria for Surface Water and Sediment from the Spokane River.

Parameter	Matrix	**Washington State** Freshwater Criteria[1]	**Spokane Tribal** Freshwater Criteria[2]
		Human Health Protection (pg/L)	Human Health Protection (pg/L)
Total PCBs	Water	7	1.3
2,3,7,8-TCDD (dioxin)		0.013	0.000104
		Aquatic Life (Chronic)	Aquatic Life (Chronic)
Cadmium	Water	HB	same as WA State
Copper		HB	HB*
Lead		HB	same as WA State
Zinc		HB	same as WA State
		Washington State Freshwater Sediment (ug/Kg dry weight)	
		Cleanup Objective[3]	Cleanup Screening Level[3]
Total PCBs (Aroclor)	Sediment	110	2500
Cadmium		2.1	5.4
Copper		400	1200
Lead		360	> 1300
Zinc		3200	> 4200

[1] Water Quality Standards for the Surface Waters of the State of Washington (Ecology, 2006).
[2] Spokane Tribe of Indians Surface Water Quality Standards (STI, 2010).
[3] Sediment Management Standards (Ecology, 2013).
* The Spokane Tribal Aquatic Life Chronic Criterion for copper is lower than Washington's.
HB: Hardness based.

Results

Surface Water

Conventional Measurements

During each of the three sample events, instantaneous field measurements – including temperature, conductivity, pH, and dissolved oxygen (DO) – were obtained at the UGM monitoring site. Results are presented in Table 6. While pH was fairly consistent over the course of the study, temperature, conductivity and DO results were more variable. Higher conductivity values during the September monitoring events are indicative of the influence of groundwater in the river.

Table 6. Ambient Surface Water Measurements from the UGM Site.

Date:	5/4/15	5/5/15	9/9/15	9/10/15		1/27/16
Time:	1725	1720	1900	1045	1845	1230
Temperature (C°)	12.6	12.3	17.0	17.2	17.2	5.4
Conductivity (umhos/cm)	118	120	247	249	246	169
pH (pH units)	7.5	7.9	7.9	7.8	7.9	7.2
Dissolved Oxygen (mg/L)	10.92	10.77	7.90	8.00	8.07	10.51

General Chemistry

Table 7 shows the general chemistry results for the study. Total organic carbon (TOC) and total suspended solids (TSS) are generally low in the Spokane River compared to other rivers in Washington State, and current study results reflect this. The TOC results were below 2 mg/L and TSS ranged from not-detected at 1 mg/L to a high of 3 mg/L. Total non-volatile suspended sediments (TNVSS) are a measure of the inorganic portion of suspended sediments. TNVSS ranged from not-detected at 1 mg/L to a high of 2 mg/L.

Table 7. General Chemistry Results (mg/L) from the UGM Site.

Sample Type	Composite	Grab	Composite	Replicate	Composite	Replicate
Sample No.	1505050-10	-11	1509068-10	-11	1602016-10	-11
Start Date	5/4/15	5/5/15	9/9/15		1/26/16	
Start Time	1725	1720	1940	1945	1120	1130
End Date	5/5/15	NA	9/10/15		1/27/16	
End Time	1720		1055	1055	1650	1650
Total Organic Carbon	**1.7**	**1.8**	**1.1**	1.0 U	**1.3**	**1.3**
Dissolved Organic Carbon	**1.5**	**1.5**	1.0 U	1.0 U	**1.0**	**1.1**
Total Suspended Solids	**2**	**2**	2 U	1 U	**3**	**3**
TNVSS	**1**	2 U	2 U	1 U	2 UJ	**2**

Bolded values indicate detected results.
J = Analyte was positively identified; reported result is an approximate concentration.
U = Not detected above the reported quantitation limit.
UJ = Not detected above the reported estimated quantitation limit.
NA = Not applicable.

PCBs

As described in the *Data Quality* section, due to PCB contamination in the CLAM sampling system, high levels of PCBs in the transfer blank for the XAD-2 samples and an unknown level of PCB contamination from the 2-liter composite samples, all surface water PCB data for the study should be considered semi-quantitative.

All surface water samples using CLAMs were censored against a blank SPE disk that was kept at the laboratory after disk preparation and conditioning, and later analyzed with the rest of the samples. The XAD-2 and 2-liter samples were censored against laboratory method blanks. Factoring out the contamination by censoring against the blank SPE disks significantly lowered the total PCB (tPCB) congener results for the May and September events.

Full results for surface water data collected and extracted through the CLAM method are available in Appendix C, Table C-1. Surface water data extracted through XAD-2 (20-liter composite samples) and liquid-liquid methods (2-liter samples) are shown in Table C-2. Table 8 gives the tPCB results and volumes of water sampled. The actual volume from the 20-liter canisters used for composting samples is closer to 19.5 liters. Total PCBs are calculated by dividing the tPCB mass in picograms (pg) by the volume of water samples in liters (L) to get a final result in pg/L. Figure 6 shows tPCB results for both the environmental samples and transfer blanks.

Table 8. Total PCBs in Surface Water from the UGM Site.

Date:	5/4/15 - 5/5/15			9/9/15 - 9/10/15				1/26/16			
Collection Type:	CLAM-Lab	CLAM-Field		CLAM-Lab		CLAM-Field		XAD-Lab		2 Liter	
Measurement											
tPCB mass (pg)	1489	1364	1245	2005	998	3635	3173	NA	NA	NA	NA
Volume (L)	19.5	20.7	15.6	19.5	19.5	30.8	40.8	19.5	19.5	2	2
tPCBs (pg/L)	**76**	**66**	**80**	**103**	**51**	**118**	**78**	**117**	**117**	**97**	**88**

NA = not applicable – original sample mass not given by lab but reported as pg/L.

Transfer blank concentrations are included in Figure 6 for all three sampling events because they can be subtracted from the associated environmental results to get a more conservative estimate of concentrations for each sampling event. The 2-liter samples are an exception as they had no transfer blank collected for them.

The Washington State Human Health criterion and the Spokane Tribe of Indian's Water Quality criterion for total PCBs are shown in Figure 6 at 7 pg/L and 1.3 pg/L to give a general idea of surface water results compared to criteria. As stated in the *Assessment Criteria* and *Data Quality* sub-sections of this report, surface water data extracted through CLAM and XAD-2 will not be entered into EIM or used for assessment of attainment of water quality standards.

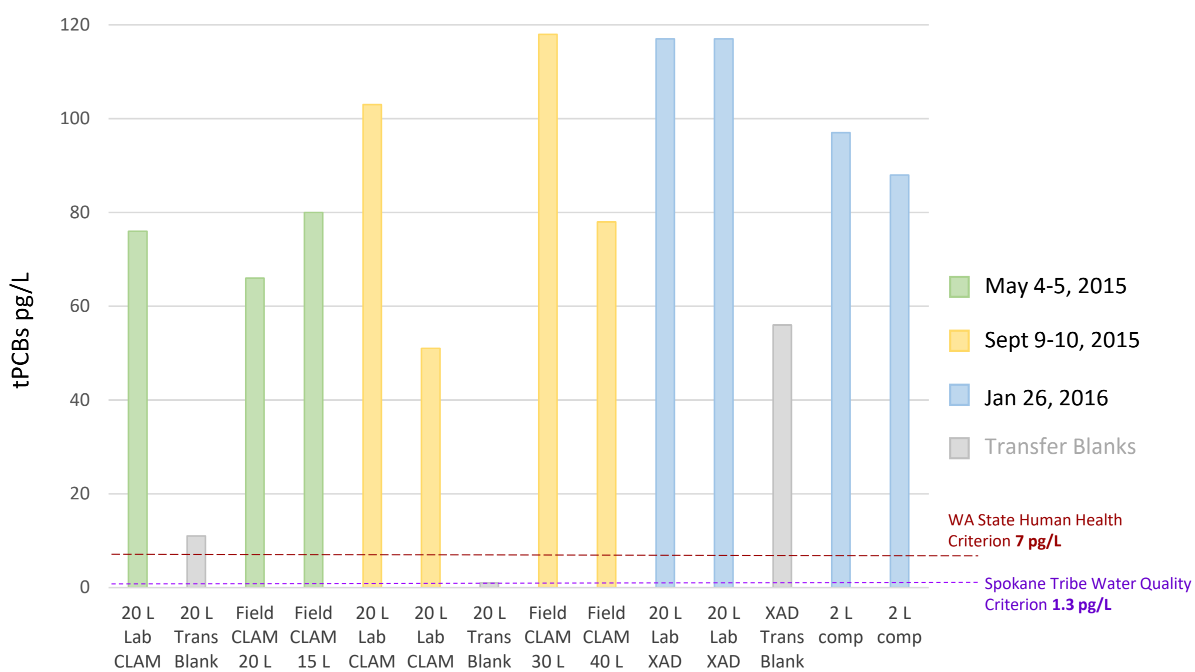


Figure 6. Total PCB Results (pg/L) for Surface Water Sampling.

After subtraction of the transfer blank concentrations shown in Figure 6, the mean seasonal tPCB concentrations for the study were found to range from 63 – 87 pg/L at the UGM monitoring site (Table 9). Given the inclusion of NJ qualified data and use of the "3x rule" for blank censoring, these total values may be biased slightly high.

Table 9. Seasonal Surface Water Results for Total PCBs from the UGM Site.

Seasonal Event	Sampling Date(s)	Extraction Method	N	tPCBs (pg/L)		Mean Daily Flow (cfs)*
				Range	Mean	
May	5/4/15 - 5/5/15	CLAM Lab (20 L) & CLAM Field	3	55-69	**63**	5,089
Sept	9/9/2015 - 9/10/15	CLAM Lab (20 L) & CLAM Field	4	50-117	**87**	1,652
Jan	1/26/2016	XAD-2 (20 L) & liquid-liquid (2 liter) in Lab	4	61-97	**77**	6,511

N: Number of samples. * Mean daily flow calculated from hourly discharge data from Long Lake Dam

PBDEs

Full results for surface water PBDE data collected and extracted through the CLAM method are available in Appendix C, Table C-3. PBDEs were analyzed for the May and September sampling but not for January. PBDE 209 was the only congener among the three most prevalent and common PBDEs (47, 99, and 209) that was not detected above the background noise of PBDE detections in the CLAM SPE disk blanks and laboratory method blanks (Figure 7). PBDE 47 concentrations were fairly similar across both sampling seasons, ranging from 15 – 32 pg/L. There was more variability among the PBDE 99 and 209 results in general. Only half of the samples had detections of PBDE 209. September PBDE 209 results for the 20-liter composite samples analyzed with CLAMs in the laboratory were higher relative to all the other samples (400 and 830 pg/L compared to ND – 245 pg/L).

As with PCBs, PBDE CLAM data should also be considered semi-quantitative due to background contamination from both the laboratory and SPE disk housing.

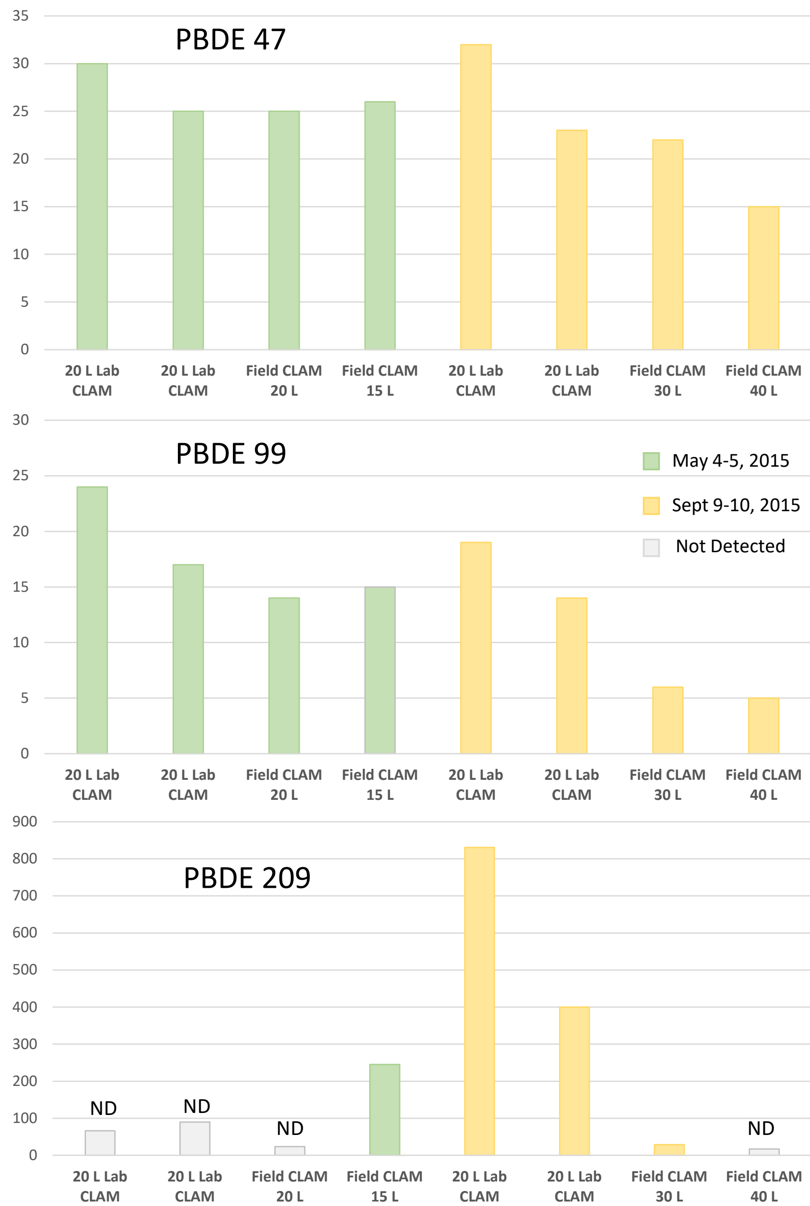


Figure 7. PBDE 47, 99, and 209 Results (pg/L) for Surface Water Sampling.

Metals

Six grab samples (two per sampling event) for both total and dissolved cadmium, copper, lead, and zinc were collected at the UGM site during the study. All metals concentrations were 1-2 orders of magnitude below the Washington State hardness-based chronic criteria for the protection of aquatic life and the Spokane Tribe of Indian's hardness-based chronic criteria for copper (Table 10). The Tribe has a slightly lower chronic criterion for copper.

There were no detections of metals in the transfer (total) and filter (dissolved) blanks associated with each sampling event, with the exception of total copper (0.14 ug/L) in one of the samples from May.

Table 10. Metals Concentrations (ug/L) in Grab Samples Compared to Water Quality Criteria[†].

Sample ID	UGM	UGM	Trans Blank	UGM	UGM	Replicate	Trans Blank	UGM	UGM	Replicate	Trans Blank
Sample No.	1505050-01	-2	-4	1509068-01	-2	-3	-4	1602016-01	-2	-3	-4
Date	5/4/15	5/5/15	5/5/15	9/10/15	9/10/15	9/10/15	9/10/15	1/26/16	1/26/16	1/26/16	1/26/16
Time	1805	1650	1645	1140	1845	1145	1155	1035	1635	1105	1058
Hardness (mg/L)	**53.6**	**53.8**	0.30 U	**115**	**112**	**114**	NA	**75.9**	**77.7**	**77.8**	0.30 U
Cadmium - total	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
Cadmium - dissolved	**0.059**	**0.061**	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	**0.029**	**0.038**	**0.032**	0.020 U
Chronic WQ Criterion	*0.65*	*0.65*	NA	*1.14*	*1.12*	*1.14*	NA	0.84	0.86	0.86	NA
Copper - total	**0.73**	**0.67**	**0.14**	**0.47**	**0.51**	**0.74**	0.10 U	**0.54**	**0.60**	**0.58**	0.10 U
Copper - dissolved	**0.58**	**0.47**	0.10 U	**0.42**	**0.43**	**0.44**	0.10 U	**0.42**	**0.43**	**0.41**	0.10 U
WA Chronic WQC	*6.66*	*6.68*	NA	*12.79*	*12.51*	*12.70*	NA	8.97	9.15	9.16	NA
Spokane Chronic WQC	*5.26*	*5.27*	NA	*10.09*	*9.87*	*10.02*	NA	7.08	7.22	7.23	NA
Lead - total	**0.78**	**0.85**	0.10 U	**0.15**	**0.16**	**0.16**	0.10 U	**0.43**	**0.45**	**0.42**	0.10 U
Lead - dissolved	**0.208**	**0.198**	0.020 U	0.02 U	0.02 U	0.02 U	0.020 U	**0.090**	**0.097**	**0.096**	0.020 U
Chronic WQ Criterion	*1.27*	*1.27*	NA	*2.93*	*2.85*	*2.90*	NA	1.86	1.91	1.91	NA
Zinc -total	**23.6**	**26.1**	5.0 U	**5.8**	**6.1**	**5.5**	5.0 U	**19.3**	**19.3**	**20.2**	5.0 U
Zinc - dissolved	**13.1**	**17.3**	1.0 U	**4.4**	**6.6**	**13.3**	1.0 U	**18.2**	**20.6**	**23.8**	1.0 U
Chronic WQ Criterion	*61.61*	*61.81*	NA	*117.65*	*115.04*	*116.78*	NA	82.73	84.39	84.48	NA

[†] Water Quality Standards for the Surface Waters of the State of Washington (Ecology, 2006) Aquatic Life Chronic Criteria and Spokane Tribe of Indians Water Quality Criterion for Copper (STI, 2010).
Bold = Visual aid for detected compounds.
Highlighted numbers show dissolved metals concentrations compared to applicable water quality criteria.
U = Not detected above the reported quantitation limit.
NA = Not analyzed.

Sediment Traps

Sediment traps were deployed for three hydrological periods, ranging from 134 – 138 days or about 4.5 months each from late spring 2015 through early summer 2016. Table 11 gives the sample information and general chemistry results for sediment trap samples. Most of the sediment tables and figures are also color-coded in this section of the report to correspond with the sampling periods.

Table 11. Sediment Trap Sample Information.

Sampling Period	Sample No.	Start Date	End Date	Days Deployed	Wet Weight (g)	Dry Weight (g)	% moisture	% solids	% TOC
Spring - Summer	1606061-1	4/29/15	9/10/15	134	112	11	86.5	9.5	12.3
Spring - Summer (rep)	1606061-2	4/29/15	9/10/15	134	129	13	87.8	10.2	11.9
Fall - winter	1606061-3	9/10/15	1/26/16	138	65	7	89.9	10.7	10.6
Winter - Spring	1606061-4	1/26/16	6/9/16	135	144	37	64.9	25.6	4.9
Winter - Spring (rep)	1606061-5	1/26/16	6/9/16	135	167	45	62.4	26.7	5.0

TOC = total organic carbon
rep = replicate sediment trap

PCBs

Total PCB congener results for the sediment traps are shown in Figure 8. The full suite of congener results are in Appendix C, Table C-4. Concentrations for spring-summer (green) and winter-spring (blue) sampling periods and between the replicate samples were similar, ranging from 8 – 13 ug/kg (ppb), while the single fall-winter (yellow) sample had a concentration between 2-3 times higher (29 ppb). All tPCB results were below the Washington State Freshwater Sediment Cleanup Objective (SCO) of 110 ug/Kg (*based on total PCB Aroclors*).

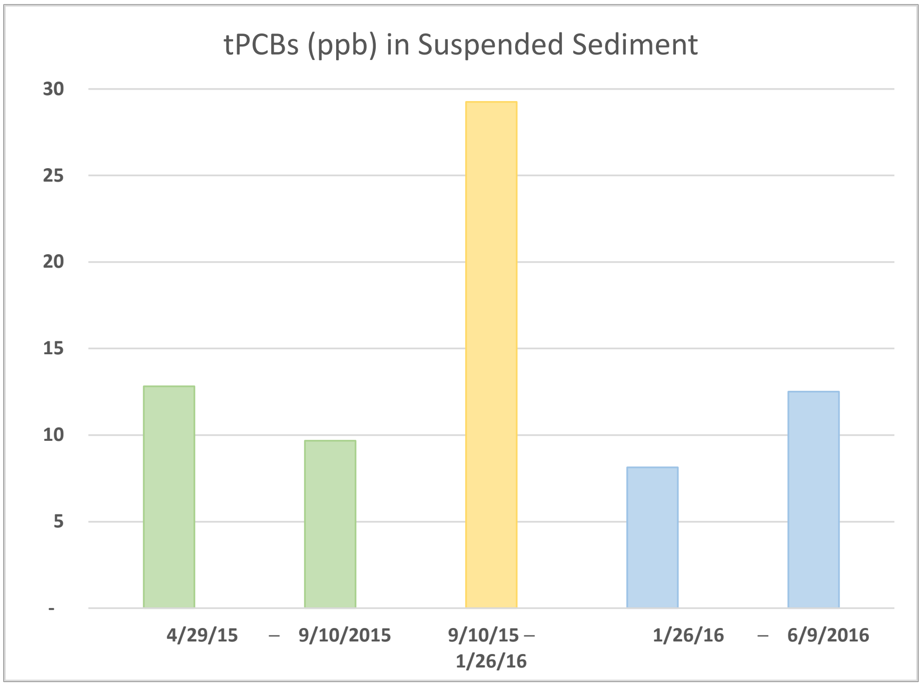


Figure 8. Total PCB Congeners in Suspended Sediments (ug/Kg, dry weight).

PCB homologue analyses of the suspended sediment samples did not indicate an easily discernable difference between homologue patterns among the three sampling periods (Figure 9). The majority of the congeners came from the tetra-, penta-, and hexa-homologue groups.

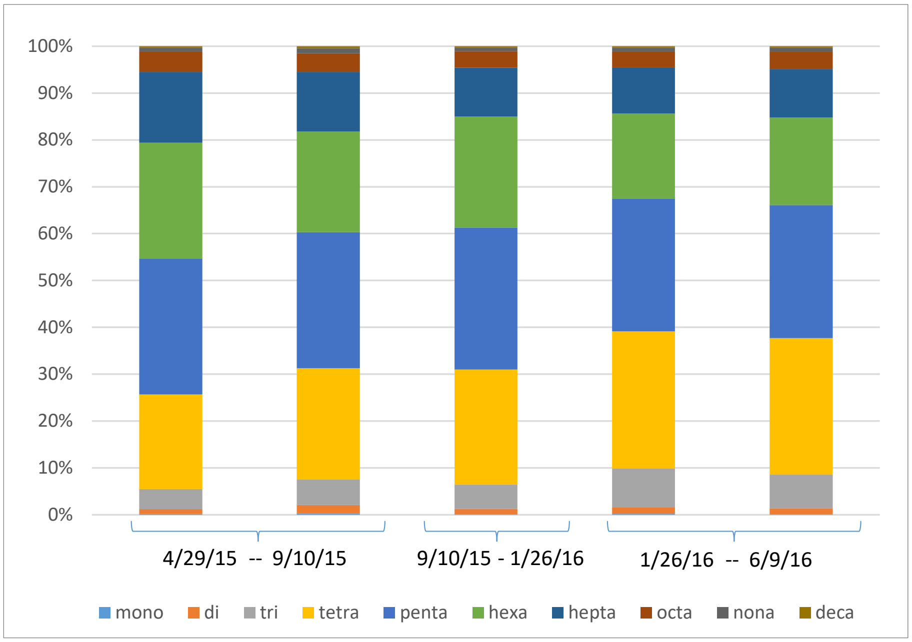


Figure 9. Homologue Distribution of PCBs in Suspended Sediments.

PBDEs

PBDEs followed the same pattern as PCBs with the fall-winter having 2-3 times the concentration of the spring-summer and winter-spring sampling periods (Figure 10). The full suite of PBDE congener results can be found in Appendix C, Table C-5.

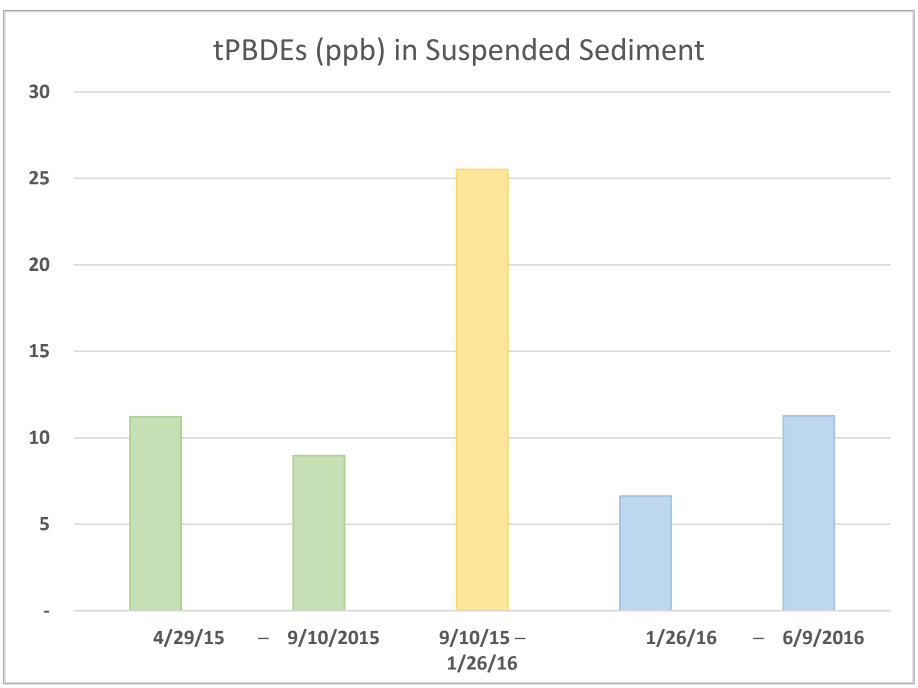


Figure 10. Total PBDEs in Suspended Sediments (ug/Kg, dry weight).

Dioxins and Furans

Dioxins and furans followed the same pattern as PCBs and PBDEs with the fall-winter having 2-3 times the concentration of the other sampling periods (Table 12 and Figure 11). Figure 11 graphs the calculated dioxin Toxicity Equivalent Quotient (TEQ) values. TEQs are toxicity-weighted totals that are based on 2,3,7,8-TCDD, the most toxic of the dioxin congeners.

Table 12. Dioxins and Furans Results for Sediment Traps (pg/g, part per trillion, dry weight).

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring				Toxicity Equivalent Factors (TEFs)
Sample No.	1606061-1		1606061-2 (rep)		1606061-3		1606061-4		1606061-5 (rep)		
Deployment Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16				
2,3,7,8-TCDD	**0.945**		**0.962**		**1.1**		**0.141**		**0.304**		1
1,2,3,7,8-PECDD	**0.338**	**NJ**	**0.565**	**J**	**1.34**	**J**	**0.233**	**J**	**0.553**	**J**	1
1,2,3,4,7,8-HXCDD	**0.416**	**J**	**1.01**	**J**	**1.98**	**J**	**0.462**	**J**	**1.02**	**J**	0.1
1,2,3,6,7,8-HXCDD	**2.32**	**J**	**1.52**	**J**	**4.45**		**1.54**		**3.86**		0.1
1,2,3,7,8,9-HXCDD	**1.56**	**J**	**2.07**	**J**	**4.58**		**1.25**		**2.36**		0.1
1,2,3,4,6,7,8-HPCDD	**32.3**		**19.9**	**J**	**60.9**		**23**		**54.4**		0.01
OCDD	**238**		**137**	**J**	**421**		**159**		**382**		0.0003
2,3,7,8-TCDF	**2.57**		**2.16**		**3.59**		**0.845**		**1.25**		0.1
1,2,3,7,8-PECDF	**0.23**	**NJ**	0.316	UJ	**0.427**	**J**	**0.152**	**J**	**0.234**	**NJ**	0.03
2,3,4,7,8-PECDF	**0.466**	**J**	**0.352**	**J**	**0.857**	**J**	**0.234**	**J**	**0.407**	**J**	0.3
1,2,3,4,7,8-HXCDF	**0.547**	**NJ**	**0.651**	**J**	**1.28**	**J**	**0.404**	**J**	**0.738**	**J**	0.1
1,2,3,6,7,8-HXCDF	**0.339**	**J**	**0.447**	**J**	**0.921**	**J**	**0.341**	**J**	**0.461**	**J**	0.1
1,2,3,7,8,9-HXCDF	0.151	UJ	0.425	UJ	0.163	UJ	0.0343	UJ	0.059	UJ	0.1
2,3,4,6,7,8-HXCDF	**0.297**	**NJ**	0.425	UJ	**0.637**	**NJ**	**0.274**	**J**	**0.438**	**J**	0.1
1,2,3,4,6,7,8-HPCDF	**6.92**		**4.57**	**J**	**13.8**		**6.42**		**8.44**		0.01
1,2,3,4,7,8,9-HPCDF	**0.449**		**0.599**	**NJ**	**0.941**	**J**	**0.389**	**J**	**0.474**	**J**	0.01
OCDF	**17.1**		**13.7**	**J**	**33.1**		**19.8**		**16**		0.0003
TEQ[1] (ND = 0)	**2.71**		**2.71**		**5.35**		**1.31**		**2.75**		

[1] Toxicity Equivalent Quotient (TEQ) calculated using Toxic Equivalency Factors (TEFs) from EPA, 2010.
Bold: Visual aid for detected compounds.
ND = 0: Non-detected values (UJ qualified) are not included in the TEQ calculation.
J: Analyte positively identified; results is an estimate.
NJ: Analyte tentatively identified; result is approximate.
UJ: Analyte not found at the estimated reporting limit shown.

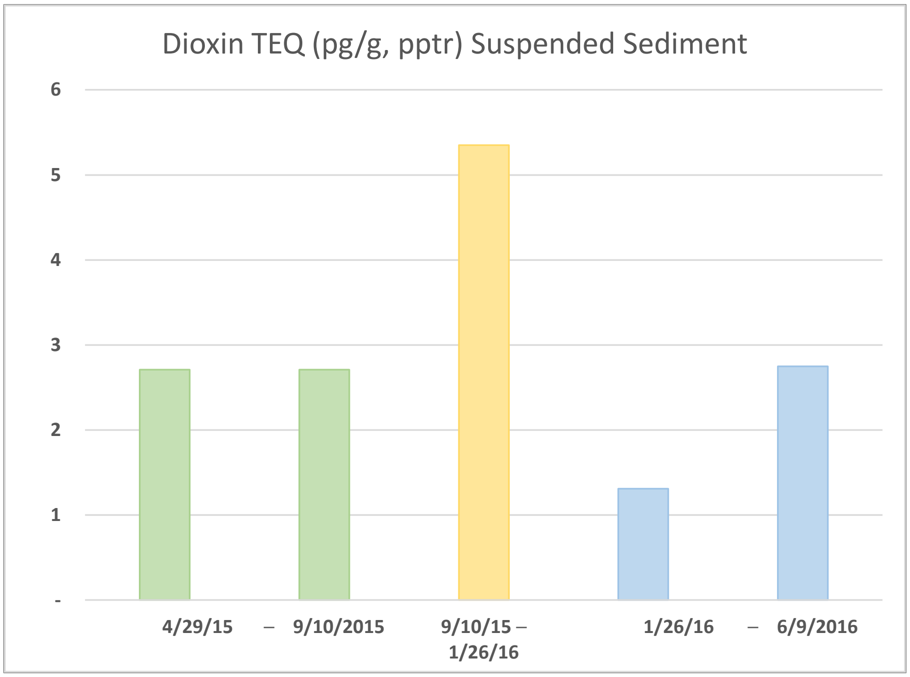


Figure 11. Dioxins and Furans Toxicity Equivalent Quotient (TEQ).

Metals

Suspended sediments were analyzed for cadmium, copper, lead, and zinc. Concentrations were generally low and well below Washington's Freshwater Sediment Cleanup Objectives (SCO) and Cleanup Screening Levels (CSL), with the exception of cadmium exceeding both SCO and CSL for all samples (Table 13).

Table 13. Metals Results for Sediment Traps (mg/Kg, part per million, dry weight).

Sampling Season:	Spring - Summer				Fall - Winter		Winter - Spring				Freshwater Sediment Standards	
Sample No:	1606061-1		1606061-2 (rep)		1606061-3		1606061-4		1606061-5 (rep)			
Deployment Dates:	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16				SCO	CSL
Cadmium	**9.4**	J	**7.7**	J	**12.1**	J	**8.9**	J	**11.4**		2.1	5.4
Copper	**30**	J	**25**	J	**36**	J	**24**		**30**		400	1200
Lead	**154**	J	**143**	J	**169**	J	**131**	J	**165**		360	1300
Zinc	**1620**	J	**1410**	J	**1590**	J	**1110**		**1430**		3200	4200

Bold = Visual aid for detected compounds.
J = Analyte positively identified; results is an estimate.
SCO = Sediment Cleanup Objective.
CSL = Cleanup Screening Level.

Metals generally followed the same pattern as PCBs, PBDEs, and dioxins with the fall-winter having a higher concentration than the other sampling periods, but the difference was less (Figure 12).

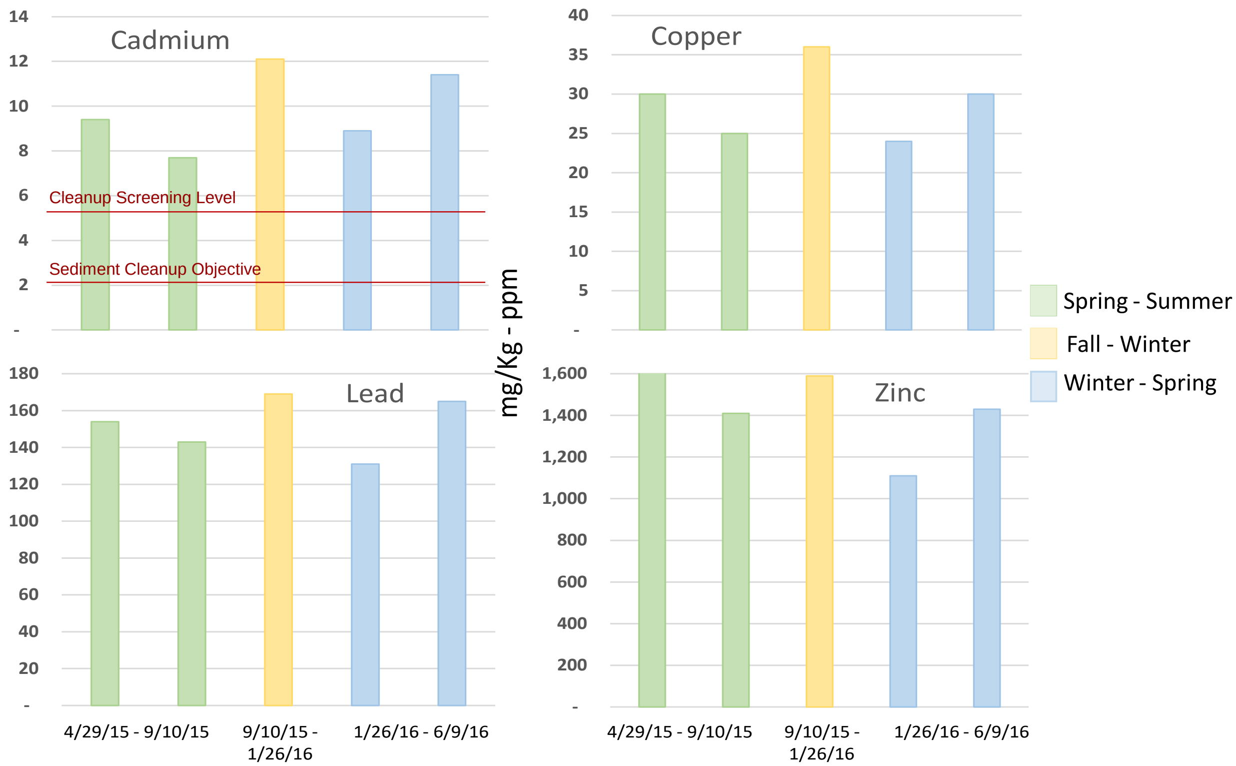


Figure 12. Seasonal Cadmium, Copper, Lead, and Zinc in Suspended Sediments.

PCB Congener Patterns in all Matrices

A qualitative analysis of PCB congeners detected in all surface water and suspended sediment samples, including CLAM disk blanks, revealed some noticeable patterns (see Appendix C, Table C-6). The presence of a congener in Table C-6 indicates that it was detected. If the chemical signal was particularly strong compared to background contamination, it is bolded and underlined. The following patterns were observed:

- Far more congeners and coelutes (two or more congeners reported together) were detected in suspended sediment samples compared to surface water samples. There were 91 congeners or coelutes routinely detected in suspended sediment samples and 18 routinely detected in surface water samples. All of the prominent PCBs found in surface water samples were also present in suspended sediment samples.
- The lighter molecular weight congeners (mono- through tetra- homologues) were the major contamination contributors in the high-density polypropylene CLAM disk housing, including PCB-011 (Table C-6). The heavier PCBs (penta- through octa- homologues) were more prominent in the surface water samples.

Discussion

Seasonality and River Flow

Flow discharge in the Spokane River at the study sites located in Little Falls Pool is determined almost entirely by the discharge of water from Long Lake Dam at the outlet of Lake Spokane. Spokane River flows are largely controlled by dam operations. Natural seasonal events such as spring snowmelt and storm events in the spring, fall, and winter can also impact river flow.

Hydrological events can influence both erosion and runoff processes in riverine and reservoir systems. Stormwater runoff can wash contaminants off the land and into surface water. Fluctuating water levels in a reservoir can lead to resuspension and transport of deposited sediments downstream (Thornton et al., 1990). Lake Spokane was drawn-down in January 2016 while sediment traps were deployed in Little Falls Pool. This draw-down happens about every other year on average when winter flows allow (Avista, Personal Communication).

The role of seasonal river flows and the Lake Spokane draw-down event, along with timing of the surface water and sediment trap sample collection, likely influenced study results. This will be explored further in the following discussion.

Surface Water

During June 2016 and February 2017, as part of Ecology's study, *Assessment Methods for Sampling Low-Level Toxics in Surface Waters* (Low Level study), CLAMs were used to measure PCBs at the UGM monitoring site (Hobbs and McCall, 2016). Researchers for the Low Level study collaborated with researchers for this study to compile a more robust data set for the CLAM data. These data will be used to draft a Standard Operating Procedure (SOP) for use of the CLAM in monitoring toxics in Washington State surface waters.

While the 2017 CLAM results from the Low Level study are not yet available, the June 2016 results were found to be similar to those in the current *Spokane Tribal Boundary* study (Table 14). The precision between triplicate CLAM sample results for the Low Level study was very good with a relative standard deviation (RSD) of 2.6%. The similarity of tPCB results between the two studies, especially between samples collected in May 2015 and June 2016 (similar seasons), adds to a preponderance of evidence that tPCB concentrations in surface water at the UGM site tend to trend below 100 pg/L. Mean concentrations of tPCBs (after transfer blank subtraction) for the *Spokane Tribal Boundary* study range from 63-87 pg/L.

Researchers for the Low Level study used CLAM disks with a stainless steel housing instead of high-density polypropylene and found considerably less background contamination. Total PCB concentrations in the SPE disk blanks accounted for only 1-2% of the tPCBs in samples for the Low Level study, while tPCB SPE disk blank concentrations accounted for roughly half of the tPCBs in the *Spokane Tribal Boundary* study (Table 15).

Table 14. Total PCBs in Surface Water at the UGM Site from Two Studies.

Date:	5/4/15 - 5/5/15			9/9/15 - 9/10/15				1/26/16				6/10/16		
Collection Type:	CLAM - Lab	CLAM - Field		CLAM - Lab		CLAM - Field		XAD - Lab		2 Liter		Low Level Study†		
Measurement												CLAM - Field		
tPCB mass (pg)	1489	1364	1245	2005	998	3635	3173	NA	NA	NA	NA	3235	2865	2351
Volume (L)	19.5	20.7	15.6	19.5	19.5	30.8	40.8	19.5	19.5	2	2	42.5	37	32
tPCBs (pg/L)	**76**	**66**	**80**	**103**	**51**	**118**	**78**	**61***	**61***	**97**	**88**	**76**	**77**	**73**

NA = not applicable – original sample mass not given by lab but reported as pg/L.
† Data from Assessment Methods for Sampling Low-Level Study (*report in draft*).
* Values reported after subtraction of transfer blank results.

Table 15. Contribution of Total PCBs to Samples from SPE Disks.

Date	5/4/15 - 5/5/15			9/9/15 - 9/10/15				6/10/16		
Collection Type	CLAM-Lab	CLAM - Field		CLAM - Lab		CLAM - Field		Low Level Study*		
								CLAM - Field		
tPCB mass (pg) of Sample	4652	4322	4268	3047	2033	5537	5648	3235	2865	2351
tPCB mass (pg) of Disk Blank	2593	2593	2593	1229	1229	2458	2458	43	43	43
% of Sample	**56%**	**60%**	**61%**	**40%**	**60%**	**44%**	**44%**	**1%**	**2%**	**2%**

* Data from Assessment Methods for Sampling Low-Level Study (*report in draft*).

Suspended Sediments

Increased Contaminant Signal in Fall-Winter Deployment

The increase in suspended sediment contaminant concentrations in the fall-winter (9/10/15 – 1/26/16) sediment trap deployment period was further explored for PCBs. Figure 13 shows the relative Total PCB concentrations when normalized to % solids and % TOC. The increased concentration in fall-winter is still present, though significantly reduced when TOC is accounted for.

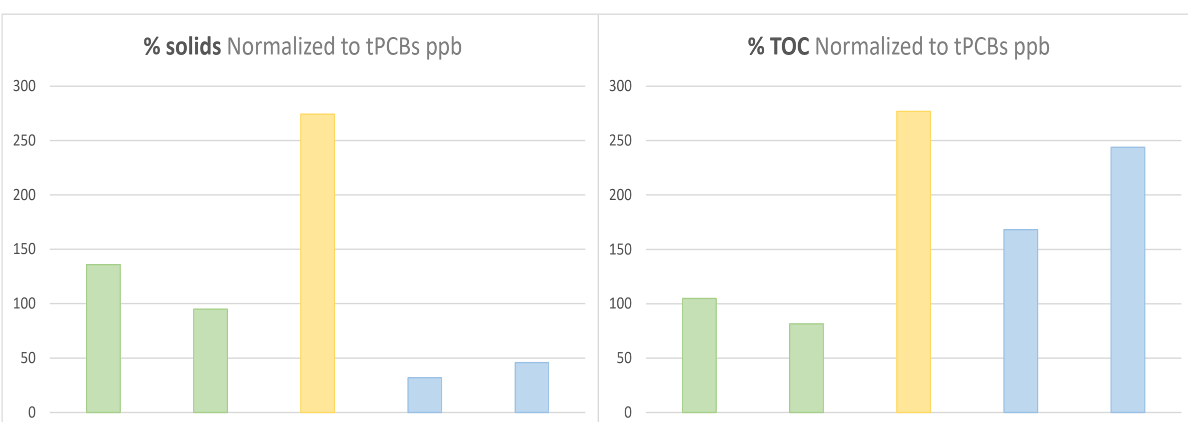


Figure 13. Total PCBs in Suspended Sediments Normalized to % Solids and % Total Organic Carbon (TOC).

One possibility for why there were higher contaminant concentrations in the fall-winter suspended sediment sample is that Lake Spokane was drawn-down in January 2016, when the sediment traps were deployed in Little Falls Pool (see Figure 14). Depositional lake sediments may have been mobilized downstream during the draw-down causing a relative spike in PCBs for the 4.5-month deployment period. Another possibility is that storm events contributed to wash off of PCBs from the land during this period. Rainfall data show a significant storm occurred in the Spokane River watershed in early December, including over an inch of rain on December 7, 2015 (Weather Underground). There was a sudden increase in discharge from Long Lake Dam on December 9 which may have been in response to the December storm event (see Figure 14).

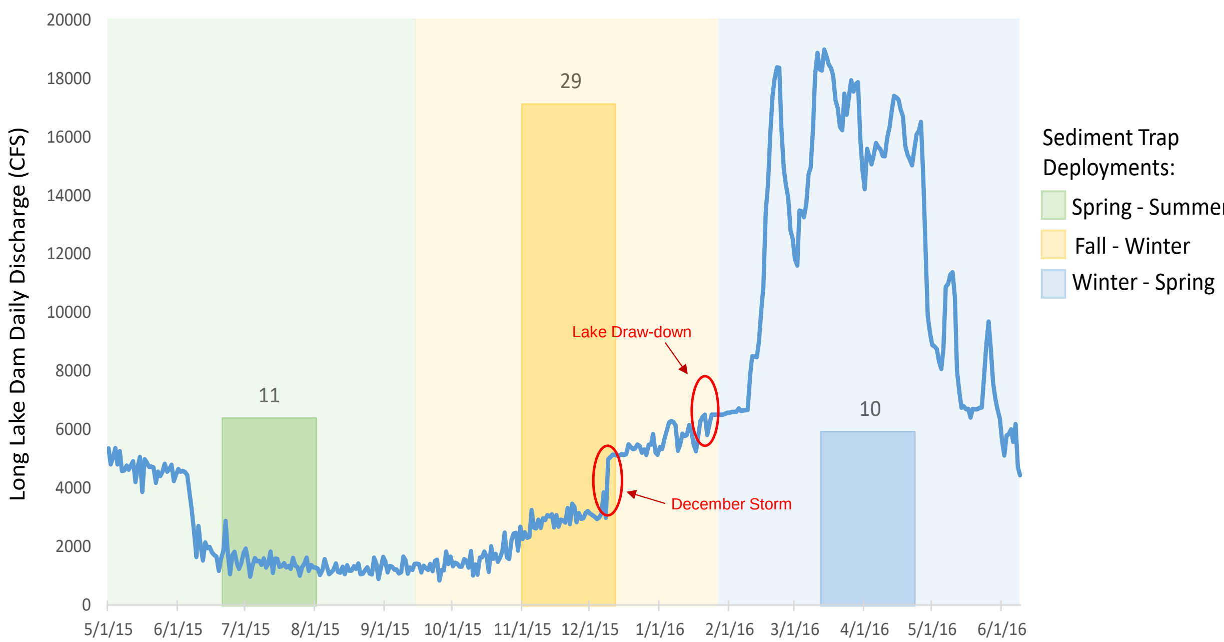


Figure 14. Mean Total PCBs (ppb) in Suspended Sediments with Hydrograph.

Sediment Traps versus Centrifugation

Suspended sediments were also collected at the same time as CLAM samples during the *Assessment Methods for Low-Level Toxics* (Low Level study; Hobbs and McCall, 2016). Suspended sediments were collected with EAP's centrifuge trailer system that consists of two large capacity flow-through centrifuges (Alpha Laval, Sedisamp II, Model 101L). Sampling occurred over a 24-hour period with more than 1600 liters of river water processed through each centrifuge.

Figure 15 presents total PCB (tPCB) concentrations from the replicate centrifuges on June 10, 2016 (13.2 and 15.8 ppb). These results are similar to the spring-summer (4/29/15 – 9/10/15) and winter-spring (1/26/16 – 6/9/16) results from the *Spokane Tribal Boundary* study. Total PBDE concentrations from June 10, 2016 are also similar to spring-summer and winter-spring results (Figure 16). February 2017 suspended sediment data from the Low Level study are not yet available.

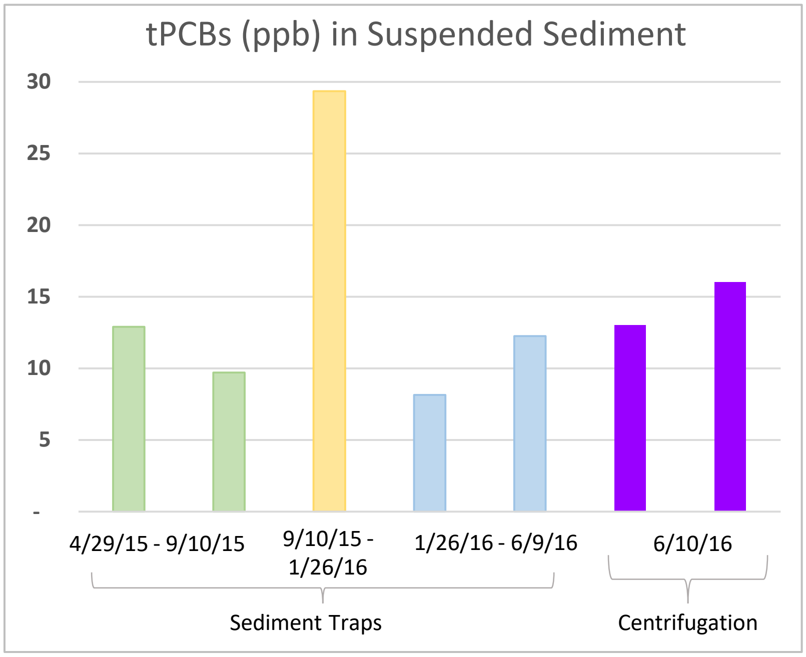


Figure 15. PCBs in Suspended Sediments Collected by Sediment Traps and by Centrifugation at the UGM Site.

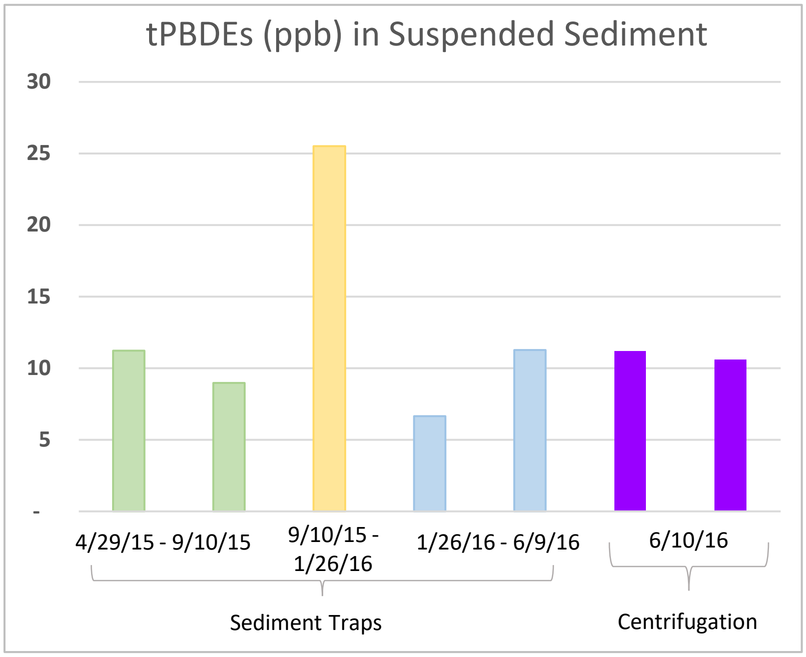


Figure 16. PBDEs in Suspended Sediments Collected by Sediment Traps and by Centrifugation at the UGM Site.

Conclusions

Results of this 2015–2016 study support the following conclusions:

- The mean of seasonal total PCB concentrations in surface water for the study ranged from 63 – 87 pg/L at the upper Spokane Tribal boundary monitoring site (Union Gospel Mission dock) using three collection and extraction methods: 2-liter, CLAM, and XAD-2. Although the surface water results are higher than the Washington State Human Health water quality criterion of 7 pg/L and the Spokane Tribal water quality criterion of 1.3 pg/L for total PCBs, the results are considered to be semi-quantitative and will not be used for formal assessment of water quality criteria attainment.
- The CLAM collection method employed during this study used SPE disk housings made of high-density polypropylene which contained measurable levels of the mono- through tetra-PCB congeners as well as some PBDEs. Although the authors were able to censor the environmental samples against the blank CLAM SPE disk results, there would be more confidence in the data had the sampling system not been contaminated.
- Metals (cadmium, copper, lead, and zinc) in seasonal surface water grab samples were 1-2 orders of magnitude lower than Washington State's hardness-based chronic criteria for the protection of aquatic life and the Spokane Tribe of Indian's hardness-based chronic criteria for copper. Metals in suspended sediment samples were well below Washington's freshwater sediment screening levels, except for cadmium which exceeded the Sediment Cleanup Objective (SCO) and Cleanup Screening level (CSL).
- All total PCB results for suspended sediments from sediment traps were below the Washington State Freshwater Sediment Cleanup Objective of 110 ug/Kg.
- PCB, PBDE, and dioxins/furan concentrations were 2 to 3 times higher in suspended sediments from traps deployed during the fall-winter (9/10/15 – 1/26/16) monitoring period compared to the other two monitoring periods.

Recommendations

Results of this 2015–2016 study support the following recommendations:

- Sediment traps provide an excellent seasonal average of pollutants in the water column and have fewer data quality issues (e.g., blank contamination). Seasonal sediment trap monitoring should continue at the eastern Spokane Tribal boundary site in Little Falls Pool (upstream of Chamokane Creek and near the Union Gospel Mission dock) to assess contaminant trends. If resources are available, sediment trap monitoring could be expanded to include the Upriver Dam and Nine Mile Dam reservoirs to show relative contaminant trends in the Spokane River. Specific enhancements to sediment trap monitoring include:
    - Provide additional secure means of retrieval (besides just a snag line) with the use of either a transponder or being cabled to the bank.
    - Deploy multiple traps per site to ensure that enough solid sample material is collected for analyses.
    - Include both PCB congeners and PBDEs in the analyses. Dioxins/furans and any metals of interest could be added to the analyte list if funding allows.
- Continue seasonal contaminant monitoring with CLAMs at the eastern Spokane Tribal boundary surface water site (Union Gospel Mission dock). Use of stainless steel disk housing should eliminate contamination issues from high-density polypropylene housing. Analysis should be conducted for PCBs, and also PBDEs if funding allows.
- Surface water monitoring during draw-down events in Lake Spokane could confirm whether or not increased levels of contaminants sorbed to sediments are transported into Little Falls Pool. CLAMs could be used to test for PCBs and other contaminants of interest. Total suspended solids (TSS) and turbidity should be monitored at the same time.

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Appendices

Appendix A. 303(d) Listings for Toxics in the Spokane River

Table A-1 shows all water quality impairments and waters of concern for toxics parameters in the mainstem Spokane River including Lake Spokane. Not shown in Table A-1 are the listings for Category 1 (meets tested criteria) and Category 3 (insufficient data).

Table A-1. 303(d) Listings for Toxics Parameters in the Spokane River.

Listing ID	WRIAs	Waterbody Names	EPA-Approved 2012 Category	2008 Category	Parameter	Medium	Assessment Unit ID
42410	54 - Lower Spokane	SPOKANE LAKE	5	5	2,3,7,8-TCDD	Tissue	47117I6C1
42411	54 - Lower Spokane	SPOKANE RIVER	5	5	2,3,7,8-TCDD	Tissue	17010307000774
51586	54 - Lower Spokane	SPOKANE RIVER	5	5	2,3,7,8-TCDD	Tissue	17010307009102
51587	57 - Middle Spokane	SPOKANE RIVER	5	5	2,3,7,8-TCDD	Tissue	17010305000011
78625	54 - Lower Spokane	SPOKANE RIVER	5	3	2,3,7,8-TCDD TEQ	Tissue	17010307009085
8201	57 - Middle Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010305000011
8202	57 - Middle Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010305000009
8207	57 - Middle Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010305000010
14397	57 - Middle Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010305000012
14400	54 - Lower Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010307009102
78968	54 - Lower Spokane	SPOKANE RIVER	5	3	PCB	Tissue	17010307009085
9027	54 - Lower Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010307000010
9033	54 - Lower Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010307000774
14385	54 - Lower Spokane	SPOKANE RIVER	5	5	PCB	Tissue	17010307009615
78928	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117I7B9
78929	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117H5J8
78930	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117I5A4
78931	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117I7D3
78932	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117I5A5
78933	54 - Lower Spokane	SPOKANE LAKE	5	3	PCB	Tissue	47117I7E2
9015	54 - Lower Spokane	SPOKANE LAKE	5	5	PCB	Tissue	47117I7D4
9021	54 - Lower Spokane	SPOKANE LAKE	5	5	PCB	Tissue	47117H5I3
36440	54 - Lower Spokane	SPOKANE LAKE	5	5	PCB	Tissue	47117I8C2
36441	54 - Lower Spokane	SPOKANE LAKE	5	5	PCB	Tissue	47117I6C1
9057	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010305000012
8213	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010305000011
15552	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010305000009
9046	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010307009137
9043	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010307009112
9045	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010307010781
15322	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Lead	Water	17010307007542
8200	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010305000012
8203	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010305000011
15553	57 - Middle Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010305000009
9047	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010307009137
9031	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010307009112
9044	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010307010781
15335	54 - Lower Spokane	SPOKANE RIVER	4A	4A	Zinc	Water	17010307007542
15530	54 - Lower Spokane	SPOKANE LAKE	4A	4A	Zinc	Water	47117I8D3
51638	54 - Lower Spokane	SPOKANE RIVER	2	2	2,3,7,8-TCDD TEQ	Tissue	17010307009102
51639	57 - Middle Spokane	SPOKANE RIVER	2	2	2,3,7,8-TCDD TEQ	Tissue	17010305000009
51640	57 - Middle Spokane	SPOKANE RIVER	2	2	2,3,7,8-TCDD TEQ	Tissue	17010305000011
13119	57 - Middle Spokane	SPOKANE RIVER	2	2	PCB	Water	17010305000010
14396	57 - Middle Spokane	SPOKANE RIVER	2	2	PCB	Water	17010305000011
9019	54 - Lower Spokane	SPOKANE LAKE	2	2	PCB	Water	47117I8D3
9014	54 - Lower Spokane	SPOKANE LAKE	2	2	Chlordane	Water	47117I8D3
9017	54 - Lower Spokane	SPOKANE LAKE	2	2	DDT	Water	47117I8D3
9008	54 - Lower Spokane	SPOKANE LAKE	2	2	4,4'-DDD	Water	47117H5H4
9007	54 - Lower Spokane	SPOKANE LAKE	2	2	4,4'-DDE	Water	47117I8D3
9013	54 - Lower Spokane	SPOKANE LAKE	2	2	Dieldrin	Water	47117H5H4
9030	54 - Lower Spokane	SPOKANE LAKE	2	2	Dieldrin	Water	47117I8D3
9011	54 - Lower Spokane	SPOKANE LAKE	2	2	Endrin	Water	47117I8D3
9009	54 - Lower Spokane	SPOKANE LAKE	2	2	Heptachlor	Water	47117H5H4
9010	54 - Lower Spokane	SPOKANE LAKE	2	2	Heptachlor Epoxide	Water	47117H5H4
78441	54 - Lower Spokane	SPOKANE RIVER	2	3	Zinc	Water	17010307007531

Appendix B. Data Quality Tables

Table B-1. Results for Laboratory Measure Quality Objectives (MQOs).

Parameter	Matrix / Sampling Dates	LCS (% Recovery)	Pass?	Duplicate samples (RPD)	Pass?	MS (% Recovery)	Pass?	MSD (RPD)	Pass?	Surrogate Recoveries (% Recovery)	Pass?
DOC & TOC	Surface Water	80 – 120	Yes	≤20%	Yes	75 – 125	Yes	≤20%	NAF	NA	NA
TSS & TNVSS		80 – 120	Yes	≤20%	Yes	NA	NA	NA	NA	NA	NA
Hardness		85 – 115	Yes	≤20%	NAF	75 – 125	Yes	≤20%	Yes	NA	NA
Cd, Cu, Pb, & Zn		85 –115	Yes	≤20%	NAF	75 –125	Yes	≤20%	Yes	NA	NA
PCBs	CLAM	50 – 150	Yes	≤50%	NAF	NA	NA	NA	NA	25 – 150	Yes
PBDEs		50 – 150	Yes	≤50%	NAF	NA	NA	NA	NA	25 – 150	Mostly (a)
PCBs	XAD-2	50 – 150	Yes	≤50%	NAF	NA	NA	NA	NA	25 – 150	Yes
PCBs	2 Liter	50 – 150	Yes	≤50%	NAF	NA	NA	NA	NA	25 – 150	Yes
TOC	Suspended Sediment	80 – 120	Yes	≤20%	Yes	NA	NA	NA	NA	NA	NA
% solids		NA	NA	≤20%	NAF	NA	NA	NA	NA	NA	NA
Cd, Cu, & Pb		85 – 115	Yes	≤20%	Yes	75 – 125	Mostly (b)	≤20%	Yes	NA	NA
Zinc		85 – 115	Yes	≤20%	Yes	75 – 125	No (c)	≤20%	No	NA	NA
PCBs		50 – 150†	Mostly (d)	≤50%	Yes (e)	NA	NA	NA	NA	25 – 150	Yes
PBDEs		50 – 150†	Yes	≤50%	Yes (f)	NA	NA	NA	NA	25 – 150	Yes
Dioxins/furans		25 – 150†	Mostly (g)	≤50%	Yes	NA	NA	NA	NA	25 – 150	Yes

LCS = Laboratory Control Sample   MS = Matrix Spike   MSD = Matrix Spike Duplicate
NA = Not applicable.   NAF = Not analyzed for.
Yes = Defined as 100% of the specific QA/QC compounds were within acceptance limits defined by the laboratory method quality objectives (MQOs).
Mostly = Defined as >50% of the specific QA/QC compounds were within acceptance limits defined by laboratory MQOs.
Some = Defined as <50% of the specific QA/QC compounds were within acceptance limits defined by laboratory MQOs.
No = None of the specific QA/QC compounds were within acceptance limits defined by laboratory MQOs.

(Continued on next page)

Notes for Table B-1 *(continued)*

† Per Method for Ongoing Precision and Recovery (OPR), internal standards, and labeled compounds.

(a) For the May 2015 sampling, all the surrogates were within recovery limits. For September, 2 of 4 samples had slightly low recoveries for PBDE 209L at 23% and 24%.

(b) The MS and MSD for copper were within recovery acceptance limits (75 – 125%). The MS for cadmium was slightly high (126%) and the MS for lead was low (73%); however, the MSD recoveries for both cadmium and copper were acceptable. The source sample results for cadmium and lead were therefore qualified as estimates ("J").

(c) MS and MSD recoveries for zinc were not calculated due to homogeneity in the source sample.

(d) The OPR criteria were met for all the labeled standards with the exception of PCBs 001, 002, and 003, which had no recoveries; therefore, the associated samples were qualified as estimates with a "J" flag. Labeled CB congener recoveries and Cleanup standard recoveries were all within acceptance limits.

(e) Almost all (143/146) of the detected duplicate congener pairs had an RPD ≤50% with an average RPD of 8%.

(f) All (n = 35) of the detected duplicate congener pairs had an RPD ≤50% with an average RPD of 8%.

(g) The OPR criteria were met for the dioxin/furan analysis. With the exception of the labeled standards in sample number 1606061-2, the rest of the samples met the labeled standard recovery control limits. Due to possible low bias, results associated with the out of control labeled compound recoveries in the sample were flagged as estimated with either a "J" or "UJ" flag.

Appendix C. Data Tables

Tables C-1, C-2, and C-3 are available only online as zip files, linked to this report at:
https://fortress.wa.gov/ecy/publications/SummaryPages/1703019.html

Table C-4. PCB Results for Sediment Traps, pg/g, part per trillion, dry weight.

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring			
Sample Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16			
Sample No.	1606061-1		1606061-2		1606061-3		1606061-4		1606061-5	
PCB-001	**5.28**	**J**	**6.47**		**6.52**		**3.18**		**2.36**	
PCB-002	**12.1**		**12.4**		**15.7**		**9.69**		**9.3**	
PCB-003	**8**	**J**	**7**		**8.28**		**4.7**		**3.77**	
PCB-004	**4.19**	**J**	**6.29**		**8.17**		**9.41**		**4.03**	
PCB-005	1.93	UJ	**0.336**	**NJ**	**0.46**	**J**	**0.135**	**J**	**0.23**	**J**
PCB-006	**2.11**	**J**	**2.98**		**5.84**		**2.47**		**3.32**	
PCB-007	1.8	UJ	**0.986**		**1.2**	**J**	**0.497**		**0.669**	
PCB-008	**9.58**		**13.1**		**24.5**		**10.6**		**14.9**	
PCB-009	1.67	UJ	**1.08**		**1.4**		**0.584**		**0.722**	
PCB-010	1.76	UJ	**0.279**	**J**	**0.527**	**NJ**	**0.392**		**0.209**	**J**
PCB-011	**68.1**		**95**		**166**		**44**		**70.7**	
PCB-012/013	**5.23**	**J**	**7.23**		**12.1**		**5.06**		**7.18**	
PCB-014	**2.94**	**J**	**0.578**	**J**	**1.3**	**J**	**0.429**	**NJ**	**0.521**	**NJ**
PCB-015	**36.9**		**46.3**		**118**		**41.4**		**55**	
PCB-016	**13.9**		**14.9**		**33**		**24.6**		**23.9**	
PCB-017	**19.3**		**16.2**		**42.7**		**24.2**		**27.1**	
PCB-018/030	**43.7**		**33.3**		**80.4**		**58.2**		**61.3**	
PCB-019	**5.25**	**J**	**5.02**		**10.2**		**7.45**		**5.39**	
PCB-020/028	**187**		**183**		**547**		**214**		**291**	
PCB-021/033	**26.1**		**29.9**		**79.4**		**36.4**		**54.3**	
PCB-022	**35.2**		**36.7**		**95.3**		**40.9**		**54.6**	
PCB-023	0.506	UJ	0.168	UJ	**0.224**	**J**	**0.089**	**J**	0.113	UJ
PCB-024	**1.08**	**J**	**0.591**	**J**	**1.56**		**0.872**		**0.939**	
PCB-025	**11.1**		**8.65**		**25**		**10.7**		**14.2**	
PCB-026/029	**19.2**		**19.2**		**53**		**24.1**		**32.3**	
PCB-027	**4.99**	**J**	**3.7**		**10.7**		**5.87**		**6.3**	
PCB-031	**106**		**107**		**296**		**127**		**170**	
PCB-032	**4.47**		**5.24**		**22**		**15.6**		**13.6**	
PCB-034	**1.71**	**J**	**1.17**		**4.05**		**1.41**		**2.27**	
PCB-035	**4.08**	**J**	**5.18**		**12.7**		**4.25**		**6.23**	**NJ**
PCB-036	0.486	NUJ	**0.735**	**J**	**1.26**		0.197	NUJ	0.342	NUJ
PCB-037	**67.3**		**61.5**		**210**		**74.3**		**108**	
PCB-038	**1.41**	**J**	**1.24**		**2.11**		**0.447**	**NJ**	**0.52**	**NJ**
PCB-039	**2.05**	**J**	**2.29**		**6.74**		**1.9**	**NJ**	**2.76**	
PCB-040/041/071	**89.7**		**77.2**		**304**		**112**		**173**	
PCB-042	**78.2**		**71.7**		**236**		**78.6**		**119**	
PCB-043	**11.3**	**J**	**8.59**		**25.8**		**9.31**		**14.1**	
PCB-044/047/065	**314**		**268**		**778**		**274**		**397**	
PCB-045/051	**35.3**		**32.3**		**80.3**		**37.1**		**47**	
PCB-046	**10.4**		**8.11**		**24.9**		**11.2**		**14.9**	
PCB-048	**41.8**		**37.5**		**122**		**42.8**		**64.8**	
PCB-049/069	**203**		**174**		**538**		**164**		**257**	
PCB-050/053	**31.4**		**22**		**63.1**		**26.9**		**37.1**	
PCB-052	**344**		**291**		**817**		**284**		**415**	
PCB-054	0.452	NUJ	0.363	UJ	**0.809**	**NJ**	0.32	U	0.396	UJ
PCB-055	**2.47**	**J**	0.328	UJ	0.452	UJ	0.136	UJ	0.214	UJ

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring			
Sample Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16			
Sample No.	1606061-1		1606061-2		1606061-3		1606061-4		1606061-5	
PCB-056	**124**		**115**		**420**		**148**		**214**	
PCB-057	**1.14**	**J**	**1.01**		**3.82**		**0.919**	**J**	**1.45**	
PCB-058	**1.87**	**J**	**1.83**		**6.2**		**1.67**	**J**	**2.79**	
PCB-059/062/075	**28.5**		**24.6**		**77.8**		**24.1**		**35.9**	
PCB-060	**63.7**		**59**		**162**		**67.6**		**93.2**	
PCB-061/070/074/076	**562**		**498**		**1590**		**510**		**779**	
PCB-063	**16.5**		**15.3**		**48.2**		**14.4**		**21.4**	
PCB-064	**158**		**127**		**391**		**127**		**194**	
PCB-066	**418**		**402**		**1320**		**391**		**601**	
PCB-067	**8.2**	**J**	**6.7**		**23.3**		**7.64**		**11.8**	
PCB-068	**6.43**	**J**	**6.58**		**14.7**		**4.85**		**5.73**	
PCB-072	**5.34**	**J**	**4.74**		**14.7**		**3.99**		**6.16**	
PCB-073	0.117	UJ	0.113	UJ	0.232	UJ	0.0343	UJ	0.105	UJ
PCB-077	**40**		**35**		**106**		**40.8**		**53.8**	
PCB-078	0.936	UJ	0.324	UJ	0.447	UJ	0.135	UJ	0.212	UJ
PCB-079	**7.52**	**J**	**6.79**		**19.9**		**5.03**		**7.18**	
PCB-080	0.835	UJ	0.291	UJ	0.401	UJ	0.121	UJ	0.189	UJ
PCB-081	**1.57**	**J**	**1.34**		**3.5**		**1.06**		**1.6**	
PCB-082	**65.2**		**49.7**		**168**		**48.6**		**72.8**	
PCB-083/099	**435**		**316**		**1020**		**235**		**371**	
PCB-084	**113**		**85.6**		**301**		**78.2**		**123**	
PCB-085/116/117	**128**		**114**		**352**		**86.3**		**132**	
PCB-086/087/097/109/119/125	**344**		**272**		**872**		**226**		**348**	
PCB-088/091	**88.3**		**67.4**		**239**		**53.6**		**86.4**	
PCB-089	**5.11**	**J**	**4.5**		**17.4**		**5.38**		**7.71**	
PCB-090/101/113	**578**		**416**		**1290**		**309**		**483**	
PCB-092	**106**		**82.5**		**259**		**60.6**		**94.7**	
PCB-093/095/098/100/102	**404**		**280**		**884**		**237**		**349**	
PCB-094	**2.9**	**J**	**2.27**		**7.03**	**NJ**	**1.71**		**2.66**	
PCB-096	**3.18**	**J**	**2.14**		**7.38**		**2.17**		**3.25**	
PCB-103	**5.41**	**J**	**4.06**		**13.5**		**2.79**		**4.53**	
PCB-104	0.117	UJ	0.168	UJ	0.259	UJ	**0.045**	**NJ**	0.107	UJ
PCB-105	**219**		**163**		**484**		**156**		**219**	
PCB-106	2.29	UJ	0.559	UJ	0.675	UJ	0.206	UJ	0.552	UJ
PCB-107	**43.7**		**35.1**		**99.4**		**29.4**		**40.9**	
PCB-108/124	**14.5**		**14.5**		**43.7**		**12.9**		**18.8**	
PCB-110/115	**641**		**484**		**1520**		**387**		**587**	
PCB-111	**1.36**	**NJ**	0.292	UJ	**1**	**J**	**0.15**	**NJ**	**0.279**	**J**
PCB-112	0.444	UJ	0.287	UJ	0.491	UJ	0.0583	UJ	0.181	UJ
PCB-114	**13**	**J**	**9.69**		**26.2**		**8.72**		**12.5**	
PCB-118	**511**		**392**		**1220**		**347**		**500**	
PCB-120	**3.01**	**J**	**2.25**		**6.88**		**1.62**		**2.44**	
PCB-121	0.453	UJ	0.299	UJ	0.512	UJ	**0.077**	**NJ**	0.189	UJ
PCB-122	**6.24**	**J**	**5.65**		**15.6**		**5.3**		**7.3**	
PCB-123	**13.5**		**10.8**		**29.9**		**7.16**		**10.7**	
PCB-126	2.1	UJ	**2.33**		**5.21**		**1.79**		**2.36**	
PCB-127	2.37	UJ	**0.885**		**2.41**		**0.492**		**1.09**	

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring			
Sample Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16			
Sample No.	1606061-1		1606061-2		1606061-3		1606061-4		1606061-5	
PCB-128/166	**113**		**74.9**		**231**		**57.7**		**85.7**	
PCB-129/138/160/163	**769**		**519**		**1680**		**362**		**549**	
PCB-130	**49.5**		**33.8**		**100**		**22.9**		**36**	
PCB-131	**7.19**	**J**	**3.22**	**J**	**14.7**		**2.98**		**4.69**	**NJ**
PCB-132	**195**		**113**		**435**		**96.6**		**148**	
PCB-133	**11.7**		**8.48**		**27.5**	**NJ**	**5.52**		**8.13**	
PCB-134/143	**25.5**		**18.5**		**58.8**		**13.3**		**21.2**	
PCB-135/151/154	**231**		**145**		**491**		**101**		**159**	
PCB-136	**69.2**		**37.3**		**142**		**28.5**		**45.9**	
PCB-137	**18.5**		**16.8**		**55.2**		**12.4**		**18.7**	
PCB-139/140	**9.04**	**J**	**5.57**	**J**	**21.5**		**4.31**	**NJ**	**7.62**	
PCB-141	**121**		**73.4**		**240**		**52.1**		**80.2**	
PCB-142	2.42	UJ	1.07	UJ	1.63	UJ	0.597	UJ	1.26	UJ
PCB-144	**29.3**		**15.6**		**48.1**		**11.4**		**18.2**	
PCB-145	0.117	UJ	0.104	UJ	**0.587**		**0.038**	**NJ**	**0.066**	**NJ**
PCB-146	**116**		**85.7**		**245**		**56.5**		**87.6**	
PCB-147/149	**542**		**328**		**1220**		**249**		**377**	
PCB-148	**1.56**	**J**	**0.538**	**J**	**2.96**	**NJ**	**0.415**	**NJ**	**0.559**	**J**
PCB-150	**0.601**	**J**	**0.315**	**NJ**	**1.77**	**NJ**	**0.391**	**J**	**0.284**	**NJ**
PCB-152	**0.236**	**NJ**	0.104	UJ	**0.432**	**J**	**0.257**	**J**	**0.426**	**NJ**
PCB-153/168	**681**		**457**		**1520**		**298**		**478**	
PCB-155	**0.747**	**NJ**	**0.87**		**2.76**		**0.416**		**0.733**	
PCB-156/157	**65.9**		**46.1**		**122**		**37.6**		**57**	
PCB-158	**55.3**		**36.1**		**125**		**29.3**		**44.2**	
PCB-159	1.7	UJ	**6.86**	**J**	**20.9**		**0.576**	**J**	**0.892**	**NJ**
PCB-161	1.66	UJ	0.736	UJ	1.12	UJ	0.41	UJ	0.863	UJ
PCB-162	**1.77**	**J**	**2.04**	**J**	**3.6**	**J**	**1.04**	**J**	**1.3**	**J**
PCB-164	**48.3**		**33.1**		**102**		**22.3**		**35.5**	
PCB-165	1.83	UJ	0.813	UJ	1.23	UJ	0.453	UJ	0.954	UJ
PCB-167	**28.6**		**18.6**		**51.2**		**14.6**		**21.1**	
PCB-169	1.67	UJ	1.4	UJ	3.05	UJ	0.807	UJ	1.39	UJ
PCB-170	**212**		**150**		**305**		**86.8**		**141**	
PCB-171/173	**65.6**		**45.9**		**93.2**		**23.7**		**36.7**	
PCB-172	**45.1**		**26.3**		**66**		**15.1**		**23.4**	
PCB-174	**210**		**127**		**337**		**87.1**		**137**	
PCB-175	**10.4**		**5.55**		**15.3**		**3.34**		**5.69**	
PCB-176	**24.8**	**NJ**	**15.3**		**40.4**		**10.1**		**18**	
PCB-177	**112**		**72**		**174**		**48.7**		**74.9**	
PCB-178	**48.8**		**35.3**		**99.8**		**23.4**		**37.3**	
PCB-179	**86.7**		**56.5**		**148**		**37.6**		**68.6**	
PCB-180/193	**581**		**352**		**827**		**240**		**361**	
PCB-181	**0.54**	**NJ**	**0.996**	**NJ**	**1.75**	**NJ**	**0.619**		**0.917**	
PCB-182	**2.21**	**J**	**1.03**		**3.52**	**J**	**0.721**		**0.828**	
PCB-183/185	**159**		**99.5**		**248**		**59.8**		**101**	
PCB-184	**1.69**	**J**	**1.04**	**NJ**	**3.78**	**J**	**0.738**		**1.23**	
PCB-186	0.117	UJ	0.25	UJ	**0.211**	**J**	0.0865	UJ	0.156	UJ
PCB-187	**316**		**208**		**607**		**141**		**224**	
PCB-188	**0.55**	**NJ**	**0.573**	**J**	**1.38**		**0.308**		**0.481**	

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring			
Sample Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16			
Sample No.	1606061-1		1606061-2		1606061-3		1606061-4		1606061-5	
PCB-189	**9.32**	**J**	**5.84**		**13.1**		**3.97**		**5.67**	
PCB-190	**50.7**		**29.9**		**58.2**		**17.2**		**24.4**	
PCB-191	**8.95**	**J**	**4.14**		**11.7**	**J**	**2.86**		**4.13**	
PCB-192	0.117	UJ	0.274	UJ	0.222	UJ	0.0948	UJ	0.171	UJ
PCB-194	**117**		**81.8**		**189**		**54.7**		**83.6**	
PCB-195	**47.8**		**32.5**		**78.4**		**22.2**		**37.2**	
PCB-196	**62.2**		**42.3**		**108**		**25.8**		**44.7**	
PCB-197/200	**20.2**		**13.4**		**39.1**	**NJ**	**8.88**		**16.9**	
PCB-198/199	**154**		**110**		**305**		**83.5**		**136**	
PCB-201	**14.3**		**11.5**		**29.5**		**8.06**		**13.2**	
PCB-202	**34.4**		**24.4**		**70.2**		**17.2**		**28.2**	
PCB-203	**111**		**67.2**		**199**		**53.4**		**80**	
PCB-204	**0.282**	**NJ**	**0.131**	**NJ**	0.197	UJ	**0.085**	**NJ**	**0.127**	**J**
PCB-205	**5.79**	**J**	**3.83**		**8.85**		**2.67**		**4.31**	
PCB-206	**67.4**		**53.2**		**154**		**45.1**		**73.8**	
PCB-207	**8.75**	**J**	**13.9**		**22.9**		**6.83**		**10.9**	
PCB-208	**21**		**36.5**		**54.7**		**15.5**		**25.8**	
PCB-209	**46.1**		**40.7**		**81.7**		**25**		**39.9**	
1-Mono	**25**		**26**		**31**		**18**		**15**	
2-Di	**129**		**174**		**339**		**115**		**157**	
3-Tri	**554**		**536**		**1533**		**672**		**875**	
4-Tetra	**2604**		**2295**		**7191**		**2388**		**3568**	
5-Penta	**3744**		**2816**		**8885**		**2304**		**3480**	
6-Hexa	**3191**		**2080**		**6963**		**1481**		**2287**	
7-Hepta	**1945**		**1237**		**3054**		**803**		**1266**	
8-Octa	**567**		**387**		**1027**		**276**		**444**	
9-Nona	**97**		**104**		**232**		**67**		**111**	
Total PCBs	**12904**		**9695**		**29337**		**8150**		**12244**	

Bold = Visual aid for detected compounds.
J = Analyte positively identified; results is an estimate.
NJ = Analyte tentatively identified; result is approximate.
UJ = Analyte not found at the estimated reporting limit shown.
NUJ = Analyte tentatively identified and not found at the estimated reporting limit shown.

Table C-5. PBDE Results for Sediment Traps, pg/g, part per trillion, dry weight.

Sampling Season	Spring - Summer				Fall - Winter		Winter - Spring			
Sample No.	1606061-1		1606061-2 (rep)		1606061-3		1606061-4		1606061-5 (rep)	
Deployment Dates	4/29/15 - 9/10/15				9/10/15 - 1/26/16		1/26/16 - 6/9/16			
BDE-007	**20.3**	**J**	**7.19**	**J**	**26**		**5.65**		**8.34**	
BDE-008/011	**7.38**	**J**	**3.42**	**J**	**12.6**	**J**	**3.46**		**5.68**	**J**
BDE-010	0.851	UJ	0.207	UJ	0.327	UJ	0.0687	UJ	0.119	UJ
BDE-012/013	**2.39**	**J**	**1.24**	**J**	**4.19**	**J**	**1.29**	**J**	**2.12**	**J**
BDE-015	**22.8**	**J**	**20.7**		**36.3**		**13.4**		**19.4**	
BDE-017/025	**225**		**118**		**467**		**57.9**		**110**	
BDE-028/033	**132**		**108**		**244**		**42.5**		**70.6**	
BDE-030	1.91	UJ	0.421	UJ	0.93	UJ	0.159	UJ	0.227	UJ
BDE-032	1.5	UJ	0.331	UJ	**1.18**	**J**	0.126	UJ	**0.262**	**J**
BDE-035	1.2	UJ	**0.696**	**J**	**2.7**	**NJ**	**0.496**	**NJ**	**0.719**	**NJ**
BDE-037	**5.47**	**J**	**5.32**	**J**	**12.5**	**J**	**3.32**	**J**	**5.07**	**J**
BDE-047	**3660**		**3120**		**8430**		**1500**		**2510**	
BDE-049	**473**		**332**		**1280**		**223**		**390**	
BDE-051	**43.8**	**J**	**31.8**		**122**		**19.4**		**36.2**	
BDE-066	**91.6**		**48.9**		**172**		**26.7**		**42.8**	
BDE-071	**40.5**	**J**	**36.2**		**115**		**14.7**		**29.4**	
BDE-075	**7.08**	**J**	**5.05**	**J**	**15.6**	**J**	**2.07**	**J**	**3.67**	**J**
BDE-077	**1.20**	**J**	**0.906**	**NJ**	**3.66**	**NJ**	**0.568**	**J**	**1.01**	**J**
BDE-079	0.702	UJ	**30.9**		**68.5**	**NJ**	0.0687	UJ	0.119	UJ
BDE-085	**42.3**	**J**	**49.1**		**123**		**41.2**		**52.1**	
BDE-099	**1920**		**1800**		**4960**		**1150**		**1820**	
BDE-100	**705**		**590**		**1560**		**340**		**533**	
BDE-105	2.74	UJ	1.18	UJ	3.13	UJ	0.492	UJ	0.872	UJ
BDE-116	3.72	UJ	1.66	UJ	4.39	UJ	0.689	UJ	1.22	UJ
BDE-119/120	**14.8**	**J**	**11.7**		**29.5**		**6.89**		**9.47**	
BDE-126	**2.21**	**J**	**1.6**	**J**	**2.65**	**J**	**1.01**	**J**	**2.11**	**J**
BDE-128	14.6	UJ	6.29	UJ	7.88	UJ	2.62	UJ	10.4	UJ
BDE-138/166	**10.9**	**J**	**11.2**		**25.7**		**14.7**		**16.4**	**J**
BDE-140	**8.06**	**J**	**6.97**	**J**	**19.2**		**8.85**	**J**	**9.08**	**J**
BDE-153	**178**		**161**		**445**		**138**		**203**	
BDE-154	**207**	**J**	**164**	**J**	**448**	**J**	**127**	**J**	**198**	**J**
BDE-155	**22.3**	**J**	**18.6**		**63.4**		**15.3**		**23**	**J**
BDE-181	4.82	UJ	**1.86**	**J**	**6.35**	**NJ**	**1.22**	**J**	**2.18**	**J**
BDE-183	**32.1**	**NJ**	**24**		**65**		**20.9**		**33.9**	
BDE-190	7.85	UJ	**4.6**	**J**	**16**	**J**	**3.35**	**J**	**6.17**	
BDE-203	**42.5**	**J**	**34.9**		**112**		**28.8**		**50.8**	
BDE-206	**102**	**J**	**159**	**J**	**463**	**J**	**210**	**J**	**364**	**J**
BDE-207	**173**	**J**	**202**	**J**	**671**	**J**	**236**	**J**	**434**	**J**
BDE-208	**93.6**	**J**	**135**	**J**	**474**	**J**	**159**	**J**	**278**	**J**
BDE-209	**2940**		**1720**		**5020**		**2220**		**4000**	
Total PBDEs	**11226**		**8966**		**25517**		**6637**		**11270**	

Bold = Visual aid for detected compounds.
J = Analyte positively identified, results is an estimate.
NJ = Analyte tentatively identified, result is approximate.
UJ = Analyte not found at the estimated reporting limit shown.

Table C-6. PCB Congeners Detected in Surface Water and Suspended Sediments.

Surface Water Samples						Sediment Traps			Homologue Group
May 2015	September 2015	January 2016		CLAM Disk Blanks					
CLAMs (lab and field)	CLAMs (lab and field)	XAD	2 Liter	May 2015	September 2015	May - Aug 2015	Aug 2015 - Jan 2016	Jan - Jun 2016	
				PCB-001	PCB-001	PCB-001	PCB-001	PCB-001	1
				PCB-002	**PCB-002**	**PCB-002**	**PCB-002**	**PCB-002**	1
				PCB-003	**PCB-003**	PCB-003	PCB-003	PCB-003	1
				PCB-004	PCB-004	PCB-004	PCB-004	PCB-004	2
				PCB-006	**PCB-006**	PCB-006	PCB-006	PCB-006	2
				PCB-007	**PCB-007**				2
				PCB-008	**PCB-008**	**PCB-008**	**PCB-008**	**PCB-008**	2
				PCB-009	PCB-009		PCB-009		2
	PCB-010								2
				PCB-011	**PCB-011**	**PCB-011**	**PCB-011**	**PCB-011**	2
				PCB-012/013	**PCB-012/013**	PCB-012/013	**PCB-012/013**	PCB-012/013	2
					PCB-014				2
				PCB-015	**PCB-015**	**PCB-015**	**PCB-015**	**PCB-015**	2
				PCB-016	**PCB-016**	**PCB-016**	**PCB-016**	**PCB-016**	3
				PCB-017	**PCB-017**	**PCB-017**	**PCB-017**	**PCB-017**	3
				PCB-018/030	**PCB-018/030**	**PCB-018/030**	**PCB-018/030**	**PCB-018/030**	3
	PCB-019			**PCB-019**		PCB-019	**PCB-019**	PCB-019	3
	PCB-020/028			**PCB-020/028**	**PCB-020/028**	**PCB-020/028**	**PCB-020/028**	**PCB-020/028**	3
				PCB-021/033	**PCB-021/033**	**PCB-021/033**	**PCB-021/033**	**PCB-021/033**	3
				PCB-022	PCB-022	**PCB-022**	**PCB-022**	**PCB-022**	3
							PCB-024		3
				PCB-025	PCB-025	**PCB-025**	**PCB-025**	**PCB-025**	3
				PCB-026/029	PCB-026/029	**PCB-026/029**	**PCB-026/029**	**PCB-026/029**	3
	PCB-027			PCB-027	PCB-027	PCB-027	**PCB-027**	PCB-027	3
				PCB-031	**PCB-031**	**PCB-031**	**PCB-031**	**PCB-031**	3
				PCB-032	PCB-032	PCB-032	**PCB-032**	**PCB-032**	3
	PCB-034					PCB-034	PCB-034	PCB-034	3
			PCB-035		PCB-035	PCB-035	**PCB-035**	PCB-035	3
				PCB-037	PCB-037	**PCB-037**	**PCB-037**	**PCB-037**	3
						PCB-038	PCB-038		3
					PCB-039	PCB-039	PCB-039		3
	PCB-040/041/071			**PCB-040/041/071**	PCB-040/041/071	**PCB-040/041/071**	**PCB-040/041/071**	**PCB-040/041/071**	4
	PCB-042		**PCB-042**	**PCB-042**	**PCB-042**	**PCB-042**	**PCB-042**	**PCB-042**	4
	PCB-043					**PCB-043**	**PCB-043**	**PCB-043**	4
				PCB-044/047/065	**PCB-044/047/065**	**PCB-044/047/065**	**PCB-044/047/065**	**PCB-044/047/065**	4
				PCB-045/051	**PCB-045/051**	**PCB-045/051**	**PCB-045/051**	**PCB-045/051**	4
	PCB-046		PCB-046	PCB-046		**PCB-046**	**PCB-046**	**PCB-046**	4
	PCB-048			**PCB-048**	PCB-048	**PCB-048**	**PCB-048**	**PCB-048**	4
	PCB-049/069	PCB-049/069		**PCB-049/069**	**PCB-049/069**	**PCB-049/069**	**PCB-049/069**	**PCB-049/069**	4
	PCB-050/053			**PCB-050/053**	PCB-050/053	**PCB-050/053**	**PCB-050/053**	**PCB-050/053**	4
	PCB-052			**PCB-052**		**PCB-052**	**PCB-052**	**PCB-052**	4
	PCB-054								4
	PCB-056	PCB-056	**PCB-056**	**PCB-056**	PCB-056	**PCB-056**	**PCB-056**	**PCB-056**	4
	PCB-057					PCB-057	PCB-057		4
						PCB-058	PCB-058	PCB-058	4
	PCB-059/062/075			PCB-059/062/075	PCB-059/062/075	**PCB-059/062/075**	**PCB-059/062/075**	**PCB-059/062/075**	4
	PCB-060			**PCB-060**	PCB-060	**PCB-060**	**PCB-060**	**PCB-060**	4

Table C-6 (continued). PCB Congeners Detected in Surface Water and Suspended Sediments.

Surface Water Samples						Sediment Traps			Homologue Group
May 2015	September 2015	January 2016		CLAM Disk Blanks					
CLAMs (lab and field)	CLAMs (lab and field)	XAD	2 Liter	May 2015	September 2015	May - Aug 2015	Aug 2015 - Jan 2016	Jan - Jun 2016	
	PCB-061/070/074/076	PCB-061/070/074/076	**PCB-061/070/074/076**	**PCB-061/070/074/076**	PCB-061/070/074/076	**PCB-061/070/074/076**	**PCB-061/070/074/076**	**PCB-061/070/074/076**	4
	PCB-063					**PCB-063**	**PCB-063**	**PCB-063**	4
	PCB-064	PCB-064			PCB-064	**PCB-064**	**PCB-064**	**PCB-064**	4
	PCB-066	PCB-066		**PCB-066**	PCB-066	**PCB-066**	**PCB-066**	**PCB-066**	4
	PCB-067					PCB-067	**PCB-067**	**PCB-067**	4
				PCB-068	**PCB-068**	PCB-068	**PCB-068**	PCB-068	4
	PCB-072					PCB-072	**PCB-072**	PCB-072	4
	PCB-077	PCB-077	PCB-077			**PCB-077**	**PCB-077**	**PCB-077**	4
PCB-079	PCB-079					PCB-079	**PCB-079**	PCB-079	4
						PCB-081	PCB-081	PCB-081	4
PCB-082	**PCB-082**	PCB-082	PCB-082			**PCB-082**	**PCB-082**	**PCB-082**	5
PCB-083/099	**PCB-083/099**	**PCB-083/099**		**PCB-083/099**	PCB-083/099	**PCB-083/099**	**PCB-083/099**	**PCB-083/099**	5
PCB-084	**PCB-084**	PCB-084	**PCB-084**			**PCB-084**	**PCB-084**	**PCB-084**	5
PCB-085/116/117	**PCB-085/116/117**	PCB-085/116/117	**PCB-085/116/117**			**PCB-085/116/117**	**PCB-085/116/117**	**PCB-085/116/117**	5
PCB-086/087/097/109/119/125	**PCB-086/087/097/109/119/125**	PCB-086/087/097/109/119/125	**PCB-086/087/097/109/119/125**	PCB-086/087/097/109/119/125	PCB-086/087/097/109/119/125	**PCB-086/087/097/109/119/125**	**PCB-086/087/097/109/119/125**	**PCB-086/087/097/109/119/125**	5
PCB-088/091	**PCB-088/091**	PCB-088/091	PCB-088/091		PCB-088/091	**PCB-088/091**	**PCB-088/091**	**PCB-088/091**	5
PCB-089	PCB-089					PCB-089	**PCB-089**	PCB-089	5
PCB-090/101/113	**PCB-090/101/113**	**PCB-090/101/113**	**PCB-090/101/113**	**PCB-090/101/113**	PCB-090/101/113	**PCB-090/101/113**	**PCB-090/101/113**	**PCB-090/101/113**	5
PCB-092	**PCB-092**	PCB-092	PCB-092			**PCB-092**	**PCB-092**	**PCB-092**	5
PCB-093/095/098/100/102	**PCB-093/095/098/100/102**	PCB-093/095/098/100/102				**PCB-093/095/098/100/102**	**PCB-093/095/098/100/102**	**PCB-093/095/098/100/102**	5
	PCB-094					PCB-094	PCB-094	PCB-094	5
	PCB-096					PCB-096	PCB-096	PCB-096	5
						PCB-103	**PCB-103**	PCB-103	5
PCB-105	**PCB-105**					**PCB-105**	**PCB-105**	**PCB-105**	5
PCB-107	PCB-107		PCB-107			**PCB-107**	**PCB-107**	**PCB-107**	5
	PCB-108/124					**PCB-108/124**	**PCB-108/124**	**PCB-108/124**	5
PCB-110/115	**PCB-110/115**	**PCB-110/115**	**PCB-110/115**	PCB-110/115	PCB-110/115	**PCB-110/115**	**PCB-110/115**	**PCB-110/115**	5
	PCB-114					**PCB-114**	**PCB-114**	**PCB-114**	5
PCB-118	**PCB-118**	**PCB-118**		PCB-118	PCB-118	**PCB-118**	**PCB-118**	**PCB-118**	5
						PCB-120	PCB-120	PCB-120	5
						PCB-122	**PCB-122**	PCB-122	5
						PCB-123	**PCB-123**	**PCB-123**	5
							PCB-126	PCB-126	5
							PCB-127		5
PCB-128/166	**PCB-128/166**	PCB-128/166	PCB-128/166			**PCB-128/166**	**PCB-128/166**	**PCB-128/166**	6
PCB-129/138/160/163	**PCB-129/138/160/163**	**PCB-129/138/160/163**		PCB-129/138/160/163		**PCB-129/138/160/163**	**PCB-129/138/160/163**	**PCB-129/138/160/163**	6
PCB-130	PCB-130					**PCB-130**	**PCB-130**	**PCB-130**	6
						PCB-131	**PCB-131**	PCB-131	6
PCB-132	**PCB-132**	PCB-132	PCB-132			**PCB-132**	**PCB-132**	**PCB-132**	6
						PCB-133	PCB-133	PCB-133	6
PCB-134/143						**PCB-134/143**	**PCB-134/143**	**PCB-134/143**	6
PCB-135/151/154	**PCB-135/151/154**	**PCB-135/151/154**	**PCB-135/151/154**	PCB-135/151/154		**PCB-135/151/154**	**PCB-135/151/154**	**PCB-135/151/154**	6
PCB-136	PCB-136	PCB-136	PCB-136			**PCB-136**	**PCB-136**	**PCB-136**	6
	PCB-137					**PCB-137**	**PCB-137**	**PCB-137**	6
						PCB-139/140	**PCB-139/140**	PCB-139/140	6

Table C-6 (continued). PCB Congeners Detected in Surface Water and Suspended Sediments.

Surface Water Samples						Sediment Traps			Homologue Group
May 2015	September 2015	January 2016		CLAM Disk Blanks					
CLAMs (lab and field)	CLAMs (lab and field)	XAD	2 Liter	May 2015	September 2015	May - Aug 2015	Aug 2015 - Jan 2016	Jan - Jun 2016	
PCB-141	**PCB-141**	PCB-141	PCB-141			**PCB-141**	**PCB-141**	**PCB-141**	6
	PCB-144					**PCB-144**	**PCB-144**	**PCB-144**	6
PCB-146	**PCB-146**	PCB-146	PCB-146			**PCB-146**	**PCB-146**	**PCB-146**	6
PCB-147/149	**PCB-147/149**	**PCB-147/149**	**PCB-147/149**	**PCB-147/149**	PCB-147/149	**PCB-147/149**	**PCB-147/149**	**PCB-147/149**	6
PCB-153/168	**PCB-153/168**	**PCB-153/168**		PCB-153/168		**PCB-153/168**	**PCB-153/168**	**PCB-153/168**	6
							PCB-155		6
PCB-156/157	PCB-156/157	PCB-156/157	PCB-156/157			**PCB-156/157**	**PCB-156/157**	**PCB-156/157**	6
PCB-158	PCB-158	PCB-158	PCB-158			**PCB-158**	**PCB-158**	**PCB-158**	6
							PCB-159		6
						PCB-162	PCB-162	PCB-162	6
PCB-164	PCB-164	PCB-164				**PCB-164**	**PCB-164**	**PCB-164**	6
	PCB-167					**PCB-167**	**PCB-167**	**PCB-167**	6
PCB-170	**PCB-170**	PCB-170	PCB-170			**PCB-170**	**PCB-170**	**PCB-170**	6
PCB-171/173	PCB-171/173					**PCB-171/173**	**PCB-171/173**	**PCB-171/173**	7
PCB-172						**PCB-172**	**PCB-172**	**PCB-172**	7
PCB-174	**PCB-174**	PCB-174	PCB-174			**PCB-174**	**PCB-174**	**PCB-174**	7
						PCB-175	**PCB-175**	PCB-175	7
	PCB-176					**PCB-176**	**PCB-176**	**PCB-176**	7
PCB-177	**PCB-177**		PCB-177			**PCB-177**	**PCB-177**	**PCB-177**	7
PCB-178	PCB-178		PCB-178			**PCB-178**	**PCB-178**	**PCB-178**	7
PCB-179	PCB-179	PCB-179	PCB-179			**PCB-179**	**PCB-179**	**PCB-179**	7
PCB-180/193	**PCB-180/193**	PCB-180/193				**PCB-180/193**	**PCB-180/193**	**PCB-180/193**	7
						PCB-182	PCB-182		7
PCB-183/185	**PCB-183/185**	PCB-183/185	PCB-183/185			**PCB-183/185**	**PCB-183/185**	**PCB-183/185**	7
							PCB-184		7
PCB-187	**PCB-187**	PCB-187	PCB-187			**PCB-187**	**PCB-187**	**PCB-187**	7
							PCB-188		7
						PCB-189	**PCB-189**	PCB-189	7
	PCB-190					**PCB-190**	**PCB-190**	**PCB-190**	7
						PCB-191	PCB-191	PCB-191	7
PCB-194	PCB-194		PCB-194			**PCB-194**	**PCB-194**	**PCB-194**	8
PCB-195						**PCB-195**	**PCB-195**	**PCB-195**	8
	PCB-196		PCB-196			**PCB-196**	**PCB-196**	**PCB-196**	8
PCB-197/200						**PCB-197/200**	PCB-197/200	**PCB-197/200**	8
PCB-198/199	PCB-198/199		PCB-198/199			**PCB-198/199**	**PCB-198/199**	**PCB-198/199**	8
						PCB-201	**PCB-201**	**PCB-201**	8
PCB-202	PCB-202		PCB-202			**PCB-202**	**PCB-202**	**PCB-202**	8
PCB-203	PCB-203		PCB-203			**PCB-203**	**PCB-203**	**PCB-203**	8
						PCB-205	PCB-205	PCB-205	8
	PCB-206					**PCB-206**	**PCB-206**	**PCB-206**	9
						PCB-207	**PCB-207**	**PCB-207**	9
						PCB-208	**PCB-208**	**PCB-208**	9
						PCB-209	**PCB-209**	**PCB-209**	10

Appendix D. Glossary, Acronyms, and Abbreviations

Glossary

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Coelute: In analytical chromatography when two or more compounds do not separate on the chromatographic column.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Parameter: Water quality constituent being measured (analyte). A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

PCB congener: Any single, unique, well-defined chemical compound in the PCB group. They are identified by the number and position of chlorine atoms around the biphenyl rings. There are theoretically 209 possible congeners.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Point source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites where more than 5 acres of land have been cleared.

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Total Maximum Daily Load (TMDL): Water cleanup plan. A distribution of a substance in a waterbody designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Toxics: Toxic chemicals.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

Acronyms and Abbreviations

CLAM	Continuous Low-level Aqueous Monitoring device
DO	Dissolved oxygen
EAP	Ecology's Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
HLB	A type of sorption media
MEL	Manchester Environmental Laboratory
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyl
QA	Quality assurance
QC	Quality control
RPD	Relative percent difference
SOP	Standard operating procedures
SPE	Solid Phase Extraction
SRRTTF	Spokane River Regional Toxics Task Force
TEQ	Toxicity Equivalent Quotient
TMDL	(See Glossary above)
tPCB	Total PCB
UGM	Union Gospel Mission, near Little Falls Pool
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area
XAD-2	A type of sorption media made up of small polymer resin beads

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
L	liter
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
ng/g	nanograms per gram (parts per billion)
pg	picogram
pg/g	picograms per gram (parts per trillion)
pg/L	picograms per liter (parts per quadrillion)
ug/Kg	micrograms per kilogram (parts per billion)
ug/L	micrograms per liter (parts per billion)
umhos/cm	micromhos per centimeter, a unit of conductivity