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Wenatchee River PCB and DDT Source Assessment

August 2016

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Addendum 2 to Quality Assurance Project Plan

Wenatchee River PCB and DDT Source Assessment

August 2016

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EAP: Environmental Assessment Program

WQP: Water Quality Program

1.0 Table of Contents

	Page
1.0 Table of Contents	4
2.0 Abstract	6
3.0 Background	6
3.1.4 Results of previous studies.....	7
Project Description.....	11
4.1 Project Goals.....	11
4.2 Project objectives	11
4.6 Tasks required.....	11
4.7 Practical constraints	12
Organization and Schedule	13
5.1 Key individuals and their responsibilities.....	13
5.4 Project schedule	14
5.6 Budget and funding.....	15
Quality Objectives	16
6.1 Decision Quality Objectives	16
6.2 Measurement Quality Objectives.....	16
Sampling Process Design (Experimental Design)	17
7.1 Study Design.....	17
7.1.1 Field measurements	18
7.1.2 Sampling location and frequency.....	18
7.1.3 Parameters to be determined.....	21
7.2 Maps or diagram	21
7.5 Characteristics of existing data	21
Sampling Procedures	22
8.1 Field measurement and field sampling SOPs	22
8.1.1 Water sampling.....	22
8.1.2 Biotic media.....	22
Measurement Methods.....	23
9.2 Lab procedures table.....	23
9.5 Lab(s) accredited for method(s).....	23
Quality Control (QC) Procedures	24
10.1 Table of field and lab QC required	24
References.....	25
Figures.....	26
Tables.....	26

List of Figures and Tables

Page

Figures

Figure 1: Estimated total PCB concentrations in water from SPMDs.....	8
Figure 2: Barplot of total PCBs in periphyton (upper) and water (lower) of the Wenatchee River during low-flow (September) over 2014 and 2015.....	9
Figure 3: Locations of two suspected PCB sources.....	17
Figure 4: Study sites for Phase 3 of the Wenatchee River PCB Source Assessment.	20

Tables

Table 1: Organization of project staff and responsibilities.....	13
Table 2: Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.....	14
Table 3: Estimated costs for PCB source tracking.....	15
Table 4: Estimated costs for PCB and DDT bioaccumulation sampling.....	15
Table 5: Measurement Quality Objectives.	16
Table 6: Study sites for Phase 3 of the Wenatchee River PCB Source Assessment.	19
Table 7: Measurement methods (laboratory).....	23
Table 8: Detailed summary of the number of SPMD samples for each sampling event and necessary quality control.	24

2.0 Abstract

The Wenatchee River has had some of the highest fish tissue concentrations of polychlorinated biphenyls (PCBs) measured in Washington State within the last 10-15 years. As a result of both PCBs and dichloro-diphenyl-trichloroethane (DDT) contamination in resident fish, there are currently eight listings for water quality impairment in the river under the federal Clean Water Act, Section 303(d). Sampling results from the most recent study of PCB sources has identified two chemically-distinct sources to the Wenatchee River, one located near the City of Cashmere and the second near the City of Wenatchee. This project will further delineate the PCB sources within the Wenatchee River, providing greater certainty of the two localized sources.

Previous study has also found that concentrations of PCBs in biofilms on rocks (mainly attached algae) are highly correlated with dissolved PCB concentrations in the water. High concentrations of PCBs and DDT in biofilms represent the entry into the Wenatchee food web. The location of the contaminated food source for Wenatchee resident fish is confined to the lower Wenatchee (downstream of Cashmere). This project will complete a bioaccumulation model for PCBs and DDT in the Lower Wenatchee River to increase our understanding of the bioaccumulation in the Wenatchee food web. The bioaccumulation model is necessary to predict the surface water and biofilm PCB and DDT concentrations that will yield fish tissue concentrations below state criteria.

3.0 Background

The Wenatchee River has had some of the highest fish tissue concentrations of polychlorinated biphenyls (PCBs) in Washington State within the last 10-15 years. As a result of both PCBs and dichloro-diphenyl-trichloroethane (DDT) contamination in resident fish tissues, there are currently 8 listings for water quality impairment in the river under the federal Clean Water Act, Section 303(d). In addition, a consumption advisory has been placed on mountain whitefish from the lower Wenatchee River by the Washington Department of Health (DOH). Fish advisories are based on the same data, but not the same thresholds for impairment as the 303(d) list.

As part of the process to reduce the concentrations of PCBs and DDT in resident fish tissues in the Wenatchee River, the Washington State Department of Ecology (Ecology) carried out a source assessment study to identify and prioritize sources of PCBs and DDT to the Wenatchee River in 2014/2015. The specific objectives of the study were: (1) to conduct an initial synoptic survey to assess the spatial distribution of PCBs, DDT, and DDT analogues DDD and DDE in the mainstem of the Wenatchee River, and (2) to identify and characterize sources of these compounds to the Wenatchee River, based on the results of the synoptic survey.

The Quality Assurance Project Plan (QAPP) for the Wenatchee River PCB and DDT Source Assessment was written to allow the project to be carried out in two phases (Hobbs, 2014, 2015). Phase 1 and 2 of the project have been completed and recommendations have been made for follow-up actions. Two of the main recommendations are:

- Ecology has found two source areas of PCBs to the Wenatchee River. Using the same techniques as the previous study, further delineation within the possible source areas should be carried out. This would include improved characterization of PCB loads during high- and low-flow conditions.
- Produce a complete bioaccumulation model for PCBs and DDT in the lower Wenatchee. A bioaccumulation model will allow for the prediction of surface water and biofilm concentrations necessary for fish tissues to be below the DOH fish consumption advisory targets for PCBs (46 µg /Kg) and the FTEC water quality assessment level for the protection of human health for PCBs (5.3 µg /Kg) and DDT (32 µg /Kg).

This next phase of the project (Phase 3) will address these two recommendations for follow-up actions. Further delineation of DDT contamination will not be carried out during Phase 3 and will be addressed under a separate project in the future.

3.1.4 Results of previous studies

An extensive summary of the previous study on PCBs and DDT in the Wenatchee River, prior to the initial phases of Ecology's source assessment studies, can be found in the original QAPP documents (Hobbs, 2014, 2015).

The results from Phase 1 and 2 of this project identified two chemically-distinct sources of PCBs to the Wenatchee River, one located near the City of Cashmere and the second near the City of Wenatchee. The previous work has confined the City of Cashmere site to approximately 2 river miles (between river mile 11.4 and 9.5) and the City of Wenatchee site to approximately 0.7 river miles (between river mile 1.8 and 1.1) (Figures 1 and 2).

Concentrations of PCBs in biofilms on rocks (mainly attached algae) are highly correlated with dissolved PCB concentrations in the water estimated from semi-permeable membrane devices (SPMDs) (Figure 2; $r^2_{\text{adj}} = 0.95$; $p < 0.001$). PCB concentrations in biofilms were higher in the low-flow period (August to October) compared to the high-flow period (May). High concentrations of PCBs in biofilms during the low-flow period represent the entry into the Wenatchee food web. The location of the PCB-contaminated food source (biofilms and invertebrates) for Wenatchee resident fish is confined to the lower Wenatchee River (downstream of Cashmere).

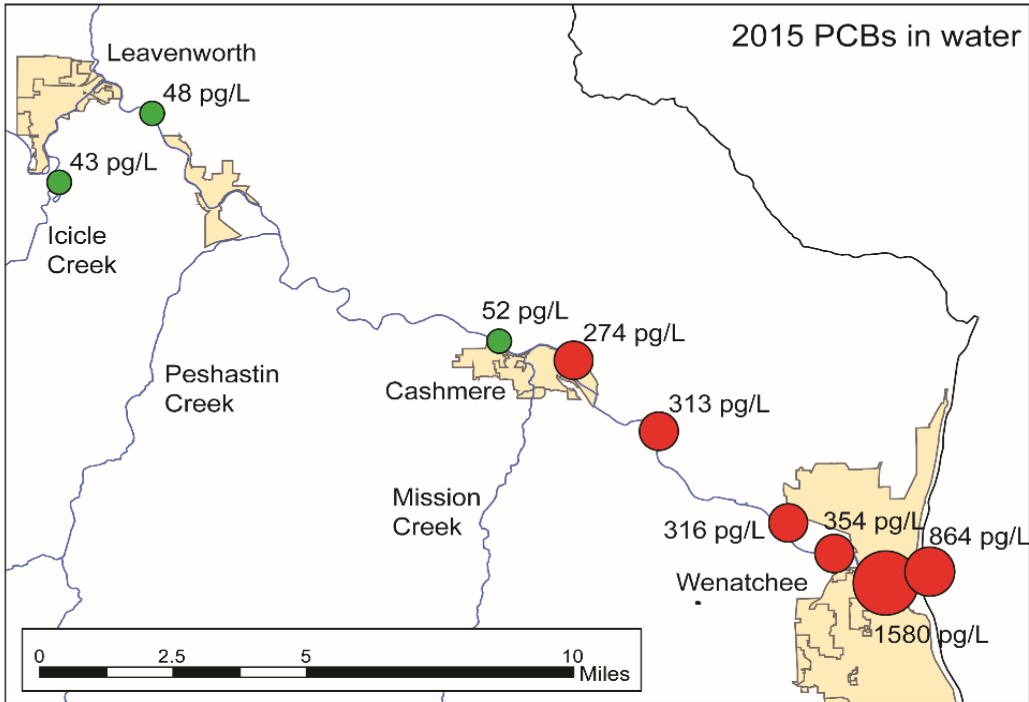
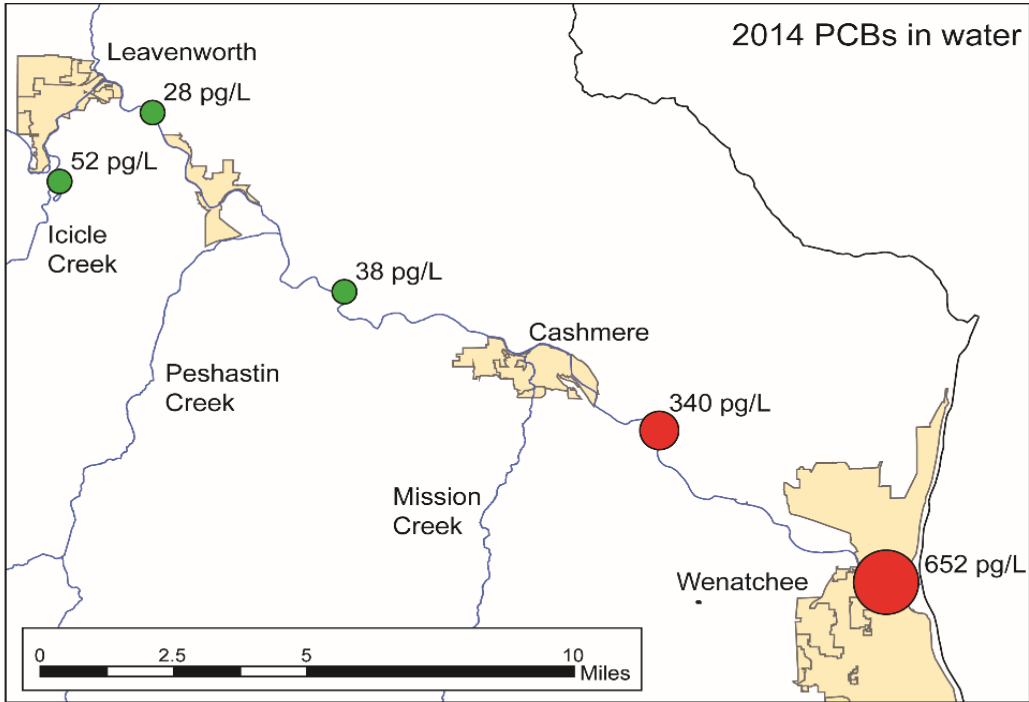


Figure 1: Estimated total PCB concentrations in water from SPMDs.

Green dots are not above the equipment background and red dots are scaled in size to the concentration.

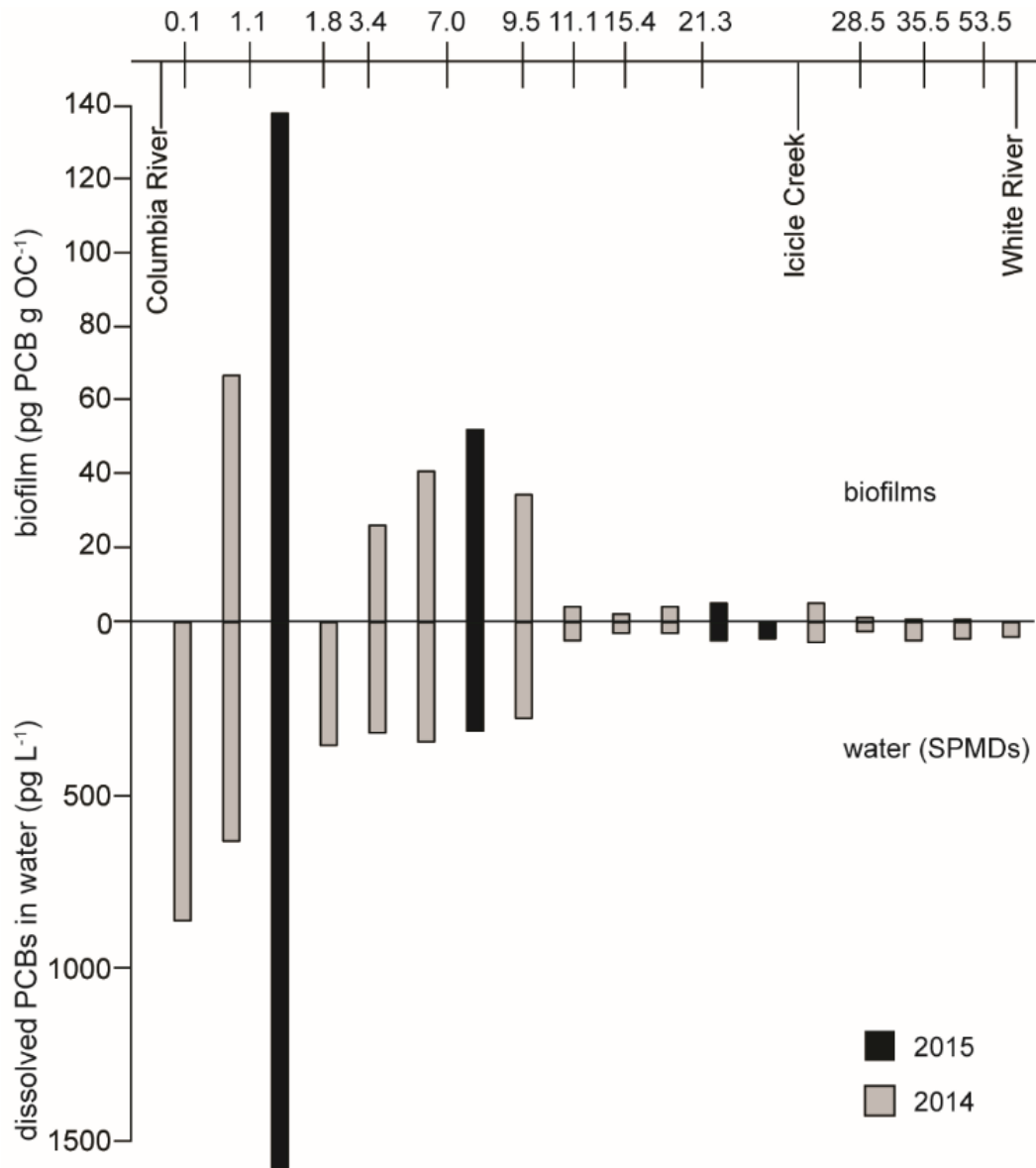


Figure 2: Barplot of total PCBs in periphyton (upper) and water (lower) of the Wenatchee River during low-flow (September) over 2014 and 2015.

River mile for the Wenatchee at the top of the figure.

Analysis of mountain whitefish (MWF; *Prosopium williamsoni*) tissues and stomach contents during the previous phases of the project shows that they have a very selective diet, consisting of caddisfly and mayfly larvae, and occasionally midge larvae. The Wenatchee food web was modeled using stable isotopes. This showed that MWF sampled during the earlier phases of the study from the lower Wenatchee appear to reside and feed in the lower Wenatchee and do not migrate to the upper Wenatchee River to feed. However, MWF do appear to migrate within the lower Wenatchee.

Largescale suckers (LSS; *Catostomus macrocheilus*) are also important organisms in the Wenatchee River food web, as they are benthic feeders and occupy a lower trophic level than MWF. The diet of Columbia River LSS consists mainly of biofilms and some invertebrates (midge and caddis fly larvae) (Dauble, 1986). Confirmation of the diet, trophic position, and contaminant concentrations of the LSS tissues will be addressed in Phase 3 of the project.

Project Description

4.1 Project Goals

Further to the original goals of the Wenatchee River PCB and DDT Source Assessment (Hobbs, 2014), an additional goal of the third phase of the project is to predict the PCB and DDT concentrations needed in surface waters and biofilms to meet the water quality assessment criteria and DOH consumption advisory.

4.2 Project objectives

The specific objectives of this follow-up study are to:

- Further delineate and characterize sources of PCBs in the lower Wenatchee River.
- Sample fish and macroinvertebrate tissues in the lower Wenatchee River for PCBs and DDT to supplement existing data to be used in compiling a bioaccumulation model for the lower Wenatchee River.
- Complete a bioaccumulation model for PCBs and DDT in the lower Wenatchee River.

Sampling to further delineate PCB sources will take place over two sample events (high and low flow) and include passive samplers to estimate water concentrations (semi-permeable membrane devices; SPMDs) and biofilms. SPMDs will be deployed at the same sites being sampled for biofilms to further our understanding of the relationship between dissolved PCBs in the water and PCBs bound to biofilms. Sample sites will be located to refine the location of PCB sources down to 0.5 river miles.

During the initial source assessment Ecology was able to gain an understanding of the transfer and bioaccumulation of PCBs in the lower Wenatchee food web. The follow-up sampling will allow us to fill data gaps on the lower trophic levels of the food web, namely large scale suckers and macroinvertebrates (caddisflies and mayflies). All sampling will take place near the confluence of the Wenatchee and Columbia Rivers.

Combined, the project objectives represent Phase 3 of the Wenatchee River PCB and DDT Source Assessment.

4.6 Tasks required

This project is expected to run through fall of 2017. The overall study approach is to:

- Prepare and approve an addendum to the original Quality Assurance Project Plan (QAPP) (Hobbs, 2014) and first addendum (Hobbs, 2015).
- Conduct synoptic surveys of surface waters (SPMDs) and biofilms during the low flow of 2016 and high flow of 2017.
- Sample largescale suckers during the summer of 2016.

- Complete the final data analysis, report writing, and public presentation.

4.7 Practical constraints

Phase 3 of the source assessment will rely on the same sample methods at similar study locations during periods of river flow that have been sampled in the past. Given our understanding of the approaches and conditions, we do not foresee any practical constraints.

Organization and Schedule

5.1 Key individuals and their responsibilities

Organization of project staff and responsibilities are presented in Table 1.

Table 1: Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Lynda Jamison, WQP Central Regional Office Phone: 509 575-2434	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and addenda and approves the final documents.
Mark Peterschmidt, WQP Central Regional Office Phone: 509-575-2821	Unit Supervisor	Provides internal review of the QAPP and addenda and approves the final documents.
David Bowen, WQP Phone: 509-457-7107	Client's Section Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP and addenda and approves the final documents.
William Hobbs, EAP TSU - SCS Phone: 360-407-7512	Project Manager	Writes the QAPP. Oversees field sampling and transportation of samples to the lab. Analyzes and interprets data. Writes the draft report and final report.
Melissa McCall, EAP TSU - SCS Phone: 360-407-6765	Field Assistant	Helps collect samples and records field information. Enters data into EIM.
Siana Wong, EAP TSU - SCS Phone: 360-407-6432	Field Assistant	Helps collect samples and records field information. Conducts QA review of data in EIM.
Brandee Era-Miller, EAP TSU - SCS Phone: 360-407-6765	Acting Unit Supervisor for the Project Manager	Provides internal review of the QAPP and addenda, approves the budget and approves the final documents.
Tom Mackie, EAP Central Regional Office Phone: 509-454-4244	Section Manager for the Study Area	Provides internal review of the QAPP and addenda and approves the final documents.
Jessica Archer, EAP SCS Phone: 360-407-6698	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP and addenda and approves the final documents.
Joel Bird, EAP MEL Phone: 360-871-8801	Director	Reviews and approves the final QAPP and addenda.
Georgina Brooks, AXYS Analytical Services Ltd.	Contract Laboratory Project Manager	Coordinates with MEL QA Coordinator.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and addenda and approves the final documents.

EAP: Environmental Assessment Program; EIM: Environmental Information Management database; QAPP: Quality Assurance Project Plan; WQP: Water Quality Program; TSU: Toxic Studies Unit; SCS: Statewide Coordination Section

5.4 Project schedule

The overall project timeline is detailed in Table 2.

Table 2: Proposed schedule for completing field and laboratory work, data entry into EIM, and reports.

Field and laboratory work		Due date	Lead staff
Phase 3 field work begins		August 2016	William Hobbs
Phase 3 fish collection completed		September 2016	William Hobbs
Phase 3 SPMD and biofilm completed		May 2017	William Hobbs
Phase 3 Laboratory analyses completed		July 2017	
Environmental Information System (EIM) database			
EIM Study ID		WHOB002	
Product		Due date	Lead staff
EIM data loaded		September 2017	Melissa McCall
EIM data entry review		October 2017	Siana Wong
EIM complete		November 2017	Melissa McCall
Reporting			
Author lead / Support staff		William Hobbs / Melissa McCall and Siana Wong	
Schedule			
Draft QAPP Addendum for Phase 3		July 2016	
QAPP Addendum approved		September 2016	
Draft final report to supervisor		October 2017	
Draft final report to client/peer reviewer		November 2017	
Final (all reviews done) due to publications coordinator		December 2017	
Final report due on web		January 2018	

5.6 Budget and funding

Phase 3 laboratory analysis will be completed by June 30, 2017. The estimated analytical budget for the PCB source tracking component of Phase 3 of this project will total \$58,625 (Table 3), which includes estimated laboratory costs and review of QA/QC. The estimated cost for the additional sampling to support a bioaccumulation model will total \$19,854 (Table 4). The overall cost for Phase 3 of the project will total \$78,479.

Table 3: Estimated costs for PCB source tracking.

Passive media	Samples	QA	Cost	Subtotal	MEL	Contract
SPMD prep & dialysis (per membrane)	60	40	\$75	\$7,500	-	\$7,500
PCB Congeners (1668c)	12	8	\$825	\$16,500	-	\$16,500
			Total	\$24,000	\$0	\$24,000
Surface water	Samples	QA	Cost	Subtotal	MEL	Contract
SSC	36	4	\$20	\$800	\$800	-
TOC/DOC	36	4	\$75	\$3,000	\$3,000	-
			Total	\$3,800	\$3,800	\$0
Tissues	Samples	QA	Cost	Subtotal	MEL	Contract
C-N stable isotopes	22	22	\$15	\$660	-	\$660
Lipids	22	2	\$25	\$600	-	\$600
PCB Congeners (1668c)	22	2	\$775	\$18,600	-	\$18,600
			Total	\$19,860	\$0	\$19,860
			Lab (contract through MEL)	\$43,860		
			Lab MEL (incl. contract fee)	\$14,765		
			Lab Total	\$58,625		

Table 4: Estimated costs for PCB and DDT bioaccumulation sampling.

Tissues	Samples	QA	Cost	Subtotal	MEL	Contract
C-N stable isotopes	10	20	\$15	\$450	-	\$450
OC Pests (8081)	14	2	\$336	\$5376	\$5376	-
PCB Aroclors (8082)	4	1	\$173	\$865	\$865	-
Lipids	18	3	\$50	\$1050	\$1050	-
PCB Congeners (1668c)	10	2	\$800	\$9600	-	\$9600
			Total	\$17341	\$7291	\$10050
			Lab (contract through MEL)	\$10,050		
			Lab MEL (incl. contract fee)	\$9,804		
			Lab Total	\$19,854		

Quality Objectives

6.1 Decision Quality Objectives

There are no specific decision quality objectives (DQOs) for this project.

6.2 Measurement Quality Objectives

A complete summary of measurement quality objectives (MQOs) for this project is detailed in Table 5. All laboratory quality assurance/quality control (QA/QC) measures are documented in MEL's Laboratory Quality Assurance Manual (MEL, 2012). Laboratory quality control measures include the analysis of check standards, duplicates, spikes, and blanks. Check standards or laboratory control samples are perhaps the most important for the evaluation of analytical bias. Duplicates and matrix spikes help to evaluate any effects of sample matrix on the data quality. Blanks aid in determining interferences and bias for low concentrations near analytical detection limits.

Table 5: Measurement Quality Objectives.

Analysis	Check stds./lab control samples (% recov.)	Duplicate samples (RPD)	Surrogates (% recov)	Matrix spikes (% recov)	Lowest concentration of interest
Water samples					
SSC	80-120%	± 20%	NA	NA	0.5 mg L ⁻¹
Conductivity	80-120%	± 20%	NA	NA	1 µm hos cm ⁻¹
Total Organic Carbon	80-120%	± 20%	NA	NA	1 mg L ⁻¹
Dissolved Organic Carbon	80-120%	± 20%	NA	NA	1 mg L ⁻¹
SPMD Extracts					
PCB congeners	50-150%	± 50%	50-150%	50-150%	50 pg
Tissue (biofilms and invertebrates)					
PCB congeners	50-150%	± 40%	50-150%	NA	4 pg g ⁻¹ per congener
lipids	75-125%	± 20%	NA	NA	0.10%
ash-free dry weight	NA	± 20%	NA	NA	1.00%
C:N	NA	± 20%	NA	NA	0.10%
Tissue (fish)					
PCB aroclors	50-150%	± 40%	50-150%	50%-150%; RPD limit 40%	0.5 µg Kg ⁻¹
PCB congeners	50-150%	± 40%	50-150%	NA	4 ng Kg ⁻¹ per congener
DDT and analogues	50-150%	± 40%	50-150%	50%-150%; RPD limit 40%	0.1 µg Kg ⁻¹
lipids	75-125%	± 20%	NA	NA	0.10%
C:N	NA	± 20%	NA	NA	0.10%

NA = not analyzed

SSC = suspended sediment concentrations

Sampling Process Design (Experimental Design)

7.1 Study Design

Phase 3 of the study has been initiated to fill the remaining data gaps on PCB source location and bioaccumulation of PCBs and DDT in the lower Wenatchee food web. Following the successful use of SPMDs and biofilms to assess the spatial extent of PCB contamination in the Wenatchee River basin in phases 1 and 2, this study will use the same approach to further delineate two local sources of PCBs to the river. One source is near the city of Cashmere and the second is near the city of Wenatchee (Figure 3).

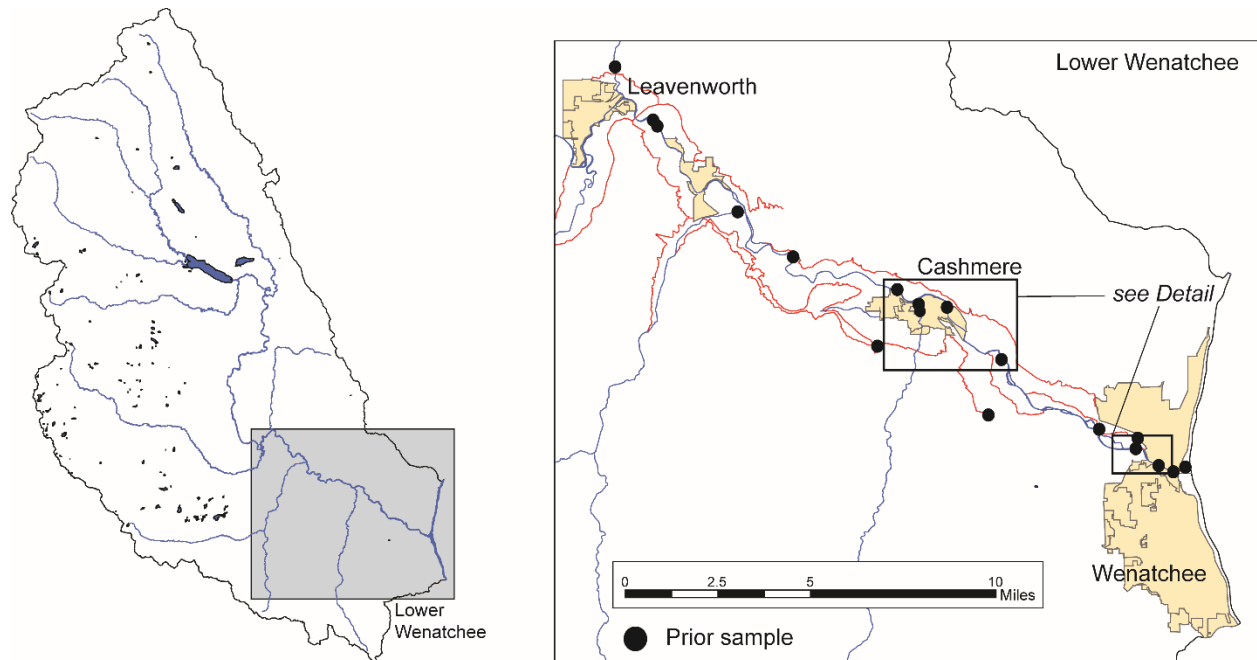


Figure 3: Locations of two suspected PCB sources.

Black dots represent previous sample sites. Study sites shown in detailed maps (Figure 4).

Further sampling of both PCBs and DDT in the lower trophic levels of the Wenatchee food web will allow us to complete a model of bioaccumulation for the lower Wenatchee River. We will use a model based on that of Arnot and Gobas (2004). This model has been employed in Washington State freshwaters in the Spokane River (Serdar et al., 2011) and Lake Washington (DeGasperi et al., 2014). This model was initially adapted by Pelletier and Mohamedali (2009) for the Puget Sound.

Individual tissues from LSS will be analyzed for PCB congeners and DDT for the model. In addition, four composite fillet tissue samples of LSS will also be analyzed for Aroclors (method 8082) as per Ecology's *Freshwater Fish Contaminant Monitoring Program* (Seiders et al., 2015). The composite data are being collected to complement 2014 composite samples of MWF and will provide a more recent evaluation of fish tissue composites from the lower Wenatchee River (Seiders et al., 2012a).

Ultimately, the goal of compiling an accurate bioaccumulation model is to predict the necessary reductions in surface water and biofilm concentrations needed for fish tissue concentrations to be: (1) below the fish consumption threshold so that the Department of Health can remove its advisory (46 µg/Kg t-PCBs), and (2) below the FTEC water quality assessment level for the protection of human health (5.3 µg/Kg t-PCBs and 32 µg/Kg DDT).

7.1.1 Field measurements

Field observations of river flow and site conditions will be recorded at the time of sampling. In situ field measurements of pH, conductivity, and temperature will also be taken in concert with sampling at each site. The relevant SOPs are discussed in *Section 8.1*.

7.1.2 Sampling location and frequency

The sampling plan for Phase 3 focuses on the lower Wenatchee River, from Cashmere downstream to the confluence with the Columbia River. Sampling will address water and biofilm PCB concentrations at low (August to September, 2016) and high (March to April, 2017) flow. Fish and invertebrates will be collected in the summer of 2016 for the PCB and DDT bioaccumulation study.

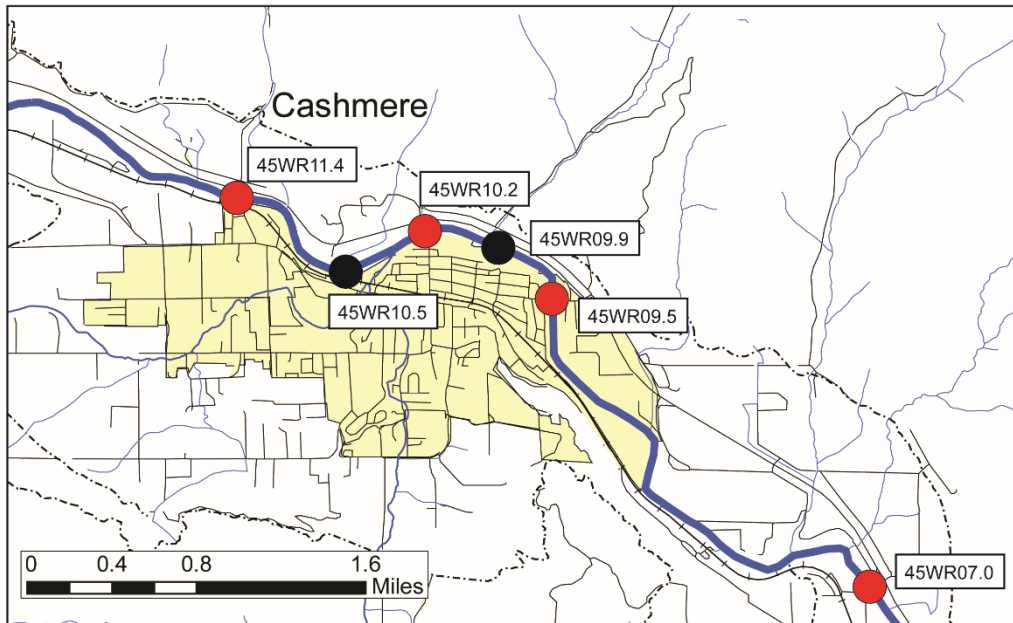
Six SPMD samplers and ten biofilm samples will be collected during each sampling event. Biofilm samples will be collected at each SPMD site to improve our understanding of the relationship between the two media. Sample sites are detailed in Table 6 and shown in Figure 4. Field deployment will follow the same protocols used previously. Deployment of the SPMDs will be for one month and biofilm collection will occur at the end of SPMD deployment.

Sampling fish and macroinvertebrate tissue for the bioaccumulation study will take place during the summer of 2016 in the vicinity of sample site 45WR01.1 (Figure 4). This is the same location mountain whitefish were sampled in 2015.

Table 6: Study sites for Phase 3 of the Wenatchee River PCB Source Assessment.

Sample site	River mile	Latitude	Longitude	Description	Rationale
45WR11.4*	11.4	47.52754	-120.48926	Goodwin Rd. Bridge, Cashmere	upstream of Cashmere
45WR10.5	10.5	47.52285	-120.48103	Wenatchee mainstem upstream of Mission Cr.	downstream of suspected contaminated area
45WR10.2	10.2	47.52537	-120.47048	Aplets Way Bridge, Cashmere	within the area of transformer deposition
45WR09.9	9.9	47.52417	-120.4638	Riverside Park, Cashmere	downstream of area of transformer deposition
45WR09.5*	9.5	47.52049	-120.45763	Cotlets Way Bridge, Cashmere	downstream of transformer site; upstream of Cashmere wastewater treatment plant
45WR07.0*	7	47.50089	-120.42565	Old Monitor Bridge @ USGS gauge 12462500	downstream of Cashmere wastewater treatment plant
45WR01.8*	1.8	47.46476	-120.35335	Wenatchee mainstem upstream of mouth	prior to Highline irrigation return and mixing with Columbia
45WR01.6	1.6	47.46489	-120.34597	Wenatchee mainstem downstream of Highline	downstream of Highline irrigation return, upstream of mixing with Columbia
45WR01.4	1.4	47.46138	-120.34282	Wenatchee Rec pipeline	upstream of Wenatchee Reclamation pipeline bridge
45WR01.1*	1.1	47.4588	-120.33682	Hwy 285 Bridge, Wenatchee	confluence site with Columbia

* Previously sampled in Phase 1 and/or 2 of the source assessment



● SPMD and biofilm sample ● biofilm sample

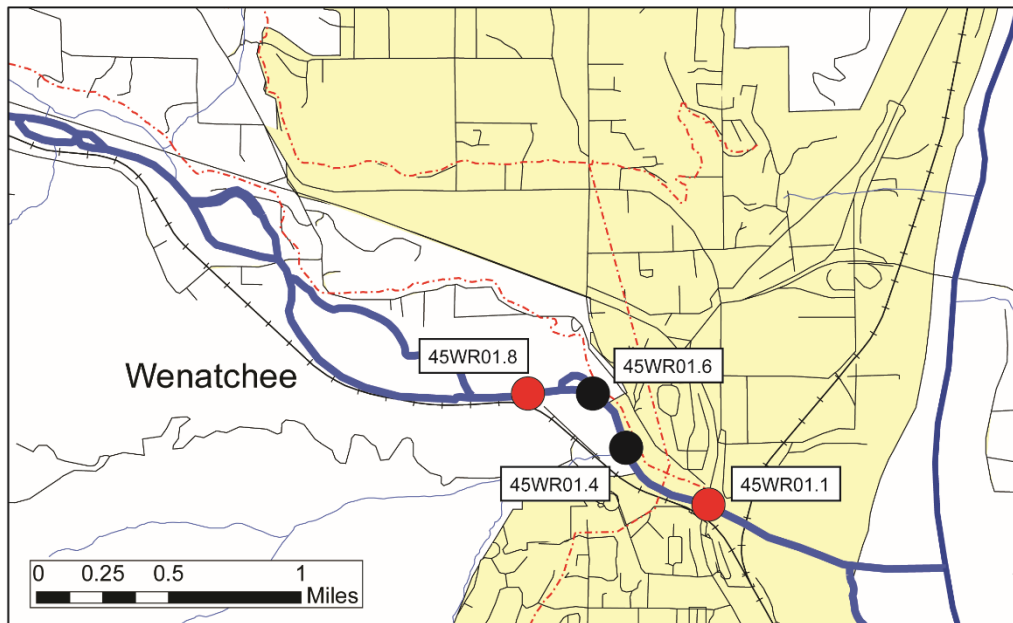


Figure 4: Study sites for Phase 3 of the Wenatchee River PCB Source Assessment.

7.1.3 Parameters to be determined

Media and parameters included in the sampling program are:

- Water (sampled using SPMDs) – PCBs (congeners).
- Water (collected as grab samples) – suspended sediment concentrations (SSC), total organic carbon (TOC), dissolved organic carbon (DOC).
- Biofilms – PCBs (congeners), lipid content, carbon and nitrogen composition and stable isotope ratios, and ash-free dry weight.
- Macroinvertebrates – PCBs (congeners), lipid content, carbon and nitrogen composition and stable isotope ratios, and ash-free dry weight.
- Fish tissues – PCBs (aroclors on composite samples; congeners on whole fish), lipid content and carbon and nitrogen composition and stable isotope ratios.

7.2 Maps or diagram

The locations of the sample sites are detailed in Figures 3 and 4, and Table 6. The rationale for the site locations is also detailed in Table 6.

7.5 Characteristics of existing data

The first two phases of the project showed some distinct spatial trends. The following observations can be made about PCBs in the Wenatchee River:

- Traveling downstream, PCB concentrations increase by an order of magnitude at Cotlets Way bridge in the city of Cashmere and again under the Hwy 285 bridge in the city of Wenatchee.
- Concentrations of PCBs bound to biofilms (attached algae and microbes) show a very similar trend to SPMDs. Biofilms represent the base of the food web in the Wenatchee River.
- Total suspended sediments and dissolved organic carbon were less than method detection limits during sampling, suggesting that most (~ 95%) of the measured PCBs were in dissolved form.
- PCB congener patterns at the sites of the suspected sources suggest different sources.

The data gaps that exist from the previous studies and that will be addressed in Phase 3 include:

- A more precise location of the localized PCB sources to the Wenatchee River.
- Greater understanding of the PCB loads in the Wenatchee River during high-flow.
- An understanding of the PCB and DDT concentrations in fish at a lower trophic level than MWF.
- An understanding and model of bioaccumulation of PCBs and DDT in the lower Wenatchee River.

Sampling Procedures

8.1 Field measurement and field sampling SOPs

8.1.1 Water sampling

Described in the original QAPP (Hobbs, 2014).

8.1.2 Biotic media

8.1.2.1 Periphyton

Described in the original QAPP (Hobbs, 2014).

8.1.2.2 Macroinvertebrates

Described in the first QAPP addendum (Hobbs, 2015).

8.1.2.3 Fish tissue and stomach contents

Described in the first QAPP addendum (Hobbs, 2015).

Measurement Methods

9.2 Lab procedures table.

The same contract lab used in the previous two phases of the project, AXYS Environmental, will be used in Phase 3. Analysis of ancillary parameters will be carried out by MEL.

Table 7: Measurement methods (laboratory).

Analyte	Sample Matrix	Approx. Number of Samples*	Expected Range of Results	Reporting Limit	Sample Prep Method	Analytical (Instrumental) Method
PCB congeners	biofilm and invertebrates	22	25 to 600 pg g ⁻¹ t-PCBs	4 pg g ⁻¹ w/w per congener	EPA 1668C	EPA 1668C
Lipids	Biofilm, invertebrates, and fish	40	0.5 - 2.0 %	0.10%	N/A	MEL SOP 730009 [†]
Ash-free dry mass	biofilm	22	0.5 - 3.0 %	1.00%	N/A	SM 10300C
C:N and isotopes	biofilm, invertebrates and fish	32	0.1 - 2.0 (%N); 1.0 - 15 (%C)	0.10%	N/A	‡ stable isotopes of N and C
PCB congeners	Invertebrates and fish	12	400 ng g ⁻¹ t-PCBs	4 pg g ⁻¹ w/w per congener	EPA 1668C	EPA 1668C
PCB congeners	SPMD extract	12	100 - 200 ng (t-PCBs)	0.5 pg per congener	dialysis; EPA 1668C	EPA 1668C
PCB aroclors	Fish	4	0.5 - 100 µg Kg ⁻¹	1.1 – 5 µg Kg ⁻¹	EPA 8082 (GC/ECD); MEL SOP	EPA 8082 (GC/ECD); MEL SOP
DDT and analogues	Fish	14	0.1 - 1000 µg Kg ⁻¹	0.5-3.0 µg Kg ⁻¹	EPA 8081 (GC/ECD); MEL SOP	EPA 8081 (GC/ECD); MEL SOP
SSC	surface water	36	<RL - 10 mg L ⁻¹	0.5 mg L ⁻¹	N/A	EPA 160.2
TOC	surface water	36	<RL - 10 mg L ⁻¹	1 mg L ⁻¹	N/A	SM 5310B
DOC	surface water	36	<RL - 2 mg L ⁻¹	1 mg L ⁻¹	N/A	SM 5310B

SSC = suspended sediment concentrations; TOC = total organic carbon; DOC = dissolved organic carbon

* Excluding field replicates and field blanks

‡ Puget Sound Estuary Program, Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Conventional Sediment Variables, Total Organic Carbon (TOC), March 1986.

† Manual of Analytical Methods for the Analyses of Pesticides in Humans and Environmental Samples. EPA-600/8-80-038.

‡ Costech Elemental Analyzer, Conflo III, MAT253.

9.5 Lab(s) accredited for method(s)

A waiver of accreditation was received for the carbon and nitrogen stable isotope analysis with the University of Washington IsoLab, Ecology Form ECY 070-152 (pers. comm. Bill Kammin).

Quality Control (QC) Procedures

10.1 Table of field and lab QC required

The necessary QC for the SPMD samples has been described in Hobbs (2014). Table 8 describes the spiking schedule and QC for Phase 3 of the project, as per the SPMD SOP (Seiders et al., 2012b).

Table 8: Detailed summary of the number of SPMD samples for each sampling event and necessary quality control.

Sample Type	Sample quantity	# of membranes per sample	# total membranes	Number of membranes to be spiked with PRC solution	Extraction Internal Standards (EIS): (spike 1 membrane per sample)	# of SPMD dialyses	# of SPMD Analyses
Field Sample	7	5	35	35	7	35	7
Field Blank	2	5	10	10	2	10	2
SPMD "Day-0" Method Blank	1	5	5	5	1	5	1
Total (Field Samples, Field Blanks + lab QC)	10	5	50	50	10	50	10
Store one aliquot of PRC solution	1	0	0	1	-	-	(1; only if needed)
Store one aliquot of EIS solution	1	0	0	-	1	-	(1; only if needed)

PCB: polychlorinated biphenyls; EIS: PCB extraction internal standards from EPA Methods 1668C and 1699; PRC: Performance Reference Compounds spiking solution prepared by AXYS and sent to EST prior to deployment; "Day-0": Fabrication Blank; sometimes called the Day-0 dialysis blank.

References

Personal Communications

William Kammin, QA Officer for EAP – approval of Form ECY070-152 Request to Waive Required Use of Accredited Lab (6/5/15).

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Figures

All figures are embedded within the text.

Tables

All tables are embedded within the text.