Final – 4/25/2023

Addendum 4 to Quality Assurance Project Plan

Wenatchee River PCB and DDT Source Assessment

Prepared for: U.S. EPA, Region 10

Prepared by: Keeley Chiasson, William Hobbs, and Mary Jo Sanborn
Chelan County Natural Resources Department
411 Washington St.
Wenatchee, WA 98801

Date Submitted: April 2023

Approved by:

Signature:	Date: 5/1/23
Keeley Chiasson, author, Project Technician, Chelan Count Natural Resource Department.	
Signature: Mary Jo Sanborn	Date: 5/1/23
Mary Jo Sanborn, co-author, Project Manager, Chelan County Natural Resource Department	
Signature:	Date: 5/1/23
Abby Hendrickson, Natural Resource Specialist, Chelan County Natural Resource Department	
Signature:	Date: 5/1/23
Mike Kaputa, Director, Chelan County Natural Resource Department	
Signature:	Date: 5/1/23
Sofia Bjorklund, Accountant, Chelan County Natural Resource Department	
Signature: W. Hobbs	Date: 5/1/23
William Hobbs, co-author, Project Partner, Department of Ecology	
Signature: Michelle Wilcox on behalf of MICHELLE WILCOX Digitally signed by MICHELLE WILCOX Date: 2023.05.08 15:50:56 -07'00'	Date:
Lauren McDaid, CRBRA Project Officer, U.S EPA	
Signature:	Date: 5/8/2023
EPA QA Chemist, U.S EPA	

Publication Information

Suggested citation for this addendum:

Chiasson, K; Hobbs, W; Sanborn, M. 2023. Addendum 4 to Quality Assurance Project Plan: Wenatchee River PCB and DDT Source Assessment.

Original Quality Assurance Project Plan:

Hobbs, William. 2014. Quality Assurance Project Plan: Wenatchee River PCB and DDT Source Assessment. Publication 14-03-117. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1403117.html.

Data for this project will be available on EPA's Water Quality Exchange (WQX) website at https://www.waterqualitydata.us/ and Ecology's Environmental Information Management (EIM) website at EIM Database. Search Organization ID for WQX: WenatcheePCBInv_WQX and Study ID for EIM: WHOB002

1.0 Table of Contents

3.0 Background 1
3.1 Introduction and problem statement 1
3.2 Study Area and Surroundings 2
3.2.1 Summary of previous studies and existing data 2

4.0 Project Description 9
4.2 Project objectives 9
4.3 Information Needed and Sources 9
4.4 Tasks Required 10
5.1 Key individual and their responsibilities 11
5.2 Special training and certifications 11
5.4 Proposed project schedule 12
5.6 Budget and funding 13

6.0 Quality Objectives 14
6.1 Decision Quality Objectives 14
6.2 Measurement Quality Objectives 14
6.2.1 Targets for precision, bias, and sensitivity 14

7.0 Study Design 14
7.1 Study boundaries 15
7.2 Field data collection 15
7.2.1 Sampling locations and frequents 15
7.2.2 Field parameters and laboratory analytes to be measured 16
7.5 Possible challenges and contingencies 16

8.0 Field Procedures 16
8.2 Measurement and Sampling Procedures 17
8.2.1 PCBs in sediment 17
8.2.2 Macroinvertebrates 18
8.3 Containers, preservation, holding times 19

9.0 Laboratory Procedures 19
9.1 Lab and field procedures table 19

10.0 Quality Control Procedures 20
10.1 Table of field and laboratory quality control 20

11.0 Data Management Procedures 21
11.2 Laboratory package requirements 21

13.0 Data Verification 21
13.1 Field data verification 23
13.2 Laboratory data verification 23
13.3 Validation requirements, if necessary 23

15.0 References 24

Figure 1. Map of Wenatchee River watershed and study areas. Black dots represent past sample locations. 2
Figure 2. 1957 Aerial photo of Wenatchee, WA. Highlights Confluence Reach, BNSF railway, and locations of Horan Natural Area, Number One and Two Canyons, and the Appleyard Terminal. 4
Figure 3. Previous results of PCBs in biofilms upstream of the confluence and at the confluence. 6
Figure 4. PCB Congener distribution for SPMDs sampled in 2014-2017 Confluence Reach. 8
Figure 6. Overview of study area, highlighting backwater channels near the Wenatchee - Columbia confluence and potential areas of interest. 15

Table 1. Organization of project staff and responsibilities. 11
Table 2. Proposed Schedule for completing field and laboratory work, data entry into the Environmental Information Management (EIM) database, and reports. 12
Table 3. Detailed project budget and funding for laboratory costs........ 13
Table 4. Measurement Quality Objectives........ 14
Table 5. Containers, preservation, and holding times........ 19
Table 6. Measurement methods (Laboratory)........ 20
Table 7. Measurement quality objectives of YSI calibration checks........ 14

Note: The numbered headings in this document correspond to the headings in the original QAPP. Only relevant sections are included here; therefore, some numbered headings may be missing.

3.0 Background

3.1 Introduction and problem statement

The Wenatchee River has had some of the highest fish tissue concentrations of polychlorinated biphenyls (PCBs) measured in Washington State over the last ~20 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). Furthermore, 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.

The specific objectives of the original Quality Assurance Project Plan (QAPP) and addendum were to: (1) 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) identify and characterize sources of these compounds to the Wenatchee River, based on the results of the synoptic survey (Hobbs, 2014).

The objective of the second addendum to the original QAPP was to further delineate the PCB sources during high and low-flow times of the year. The decision was made to focus on the sources of PCBs, as the sources and pathways of DDT contamination to the Wenatchee River are different and should be addressed under a separate study (Hobbs and Friese, 2016).

Sampling results over the last eight years have identified two chemically-distinct PCB sources to the Wenatchee River, one located near the City of Cashmere and the second near the confluence of the Wenatchee River and the Columbia River (Figure 1; Hobbs, 2018). The recommendations from the 2018 study were to investigate these PCB sources in detail.

The objective of the third addendum to the original QAPP described a plan to investigate the upstream source of PCBs near the City of Cashmere (Cashmere Reach). This includes: (1) complete a detailed survey of the source area for debris (e.g., old transformers) that may be an instream source, (2) investigate groundwater-surface water interactions in the source area, and (3) sample groundwater seeps, install temporary piezometers, or sampling existing groundwater wells within the footprint of the former landfill area (Hobbs, 2021).

This fourth addendum is a continuation of the previous work completed by Ecology, as described in preceding paragraphs. This phase of the project will be led by Chelan County Natural Resource Department (CCNRD) with technical support from Washington State Department of Ecology (Ecology). This addendum describes the plan to investigate the downstream source of PCBs near the Wenatchee – Columbia River confluence (Confluence Reach). This investigation will determine if sediments in the Confluence Reach contain legacy deposits of PCBs that are impacting the Lower Wenatchee food web. This addendum also includes details for additional water and biofilm sampling that may be needed at the Cashmere Reach to further determine whether the historic landfill is contributing PCBs to the Wenatchee River.

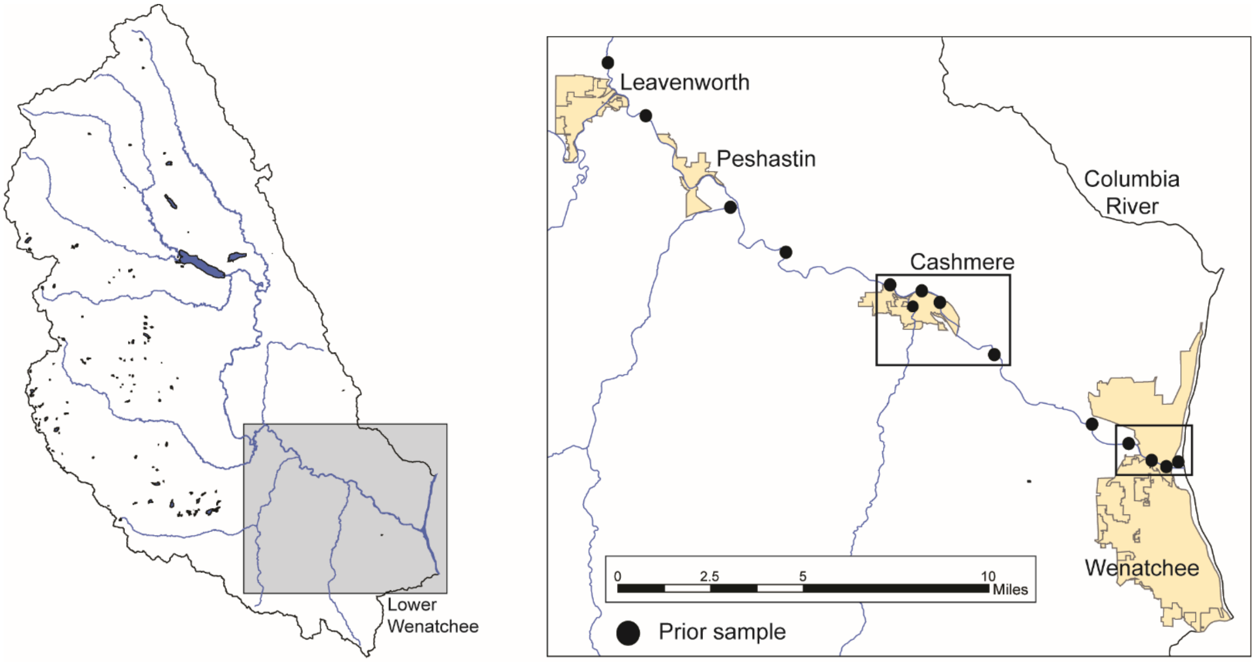

Figure 1. Map of Wenatchee River watershed and study areas. Black dots represent past sample locations.

3.2 Study Area and Surroundings

3.1.3 History of study area

The possible sources of PCBs in relationship to historical activities within the Wenatchee River Basin are described in detail in the original QAPP (Hobbs, 2014). Included below are relevant historical data specific to the Confluence Reach that were not previously described and will provide basis for further investigation.

Potential PCB Sources

Localized sources

<u>Historical land use</u>
The land surrounding the Confluence Reach was largely used for agriculture from the early 1800's to the mid/late 1900's and is now used as a combination of commercial buildings and parks/recreational areas. While PCBs are not typically associated with pesticides or insecticides it has been reported that historic uses of these applicants were often mixed with oils that may have contained PCBs (interview Jennifer Burns, CCPUD), however, this information warrants further investigation. The larger interest in regards to historical agricultural lands and possible PCB sources are abandoned/buried electrical equipment, dump zones, burn areas, land reclamation/past cleanup efforts, and imported fill material. Jim Pope, a retired Chelan County Public Utility District (CCPUD) employee mentioned in an interview that it wasn't uncommon practice for people to use the river banks as old dumping areas, and these zones were often not cleaned, but instead covered and built on top off.

Irrigation/Runoff Returns

Irrigation/runoff returns on lands that surround the Confluence Reach can act as conduits for various pollutants that get discharged into the Wenatchee River. Of particular interest are the runoff and irrigation canals that have historically supplied the water source for the Horan Natural Area Ponds. Prior to 2012 the ponds primary water sources were from Number One and Two Canyons, excess flow from irrigation canals, runoff from the City of Wenatchee's Miller Street storm drain system, and groundwater. These sources became less reliable for supplying the ponds with flowing water following 2012 and the storm drain system is no longer allowed to drain into the natural area. As a result, the ponds are now reliant on spring snowmelt runoff from Number One and Two Canyons, and on groundwater from the Wenatchee and Columbia Rivers (McCammon, 2020). These past and current sources of water travel through urban and commercial areas prior to discharging to the ponds, it's possible the runoff and irrigation returns have historically carried contaminants, such as PCBs, into the Horan Natural Area.

Railway

The section of the Great Northern Railway (GNR) that runs through South Wenatchee finished construction in 1892. The Appleyard terminal near Squilchuck Creek was established during the original construction period and remains in active use today. The railyard facility contains a 4-track electrical car repair building and likely has had other historical facilities that may have released toxics to the environment. The Appleyard terminal is relatively far downstream to the Confluence Reach (Figure 2), but has recently been flagged for remediation as a result of identified PCBs on the property and is awaiting cleanup (Mefford, 2022). Although the terminal is potentially too far downstream to have a significant impact on the Confluence Reach, the railway runs alongside the Confluence Reach and may contain PCBs in other areas along the track, such as a known underwater rail line and sewer line that is within the area of interest (interview Jim Pope, CCPUD). Additionally, from 1909 to 1956 an electrified section of railway extended from Skykomish to Wenatchee, WA. In this time period there was at least one significant train crash that occurred in 1947, near the confluence of the Wenatchee and Columbia Rivers. The extent of the train crash cleanup is unknown and it's possible that PCB-containing fluids were released during this event. Additionally, the crash occurred in a landslide prone area and its possible electrical equipment has been buried as a result of past landslide events (email communication John Mefford, Ecology).

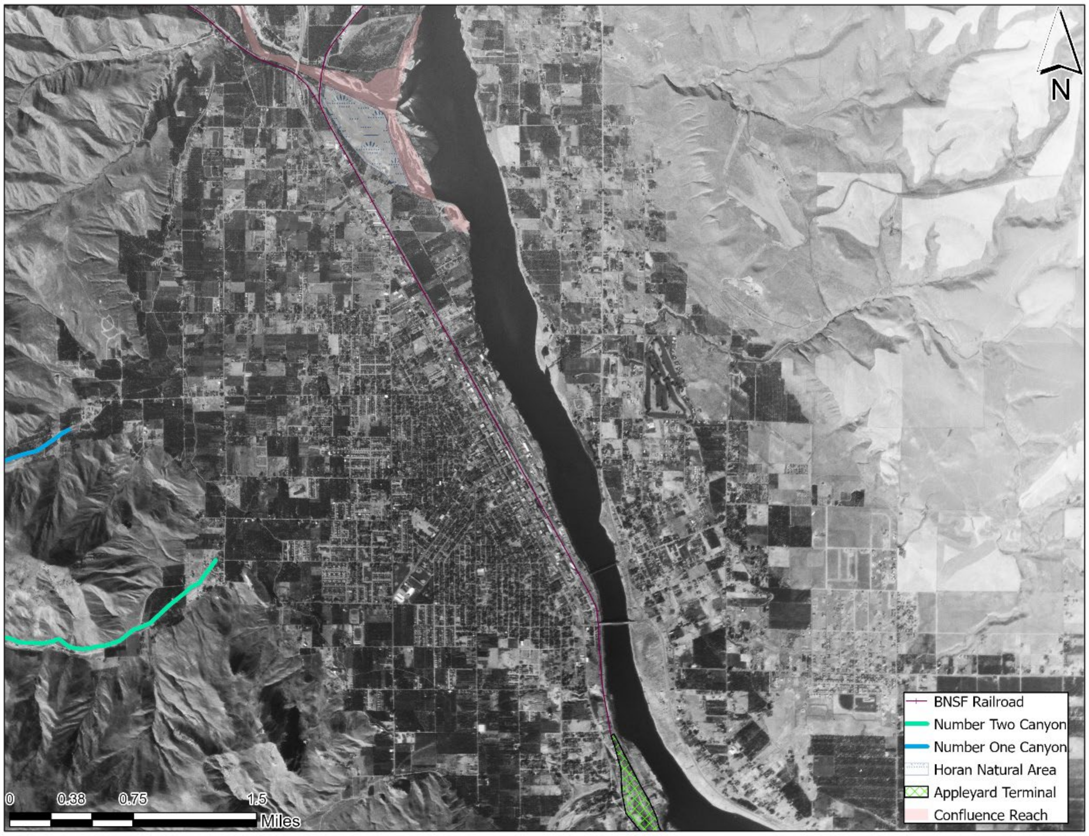

Figure 2. 1957 Aerial photo of Wenatchee, WA. Highlights Confluence Reach, BNSF railway, and locations of Horan Natural Area, Number One and Two Canyons, and the Appleyard Terminal.

3.2.2 Summary of previous studies and existing data

An extensive summary of PCBs 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). Additional data that is relevant specifically to the historic landfill near the City of Cashmere are described in detail in the QAPP Addendum 3 (Hobbs, 2021).

The main findings from previous work that are relevant to this follow up study are:

- There are two chemically-distinct PCB sources impacting the Wenatchee River:
    - The upstream source (Cashmere Reach) has been isolated to 500 feet (150 m) of river bank adjacent to Riverside Park. Riverside Park is constructed on the former Cashmere Landfill. The PCB source has a congener profile similar to the technical mixture Aroclor 1254 and is likely entering the river through groundwater.
    - The location of the downstream source (Confluence Reach) is less certain. There seems to be an influence of Columbia River water flowing back into the lower Wenatchee River. It is possible that sediments in the backwater channels in this confluence area are contributing PCBs. The PCB source in this area resembles Aroclor 1248 and contains congeners indicative of microbial dechlorination.

- PCB loads over the period 2014 to 2017 have been variable. However, the chemical profile of each PCB source is consistent over time and also between high- and low-flow periods.
- Concentrations of PCBs in fish feeding near the Confluence Reach are higher than from the Cashmere Reach. Concentrations in the water and biofilms are higher during low-flow periods; however, the PCB load is lower during this time.
- The bioconcentration of PCBs from water to biofilms is occurring by a factor (BCF) of 839 ± 183 at the Confluence Reach and 1672 ± 99 at the Cashmere Reach. This difference in BCF is likely due to the difference in congener composition between the source areas.

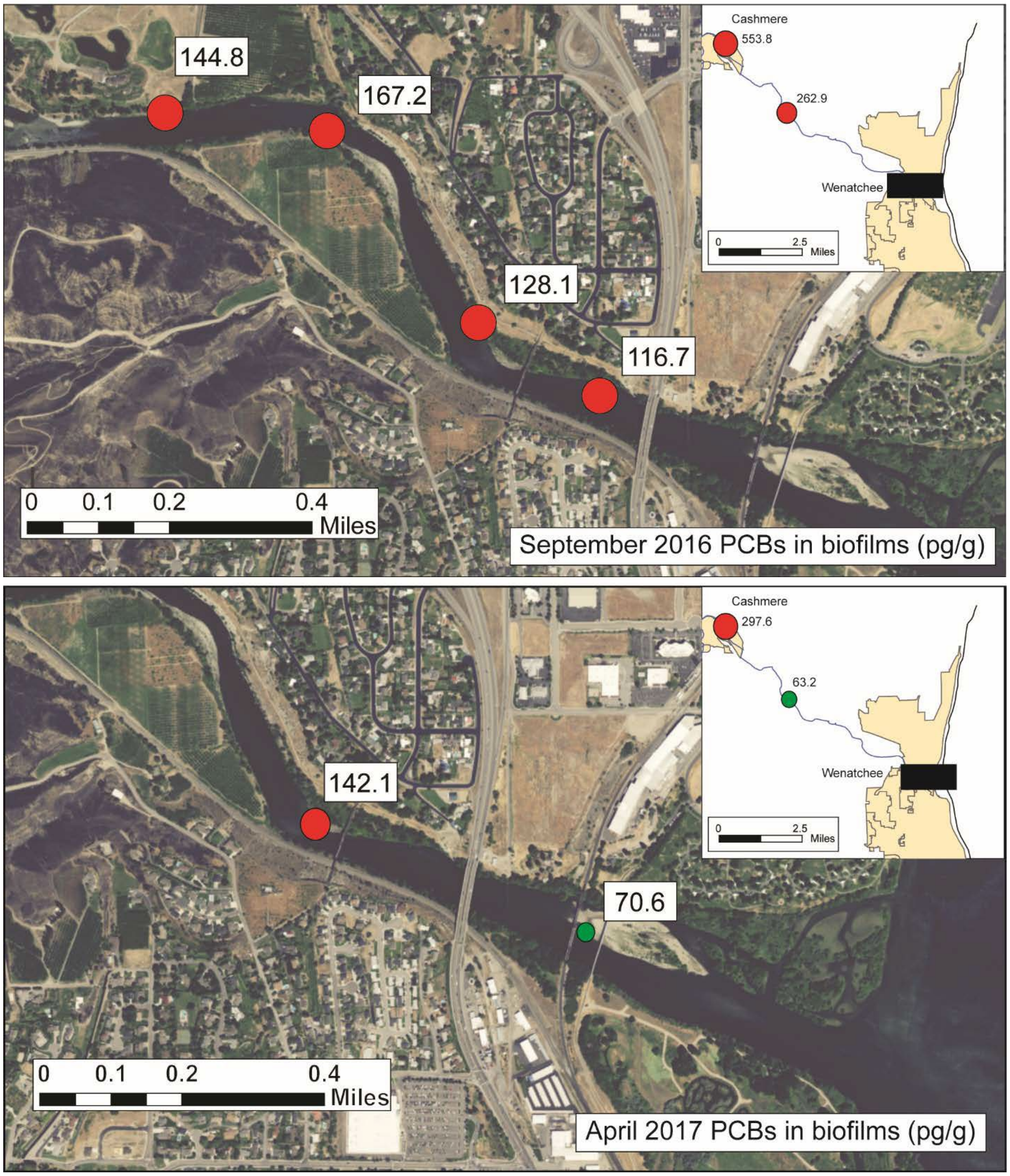

Figure 3. Previous results of PCBs in biofilms upstream of the confluence and at the confluence.

Green dots are considered within the variability of upstream background concentrations. Red dots are an order of magnitude higher, suggesting the influence of PCB inputs to the river. Dashed yellow line represents the extent of the influence from Columbia River water (Carroll et al., 200

The Confluence Reach has shown consistent congener profiles in water over time during both low- and high-flow sample periods (Figure 3). This congener profile is dominated by many lighter or less chlorinated congeners and resembles the aroclor 1248 mixture. Unlike the Cashmere Reach, there is a presence of congeners that suggest dechlorination is occurring; PCB-4 and PCB-44/47/65 (Hobbs, 2018). Dechlorination from groundwater or river sediments has been observed in the lower Columbia River (Rodenburg et al., 2015) and other contaminated sites in the US (Imamoglu et al., 2004). The dechlorination process is likely occurring in an anaerobic environment within the sediments or groundwater, altering the PCB congener profile of the contamination to the river.

In the previous study by Hobbs and Friese (2016), the PCB source near the confluence was thought to be outside the influence of Columbia River water, which flows into the confluence area with the Wenatchee River (Figure 3) (Carroll et al., 2006). The 2016 and 2017 sampling, showed that in fact the water from the Columbia River is indeed influencing this PCB source area. PCB concentrations of the biofilm samples collected in 2016 and 2017 did not vary in the lower section of the Wenatchee River, then in 2017 the semi-permeable membrane devices (SPMDs) showed that PCBs in water were higher closer to the Columbia River (Figure 3,4). Given the results in 2016 and 2017, further investigation of the sediments and water in the backwater areas at the confluence would help determine if this area is the PCB source.

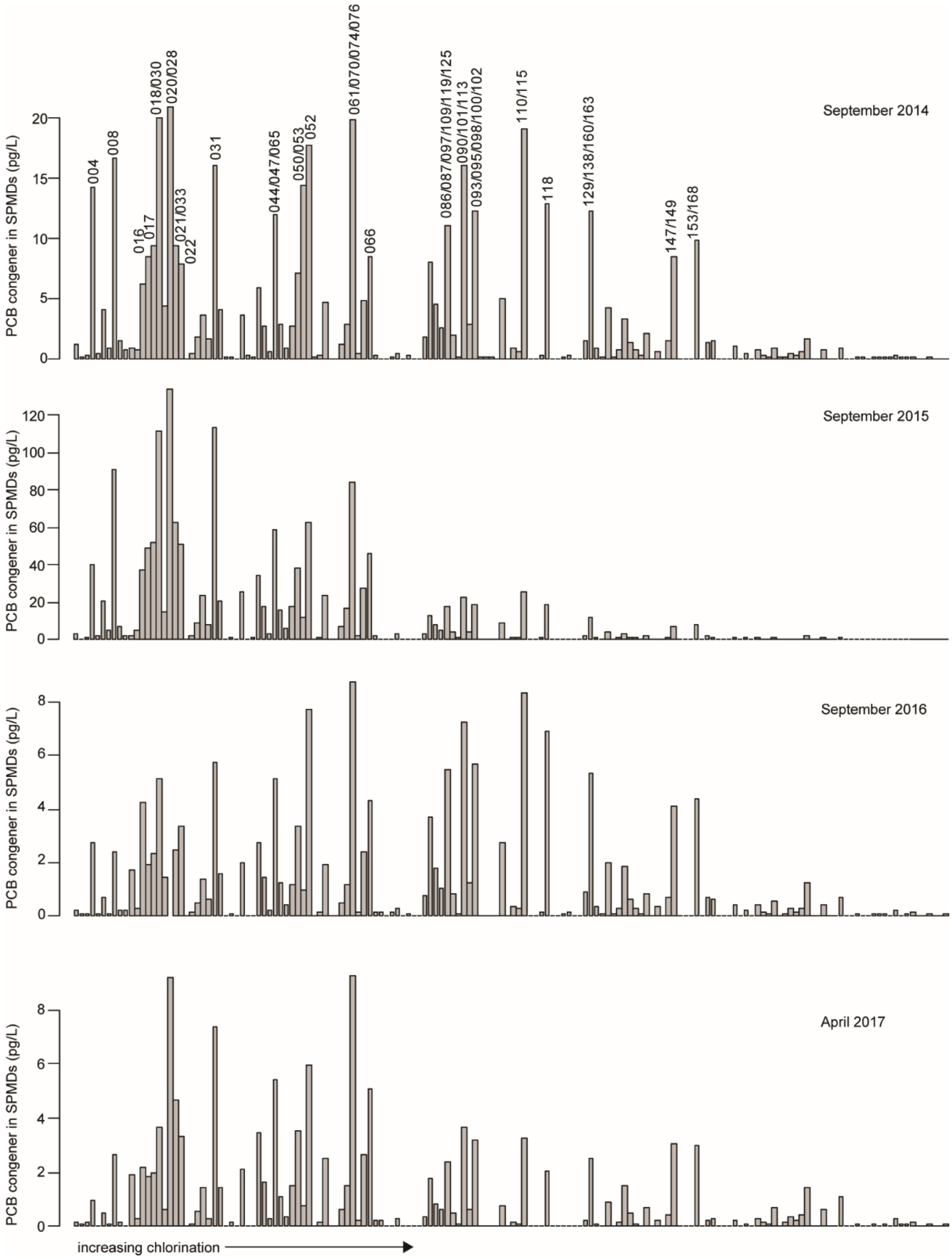

Figure 4. PCB Congener distribution for SPMDs sampled in 2014-2017 Confluence Reach.

4.0 Project Description

4.2 Project objectives

The objectives of this follow-up study are to:

- Complete a comprehensive site history investigation at the Confluence Reach to track changes in river morphology and historical activities at or near the site including reclaimed agricultural areas and industrial activities.
- Complete a synoptic sediment survey at the Confluence Reach, with a focus on backwater channels, as recommended by Ecology (Hobbs, 2018)
- Collect additional water and biofilm samples at the Cashmere Reach if necessary.

4.3 Information Needed and Sources

Historical records will need to be reviewed to assess past and current land use surrounding the Wenatchee-Columbia confluence to identify possible sources of PCBs near the Confluence Reach. The list below will be used as a guide to support the historical review process and was modified to suit this project from Battelle Memorial Institute, 2012.

1. Identify current and historical production/operations for the properties that through intentional or unintentional discharge/runoff could have contaminated the sediments near the confluence.
2. Identify PCB-related activities (e.g., transformer/capacitor use, carbonless copy paper, hydraulic fluid, marine paints) by the potential contributors of sediment contamination, and the timeframe of their use.
3. Identify historical waste handling and disposal for PCB containing materials/waste.
4. Identify possible migration pathways to sediment (e.g., waste disposal, landfills, drainage ditches and creeks receiving runoff), and how those have changed over time.
5. Review historical environmental investigation reports and data, specific to land reclamation around the Confluence Reach.
6. Review historical remedial/reclamation activities, and summarize their implications on possible PCB contamination around the Confluence Reach.
7. Summarize the activities and site characteristics that may have involved PCBs, the possible history (years) of releases, and possible migration pathways to the sediments.

Possible sources to retrieve this information can be obtained through corporate/facility documents, state/federal regulatory files, or published reports, such as those available on Ecology's Toxic Cleanup Program database. Engagement with CCPUD and other municipality officials will be beneficial to obtaining land use data and local environmental reports that aren't readily available online. Interviewing current and past residents of the area, and workers at facilities can also be beneficial sources of information on past land use activities. Aerial photographs, remote sensing, and additional correspondence with CCPUD are useful to understanding hydrology and timing of water level changes over time, reconstructing physical and industrial changes over time, and will help in understanding the river morphology at the Confluence Reach.

4.4 Tasks Required

The tasks under the project plan are:

- Prepare and approve an addendum to the original QAPP (Hobbs, 2014)
- Complete a historical investigation (i.e. records and aerial photographs) to inform sediment sampling locations, track changes in river morphology and reclaimed agricultural areas that may contain contaminated material. Includes: interviews with community members about historical practices and management of PCB containing equipment/products.
- Create a GIS layer that highlights areas of potential concern for PCB inputs and synthesize into a georeferenced map to be used during sample collection as a reference guide.
- Complete site reconnaissance at the Confluence Reach for 15 targeted macroinvertebrate sampling locations in early summer (June) or in early August, dependent on flow conditions.
- During low-flow (~August through September) complete a synoptic sediment survey at the Confluence Reach with 15 targeted sampling locations. The sampling area will focus on backwater channels, as recommended by Ecology (Hobbs, 2018) and data obtained from the historical review.
- During low-flow (~August through September) collect additional water and biofilm samples from the Cashmere Reach.
- All sample locations will be recorded using a GPS unit supplied by Ecology and will be logged using an application, such as Avenza Maps, Map Plus, or similar application. The specific application will be selected prior to field sampling and will be determined based on the applicability to the study and ability to record georeferenced data points.

5.0 Organization and Schedule

5.1 Key individual 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
Keeley Chiasson, CCNRD Phone: 509-679-6133	Project Technician	Writes QAPP. Completes historical review, creates GIS layer, and assists with logistics for field sampling.
Mary Jo Sanborn, CCNRD Phone: 509-860-2135	Project Manager	Reviews the project scope and budget, tracks progress, provides internal review of draft QAPP and addenda. Reviews all reports and approves final documents.
Abby Hendrickson, CCNRD Phone: 509-630-6430	Field Manager	Assists with historical review, oversees logistics for field sampling and assists in sampling. Writes draft and final report sections related to the Confluence Reach.
Sofia Bjorklund, CCNRD Phone: 509-860-8752	Accountant	Approves budget and tracks project spending.
Mike Kaputa, CCNRD Phone: 509-670-6935	Director	Provides internal oversight as needed.
William Hobbs, Ecology Phone: 360-995-3369	Project partner and technical support	Provides internal review of the draft QAPP, oversees field sampling and transportation of samples to lab. Analyzes and interprets data. Writes draft and final report sections associated with Cashmere Reach.
Lauren McDaid, U.S EPA Phone: 208-378-5768	CRBRA Project Officer	Reviews the draft QAPP and addenda and approves final documents.

QAPP: Quality Assurance Project Plan; EPA: Environmental Protection Agency; CCNRD: Chelan County Natural Resource Department; CRBRA: Columbia River Basin Restoration Assistance

5.2 Special training and certifications

Personnel participating in the project field work either currently have the necessary safety training to participate or will be trained prior to the start of field work. As a part of this project, we will be utilizing an Ecology boat for sampling. The Ecology personnel participating in this project is a qualified boat operator and will be responsible for driving the boat during sampling. CCNRD field crew will have the option to take a boat safety education course, but will be required to familiarize themselves with Chapter 3 of the EA Safety Manual, “Boating” (Blakely, 2008). Additional boat safety precautions will include a first aid kit and life jackets on board of the boat. The Ecology personnel will train CCNRD staff how to properly use the equipment required for collection of the proposed sample media. The Field Lead directing sample collection will be knowledgeable concerning all aspects of the project QAPP. All other field crew will be briefed by the Field Lead on sampling goals and objectives prior to sampling.

For river wading safety, all field crew will be required to wear waders that have a wading belt and to wear appropriate foot ware/wading boots. Staff will be working during low flow conditions and within backwater channels, so river current is not of significant concern. However, the field crew should remain vigilant while wading in water as general slips, trips, and falls can be consequential. As a precaution the field crew will always work in pairs and will be within eyesight of each other while wading in the river/backwater channels.

The Field Lead will be responsible for applying for and gaining all necessary permits to complete this project. This includes a research permit from WA State Parks, boat launch permits, and acquiring a discover pass for parking in WA State Parks.

5.4 Proposed project schedule

Table 2. Proposed Schedule for completing field and laboratory work, data entry into the Environmental Information Management (EIM) database, and reports.

Field and laboratory work	**Due date**	**Lead staff**
Field work completed	November 2023	Keeley Chiasson
Laboratory analyses completed	May 2024	
EPA WQX (Water Quality Exchange) database		
EPA WQX		
Product	Due date	Lead staff
WQX data loaded	May 2024	TBD
WQX QA	June 2024	TBD
WQX complete	July 2024	TBD
Quarterly reports		
Author lead	Keeley Chiasson	
Schedule		
1st quarterly report	January 2023	
2nd quarterly report	April 2023	
3rd quarterly report	July 2023	
4th quarterly report	October 2023	
5th quarterly report	January 2024	
6th quarterly report	April 2024	
7th quarterly report	July 2024	
Semi-annual Reports		
1st semi-annual report	July 2023	
2nd semi-annual report	January 2024	
3rd semi-annual report	July 2024	
Final report		
Author lead / support staff		Keeley Chiasson / Mary Jo
Schedule		
Draft due to supervisor	June 2024	
Draft due to client/peer reviewer	July 2024	
Draft due to external reviewer(s)	August 2024	
Final (all reviews done) due to pub team	September 2024	
Final report due on web	November 2024	

5.6 Budget and funding

The detailed budget for the laboratory expenses is outlined in Table 3. Laboratory contracts for testing sediment, tissues, and water for PCB congener analysis and lipids by high-resolution mass spectrometry, using EPA method 1668c, will be handled by SGS AXYS laboratory in Sidney, B.C and through WA DES Contracted labs such as: Ecology Lab, UC Davis, or UC Santa Cruz.

Table 3. Detailed project budget and funding for laboratory costs.

	Number of samples	Number of QA samples	Cost per sample ($)	In-house cost per sample ($)	Contract ($)	Subtotal ($)
Confluence Reach						
Sediments						
PCB congeners (1668c)	15	5	$1,000	-	$20,000	$20,000
Total organic carbon	15	2	$50	-	$850	$850
Grain size	15	2	$100	-	$1,700	$1,700
Tissues (invertebrates)						
C-N stable isotopes	15	10	$15	-	$375	$375
PCB congeners (1668c)	15	5	$1,000	-	$20,000	$20,000
Confluence Reach Total					$42,925	$42,925
Cashmere Reach						
Tissues and water (2021)						
PCB congeners (1668c) – water	5	5	$1,000	-	$10,000	$10,000
C-N stable isotopes	10	10	$15	-	$300	$300
Lipids	10	2	$25	-	$300	$300
PCB Congeners (1668c) - biofilm	10	1	$1,000	-	$11,000	$11,000
Cashmere Reach total				-	$21,600	$21,600
Lab shipping fees				$1,010	-	$1,010
Subtotal					$64,525	$65,535

6.0 Quality Objectives

6.1 Decision Quality Objectives

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

6.2 Measurement Quality Objectives

6.2.1 Targets for precision, bias, and sensitivity

The measurement quality objectives (MQOs) for project results, expressed in terms of acceptable precision, bias, and sensitivity are summarized in Table 4. MQO's for water chemistry are summarized, QAPP addendum 3, Table 4 (Hobbs, 2021). MQO's for water samples are summarized in QAPP addendum 2, Table 5 (Hobbs, 2015).

Table 4. Measurement Quality Objectives

Parameter	Verification Standards (LCS,CRM, CCV)	Duplicate Samples	Matrix Spikes	Matrix Spike-Duplicates	Surrogate Standards	Lowest Concentration of Interest
	% Recovery Limits	Relative Percent Difference (RPD)	% Recovery Limits	Relative Percent Difference (RPD)	% Recovery Limits[a]	Units of Concentration
Sediment samples						
PCB congeners	50-150%	± 50%	NA	NA	50-150%	0.5 ng Kg^{-1} per cong
TOC	80-120%	± 20%	NA	NA	NA	1%
Grain size	NA	± 20%	NA	NA	NA	1% dry wt
Invertebrate samples						
PCB congeners	50-150%	± 50%	NA	NA	50-150%	0.5 ng Kg^{-1} per cong
C:N stable isotopes	NA	± 20%	NA	NA	NA	0.10%

NA=not analyzed TOC=Total Organic Carbon

Table 5. Measurement quality objectives of YSI calibration checks

Parameter	Units	Accept	Qualify	Reject
pH	std. units	< or = ± 0.2	> ± 0.2 and < or = ± 0.8	> ± 0.8
Conductivity*	uS/cm	< or = ± 5	> ± 5 and < or = ± 15	> ± 15
Temperature	° C	< or = ± 0.2	> ± 0.2 and < or = ± 0.8	> ± 0.8
Dissolved Oxygen	% saturation	< or = ± 5%	> ± 5% and < or = ± 15%	> ± 15%
Dissolved Oxygen	mg/L	< or = ± 0.3	> ± 0.3 and < or = ± 0.8	> ± 0.8

* Criteria expressed as a percentage of readings; for example, buffer = 100.2 uS/cm and Hydrolab = 98.7 uS/cm; (100.2-98.7)/100.2 = 1.49% variation, which would fall into the acceptable data criteria of less than 5%.

7.0 Study Design

7.1 Study boundaries

The project will focus on backwater channels near the Wenatchee – Columbia River confluence and may include samples from about 2.7 River miles (RM) upstream the Wenatchee River from the confluence. Upstream samples will be determined based on results from the historical review of the area.

Figure 5. Overview of study area, highlighting backwater channels near the Wenatchee - Columbia confluence and potential areas of interest.

7.2 Field data collection

7.2.1 Sampling locations and frequents

The general area under investigation is highlighted in Figure 5. The historical review will guide the possible areas of interest for sediment and macroinvertebrate sampling. The historical review will focus on land use overtime and will involve reviewing historical archives, aerial photos, environmental reports, and interviewing locals to gain knowledge of historical practices that may relate to PCBs. This research will inform sampling zones within the Confluence Reach and will be selected based on proximity to old landfills or historic dumping zones, past PCB contamination, buried electrical equipment such as transformers, and other indicators of possible PCB presence. Field reconnaissance will be completed to assess the access to the sampling zones highlighted in the GIS layer, and will be completed prior to sampling. All samples will have their locations recorded using a GPS unit and will be logged on an application such as Avenza Maps, Map Plus, or similar application. Further details of the sampling approach related to the Confluence Reach are discussed in section *8.0 Field Procedures*.

Details related to the sampling at the Cashmere Reach are consistent with those discussed in QAPP addendum 3 (Hobbs, 2021).

7.2.2 Field parameters and laboratory analytes to be measured

There are one new set of parameters that will be sampled under this project. Sediment sample collection will follow Blakely (2008) and rely on composite samples from an Eckman grab sampler or alternate devices described in *8.2 Measurement and Sampling Procedures*. Samples will be analyzed for grain size, total organic carbon, and PCB congeners to establish PCB concentrations within backwater channels near the Wenatchee-Columbia confluence. Sediment grain size and organic carbon content are particularly important for the binding of PCBs to sediments (Luthy, 2004).

Parameters related to water, biofilms and macroinvertebrates are consistent with previous investigations.

7.5 Possible challenges and contingencies

A possible constraint for the sampling program related to the Confluence Reach is collecting adequate macroinvertebrate tissue volume. Sampling for macroinvertebrates at the Confluence Reach has not been previously conducted, so density is unknown. Under the circumstance we are unable to collect adequate sample volume of macroinvertebrates, we propose the installation of passive samplers, such as semi-permeable membrane devices (SPMDs), into the sediment of the backwater channels of interest to emulate the biological uptake of available contaminants. SPMDs have been used in previous phases of this project and are discussed in the original QAPP and subsequent addendums (Hobbs, 2014; Hobbs, 2021). SPMDs have only been used in the water column during previous investigations of the Wenatchee River, but other studies have utilized them in the sediments to look at porewater concentrations (Schubauer-Berigan et al., 2012; Springman et al., 2008). We will rely on performance reference compounds to model uptake and concentrations of PCBs in the porewater, as per previous sampling events in the water column of the Wenatchee River.

8.0 Field Procedures

Field procedures for sampling macroinvertebrates are described in the first QAPP addendum (Hobbs, 2015), however the methodology planned for this phase of the project is slightly different and changes will be discussed below. In the case that additional samples will be collected from the upstream Cashmere reach, field procedures for the sampling of biofilms have been described in the original QAPP (Hobbs, 2014) and in reports and publications (Hobbs, 2018; Hobbs et al., 2019). Field procedures for sampling PCBs in groundwater are described in the QAPP addendum 3 (Hobbs, 2021).

Samples will be collected within the sampling zones highlighted in the GIS layer, which will be synthesized into a georeferenced map, to be used as a field guide during sampling. Specific sampling locations will be recorded at the time of data collection using a GPS unit and the logged in Avenza Maps, Map Plus, or similar application on the field iPad. The specific application will be determined prior to sampling and will be selected based on the applicability to the study and ability to record georeferenced points.

8.2 Measurement and Sampling Procedures

8.2.1 PCBs in sediment

Sediment samples will be collected using an Eckman grab sampler and will follow the freshwater sampling protocol outlined by Blakely, 2008 in concordance with the sediment sampling protocol by LSASDS, 2020. Eckman grab samplers are best suited for sampling sites that are composed predominately of soft and fine sediment, and void of course debris. There will be 15 samples collected at the Confluence Reach that will be focused on zones highlighted in the GIS layer and in backwater channels where water moves slowly and sediments tend to be finer relative to the main river channel. When analyzing samples for organochlorine compounds, like PCBs, fine sediments are of particular interest because they tend to contain a greater portion of particulate organic carbon to bind PCBs (Hobbs, 2015).

The Eckman grab sampler is a stainless steel 9x9" spring activated scoop that is light weight and able to be deployed either by a winch or by hand lowering the sampler with a rope from a boat platform or bridge. The sampler has a maximum penetration depth of 23cm and a capacity to hold 5L of sample (Blakely, 2008). Estimated concentrations of PCBs near the Wenatchee-Columbia confluence are expected to be low, less than 200 $\mu g/kg$, as past sampling results ranged from 116-410 pg/g or 0.16-0.41 $\mu g/kg$ (Hobbs, 2021). With low concentrations of PCBs anticipated we can sample directly with the grab sampler and then, after mixing, the sample can be immediately transferred to a final pre-prepared sample container (LSASDS, 2020). Details on sample containers are described in section *8.3 Containers, preservation, holding times*.

After successful deployment of the sampler, the sample will be checked for acceptability. An acceptable sample will have a relatively flat sediment surface with some amount of overlying water that isn't excessively turbid. If there is no water present on the surface of the sample or the water is too turbid, the sample will be disposed of away from the sampling site. An acceptable sample will have the overlying water siphoned off and immediately placed into a pre-cleaned stainless-steel mixing bowl. The sediment on the sidewalls of the sampler can be removed using a pre-cleaned stainless-steel spoon. Only the top layer of sediment will be scooped off the sidewalls and placed into the mixing bowl. The sample will then be homogenized in the bowl by stirring with the stainless-steel spoon until uniform color and texture are achieved. Once homogenized we will subsample for all parameters and samples will be transferred to appropriate pre-cleaned containers with about 2cm of head space and will be stored in coolers on ice for the duration of the sampling day (Blakely, 2008).

Depending on conditions, it’s possible shallow water will be present and wading to sites of interest will be required. In this situation a Petite Ponar grab sampler can be used and follows a similar process to the Eckman and is described in detail in Blakely, 2008. To avoid biased samples in this situation the field crew will approach the sample site from the downstream direction and the sample will be collected facing upstream and the field crew will travel carefully to not disturb the sediment. If the sampling sites of interest have dry sediment the sample may be collected with a pre-cleaned stainless-steel scoop or spoon, and follow the same mixing protocol described above. In the situation sediments are too coarse to use the Eckman grab sampler, we will have a Ponar sampler onboard the boat, which is similar to the Eckman, but heavier and has a greater ability to grab coarser sediment. A sediment coring device can be used in the circumstance sediments are too coarse for both the Eckman and the Ponar grab samplers.

8.2.2 Macroinvertebrates

Macroinvertebrate tissue sampling will be collected using the Eckman grab sampler and using the non-wadable waters method outlined in *SOP #EH-04 Benthic and Macroinvertebrate Sampling and Processing*, *2003*. Sediment grab samples will be collected from fifteen (15) locations, similar to the sediment sampling locations. The sediment will be placed in a 500um mesh sieve bucket. The sediment will be washed through the mesh with water at very low pressure, to preserve the integrity of the samples. Each sampling location will collect the same volume of sediment and conduct the same number of rinses to ensure consistent site representation. After the sample is adequately rinsed it will be placed into a final pre-prepared container. Details on sample containers are described in section *8.3 Containers, preservation, holding times.* Macroinvertebrate samples will be collected at a separate date from the sediment samples, but will be collected in the same zones of interest.

If the habitat exists, we will use the Wadable Waterbody sampling protocol described in QAPP addendum 1 (Hobbs, 2015). This method may be used in combination with, or in-lieu of, the Non-Wadable Waters method, dependent on the field conditions (SOP #EH-4, 2003). Invertebrate sampling will occur either in June or early August 2023, conditions dependent. This will allow time to modify our sampling strategy for macroinvertebrates if we are unable to collect an adequate amount of specimen. As discussed in section *7.5 Possible challenges and contingencies*, SPMDs would be used as the alternate method, and would be installed in the sediment to emulate the biological uptake of available contaminants. SPMDs would remain in the sediment for approximately 30 days and QA/QC would be consistent with previous uses of SPMDs in the Wenatchee River.

A final decision will be made on the sampling approach for PCBs in tissues of macroinvertebrates after the first field reconnaissance day and the first method has been attempted.

8.3 Containers, preservation, holding times

Water sample containers, preservation, and holding times from the Cashmere reach are consistent with QAPP 3. Specifics for the Confluence Reach are described in Table 5.

Table 6. Containers, preservation, and holding times

Parameter	Matrix	Container	Preservative	Holding Time
PCBs (low-level)	sediment	Certified 4-oz amber glass w/ Teflon lid liner	Transport at 6°C; can store frozen at -18°C	6 months or 2 years frozen
TOC	sediment	Certified 2-oz amber glass w/ Teflon lid liner	Cool to 6°C	14 days or 6 months frozen
Grain size	sediment	8-oz wide-mouth glass jar with Teflon-lined lid	Refrigerate at 4ºC	6 months
PCBs (low-level)	invertebrate	8 oz. amber glass jar w/ Teflon lid	cool to 4°C	14 days
C:N Stable isotopes	invertebrate	freeze-dried material in specimen cup	cool to 4°C	6 months

9.0 Laboratory Procedures

9.1 Lab and field procedures table

Lab and field procedures for water and biofilm samples for the Cashmere Reach are consistent with QAPP 3 (Hobbs, 2018).

The laboratory methods for sediment and invertebrate sampling are in Table 6. Should SPMDs be used to measure porewater PCB concentrations, laboratory procedures will follow previous QAPPs.

Table 7. Measurement methods (Laboratory)

Analyte	Sample Matrix	Samples	Expected Range of Results	Reporting Limit	Sample Prep Method	Analytical (Instrumental) Method	Lab
Sediment samples							
PCB congeners (HRMS) (ng Kg^{-1})	Sediments	15	0.5-1500 per cong	1	EPA 1668C	EPA 1668C	SGS AXYS
Total organic carbon (%)	Sediments	15	1-15%	0.10%	PSEP TOC	¥PSEP TOC	*Other
Grain size	Sediments	15	% Fines 2 – 15%; %Sand 70-90%	1.0%	NA	¥PSEP 1986	*Other
Invertebrate samples							
PCB congeners (HRMS) (ng Kg^{-1})	Invertebrates	15	unknown	1	EPA 1668C	EPA 1668C	SGS AXYS
C:N stable Isotopes	Invertebrates	15	0.1-2.0 (%N): 1.0-15 (%C)	0.10%	NA	ǂ stable isotopes of N and C	*Other

Excluding field replicates and field blanks.
*Other- These parameters are not available for analysis at SGS AXYS and will be analyzed through WA DES Contracting such as: Ecology Lab, UC Davis, or UC Santa Cruz. Each of these labs has been utilized by Ecology in the past for analysis of TOC, C:N isotopes, and grain size.
ǂ Costech Elemental Analyzer, Conflo III, MAT253.
¥PSEP (Puget Sound Estuary Program). 1986. Recommended Protocols for Measuring Conventional Sediment Variables in Puget Sound. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, WA and Puget Sound Water Quality Authority, Olympia, WA by Tetra Tech, Inc., Bellevue, WA. 25 pp

10.0 Quality Control Procedures

10.1 Table of field and laboratory quality control

Communication among the project manager, contract lab, and Manchester Environmental Laboratory (MEL) during the initial stages of the project will ensure the sediment, invertebrate, and water chemistry results are meeting the project quality control measures. Details related to water samples are consistent with QAPP addendum 3 (Hobbs, 2018). Should additional water samples be taken in the Cashmere reach, in situ conventional parameters will be collected using a multi-parameter YSI unit; the QC thresholds for the YSI are detailed in Table 5.

11.0 Data Management Procedures

11.2 Laboratory package requirements

The laboratory data package will be generated by SGS AXYS and overseen by Ecology's Manchester Environmental Laboratory (MEL). MEL will provide a validated project data package that will include: a narrative discussing any problems encountered in the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. Quality control results will be evaluated by MEL (*discussed below in Section 13.2 Laboratory data verification*). A level 4 data package will be required from the contract lab.

The following data qualifiers will be used:

- "J" – The analyte was positively identified. The associated numerical result is an estimate.
- "UJ" – The analyte was not detected at or above the estimated reporting limit.
- "NJ" – The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

- The qualifiers will be used in accordance with the method reporting limits such that:
- For non-detect values, the estimated detection limit (EDL) is recorded in the "Result Reported Value" column and a "UJ" in the "Result Data Qualifier" column.
- No results are reported below the EDL.
- Only results reported are for those congeners that have a value at least FIVE times the signal-to-noise ratio, and that meet ion abundance ratios required by the method.
- Detected values that are below the quantitation limits (QL) are reported and qualified as estimates ("J").

- Results that do not meet ion abundance ratio criteria are reported with "NJ." If an Estimated Maximum Possible Concentration (EMPC) value is calculated and reported, the calculation is explained in the narrative, and an example calculation used for this value is provided.
- Results that contain interference from polychlorinated diphenyl ethers (PCDEs) are qualified with "NJ."

11.5 EPA WQX and Ecology EIM data upload procedures

All completed project data will be entered into EPA's Water Quality Exchange (WQX) database and Ecology's Environmental Information Management (EIM) database for availability to the public and interested parties, with the exception of possible SPMD data which is considered a modeled estimate.

The project manager will work with EPA staff to upload the validated final dataset into WQX. Data entered into EIM follow a formal data review process where data are reviewed by the project manager, the person entering the data, and an independent reviewer. EIM can be accessed on Ecology's Internet homepage at www.ecy.wa.gov. The project will be searchable under Study ID WHOB002.

12.0 Assessment and Oversight

12.1 Assessments and Response Actions

Assessment	Description	Frequency/Timing	Assessor	Reporting	Corrective Actions
Data Acquisition	Review of compliance with data MQOs prior/during data acquisition to ensure data quality	Coincident with each sampling event	CCNRD Field Manager	Notes corrective actions taken. Reports to CRBRA Project Officer.	As needed during data acquisition
Sample Event	Review of sample collection, processing, data acquisition, and data reduction procedures	Following completion of sampling event	CCNRD Field Manager in collaboration with Ecology	Report to CRBRA Project Officer. Include with regular semi-annual reporting	As needed
Project	Review of overall project compliance with QAPP procedures	50% project completion	CCNRD Project Manager	Report to CRBRA Project Officer. Include with regular semi-annual reporting	As needed

12.2 Reports to Management

12.2.1 Frequency and distribution of reports

Reports will include, per the project agreement, quarterly and semi-annual reports on progress, WQX data collection and reporting, and a final project report. Quarterly reports will be completed verbally over a video meeting with the EPA project officer and semi-annual reports will be submitted by email to the EPA project officer.

The quarterly and semi-annual reports will present and discuss findings and activities performed during the tracking period. The final report will summarize the background and goals of the project, the experimental design, data collection and analysis methods, data quality, and final results. A draft report will be distributed for review to the EPA project officer prior to being finalized.

12.2.2 Responsibility for reports

Reports will be prepared by Mary Jo Sanborn, or her designee.

13.0 Data Verification

13.1 Field data verification

The field assistant will review field notes once they are entered into Excel spreadsheets. Oversight will be provided by the project manager.

13.2 Laboratory data verification

As previously described, MEL will oversee the review and verification of all laboratory data packages. All data generated by the contract lab must be included in the final data package, including but not limited to:

- A text narrative.
- Analytical result reports.
- Analytical sequence (run) logs.
- Chromatograms.
- Spectra for all standards.
- Environmental samples.
- Batch QC samples.
- Preparation benchsheets.

All of the necessary QA/QC documentation must be provided, including results from matrix spikes, replicates, and blanks.

13.3 Validation requirements, if necessary

A level 2B data validation will be requested for this project, but will include the conversion of contract laboratory flags to MEL-amended qualifiers. Data validation will be carried out by the MEL QA Coordinator. A level 4 data package will be required from the contract lab, should a level 4 data validation be necessary in the future.

15.0 References

Blakeley, Nigel. 2008. Standard Operating Procedure for Obtaining Freshwater Sediment Samples V1.3. Washington State Dept. of Ecology. Olympia, WA.

Carroll, J., S. and R. Anderson. 2009. Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load: Water Quality Improvement Report. Washington State Dept. of Ecology. Olympia, WA. Publication 08-10-062. https://apps.ecology.wa.gov/publications/summarypages/0810062.html

Hobbs, W. and M. Friese. 2016. Wenatchee River PCB and DDT Source Assessment. Washington State Dept. of Ecology. Olympia, WA. Publication 16-03-029. https://apps.ecology.wa.gov/publications/summarypages/1603029.html

Hobbs, W. 2018. Wenatchee River PCB Source Assessment: 2016 and 2017. Washington State Dept. of Ecology. Olympia, WA. Publication 18-03-010. https://apps.ecology.wa.gov/publications/summarypages/1803010.html

Hobbs, W.O., Collyard, S.A., Larson, C., Carey, A.J. and O'Neill, S.M., 2019a. Toxic burdens of freshwater biofilms and use as a source tracking tool in rivers and streams. Environmental science & technology, 53: 11102-11111.

Hobbs, W., M. McCall, and B. Era-Miller. 2019. Evaluation of Low-Level Sampling Field Methods for PCBs and PBDEs in Surface Waters. Publication 19-03-002. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/1903002.html

Hobbs, W. 2021. Addendum 3 to Quality Assurance Project Plan: Wenatchee River PCB and DDT Source Assessment. Publication 21-03-103. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103103.html.

LSASDS Field Branch Chief, 2020. ID: LSASDPROC-200-R4 Sediment Sampling. U.S. Environmental Protection Agency, Laboratory Services and Applied Science Division. Athens, Georgia.

Luthy, R,G. 2004. Organic Contaminants in the Environment: Challenges for the Water/Environmental Engineering Community. Water and Sustainable Development: Opportunities for the Chemical Sciences: A Workshop Report to the Chemical Sciences Roundtable. Stanford University. National Academic Press (US), Washington (DC).

Marti, P. 2016. Standard Operating Procedure EAP078, Version 2.1: Standard Operating Procedure for Purging and Sampling Monitoring Wells plus Guidance on Collecting Samples for Volatiles and other Organic Compounds. Washington State Department of Ecology, Olympia, WA.

McCammon, B, P. 2020. The Wenatchee River Delta, Version 4. North Central Washington Audubon Society, Wenatchee, WA.

Mefford, John. 2022. BNSF Appleyard Initial Investigation Field Report. Washington State Department of Ecology, Olympia.

Schubauer-Berigan, J. P., Foote, E. A., & Magar, V. S. (2012). Using SPMDs to assess natural recovery of PCB-contaminated sediments in Lake Hartwell, SC: I. A field test of new in-situ deployment methods. *Soil and Sediment Contamination: An International Journal*, *21*(1), 82-100.

"SOP #EH-04" 2003. Benthic Macroinvertebrate Sampling and Processing (adapted from ERT/REAC SOP and Great Lakes National Program Office Sampling Method LG406 Revision 7). East Helena Site, Montana.

Springman, K. R., Short, J. W., Lindeberg, M., & Rice, S. D. (2008). Evaluation of bioavailable hydrocarbon sources and their induction potential in Prince William Sound, Alaska. *Marine environmental research*, *66*(1), 218-220.