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State of Washington

Addendum 7 to Quality Assurance Project Plan

Freshwater Fish Contaminant Monitoring Program: 2018

July 2018

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Addendum 7 to
Quality Assurance Project Plan

Freshwater Fish Contaminant Monitoring Program: 2018

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EAP: Environmental Assessment Program
ERO: Eastern Regional Office
TSU: Toxics Studies Unit, EAP
WQP: Water Quality Program

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2.0 Abstract

The Washington Department of Ecology (Ecology) has many efforts underway to address concerns about toxic chemicals in the environment. Many of these chemicals are persistent, bioaccumulative, and toxic (PBTs). While such monitoring is conducted by different groups to meet varied needs, most of the monitoring of freshwater fish tissue in Washington has been conducted by Ecology's Environmental Assessment (EA) Program.

Data from fish contaminant monitoring is used for a variety of purposes, such as: assessing the quality of waterbodies, conducting health risk assessments developing Total Maximum Daily Loads (TMDLs), and evaluating contaminant trends over time.

Since 2001, the continuously-funded Freshwater Fish Contaminant Monitoring Program (previously called the Washington State Toxics Monitoring Program) has characterized PBTs in freshwater fish and water throughout Washington. Over 700 fish tissue samples from over 170 sites were analyzed. Target analytes included chlorinated pesticides (CPs), polychlorinated dibenzo-p-dioxins and -furans (PCDD/Fs), mercury, polybrominated biphenyl ethers (PBDEs) flame retardants, and polychlorinated biphenyls (PCBs). Most monitoring efforts were part of an exploratory monitoring component, with the goal of characterizing contaminants in fish tissue and water from places where historical data were lacking. In 2009, a long-term monitoring component was started with the goal of tracking contaminant levels in fish over time at selected sites, including the Palouse River, to see if changes could be discerned.

This document is an addendum to the Quality Assurance Project Plan (QAPP) written in 2013 and focuses on the 2018 sampling effort for the Palouse River.

3.0 Background

This document describes the 2018 sampling effort by the Washington State Department of Ecology (Ecology) Freshwater Fish Contaminant Monitoring Program (FFCMP) and is an addendum to the original QAPP (Seiders, 2013). Section headers are numbered to match Ecology's current QAPP format but the information in each section can still be easily linked to the original plan. The five-year update of the QAPP for the FFCMP will be completed later in 2018 and will reflect the updated requirements, elements, and format of a QAPP.

3.1 Introduction and problem statement

Fish tissue sampling efforts in the Palouse River basin during the 1980s and 1990s were part of statewide screening-level studies for various contaminants. A TMDL study was done in 2005 in order to address elevated concentrations of CPs and PCBs found in the earlier studies. This TMDL study's Implementation Plan also recommended periodic monitoring of fish tissue to measure reductions in toxic contaminant concentrations.

3.2 Study area and surroundings

Johnson et al (2007) described the Palouse River basin in southeast Washington.

3.2.2 Summary of previous studies and existing data

Results from the 1984 (Hopkins et al, 1985) and 1994 (Davis and Serdar, 1996) studies showed that concentrations of several chemicals in fish did not meet Washington water quality standards. Elevated concentrations of 4,4'-DDE, alpha-BHC, dieldrin, heptachlor epoxide (all CPs), and PCBs led to Clean Water Act 303(d) listings at five sites in the watershed. The 303(d) listings are also known as Category 5 listings in Ecology's periodic statewide Water Quality Assessment (https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d).

Subsequent to the Category 5 listings, a Total Maximum Daily Load (TMDL) technical study was done in 2005 to address the listings. Outcomes of the TMDL study included a Water Quality Improvement Report and Implementation Plan, which laid out actions that would lead to the Palouse River to meet water quality standards (Johnson et al, 2007). While the 2005 study showed decreases in concentrations of these chemicals since the 1980s and 1990s, further decreases were needed in order to meet water quality standards. However, concentrations had decreased to a level where the Washington Department of Health determined that a Fish Consumption Advisory was not warranted (Johnson et al, 2007).

Table 1 shows the timeframe, species, and target analytes for fish tissue studies conducted in the Palouse River.

Table 1. Number and type of fish tissue fillet composite samples from the Palouse River by study, site, and species.

Study ->	BWMP [a]				WSPMP [b]				TMDL [c,d]			
Sample Year ->	1984				1994				2005			
Reach-> Species	Lower (Hooper RM 19.6)	Middle	South Fork	North Fork	Lower (Hooper RM 19.6)	Middle 1 (Winona RM 49.8)	South Fork	North Fork	Lower (Hooper RM 19.6)	Middle 2 (Shields Rd bridge RM 77.8)	South Fork	North Fork
CCP									1			
CHM									1	1	2	5
LNS	1											
LSS						1w			5	4	5	5
NPM	1					1			2	2	5	5
SMB									1	3		
Target Analytes												
CPs	x					x			x	x	x	x
PCBs	x					x			x	x	x	x
PBDEs									z	z	z	z
PCDD/Fs									z		z	z
Mercury									x	x	x	x
Lipids	x					x			x	x	x	x
EIM Study ID	BHOP0002				WSPMPT				AJOH0046			

Study codes: BWMP - Basic Water Monitoring Program; WSPMP - Washington State Pesticide Monitoring Program; TMDL - Total Maximum Daily Load Study; WSTMP - Washington State Toxics Monitoring Program.
References: a - Hopkins, 1985; b - Davis and Serdar, 1996; c - Johnson et al, 2007; d - Seiders et al, 2007.
w - sample analyzed as whole fish.
x - samples analyzed by the study indicated;
z - some fish also analyzed by the WSTMP for PBDEs, PCDD/Fs, and mercury (EIM Study ID WSTMP05)
Species Codes: CCP – Common carp; CHM – Chiselmouth; LNS – Longnose sucker; LSS – Largescale sucker; NPM – Northern pikeminnow; SMB – Smallmouth bass.

Figures 1-4 show results from the 2005 study for 4,4'-DDE, dieldrin, t-PCBs, and mercury in composite samples of fillet tissue. These figures show differences among species and sites. Many of the samples exceeded the old water quality standards (expressed as the FTEC) which was the numeric TMDL target for dieldrin and PCBs. Some of the 2005 samples also exceeded the proposed Policy 1-11 tissue threshold values (expressed as the TECc and TECn). The FTEC and TEC are explained below.

The FTEC is a Fish Tissue Equivalent Concentration that was previously used to determine whether the water quality standards were being met. The TECc and TECn stand for Tissue Exposure Concentration: the "c" and "n" denoting whether the health effects are carcinogenic or non-carcinogenic. These TECs incorporate updated exposure, toxicity, and risk/hazard information for the protection of human health. The TECs are part of proposed revisions to Ecology's Water Quality Program Policy 1-11, which is used to implement the water quality standards that were revised in 2016 (Ecology, 2016a). The Glossary provides more detailed explanations of these terms. These new TECs are thresholds that, when exceeded, indicate that beneficial uses may not be met. If finalized, these thresholds will be used in the next Water Quality Assessment (WQA).

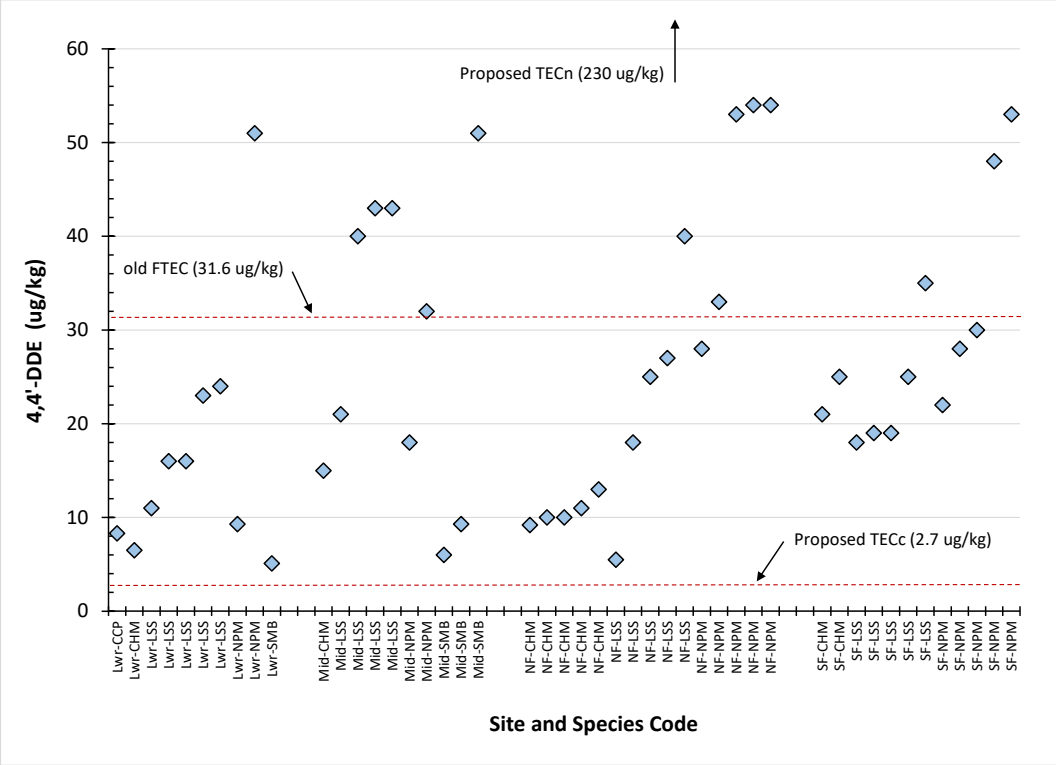

Figure 1. Results for 4,4'-DDE in fish from the Palouse River in 2005.

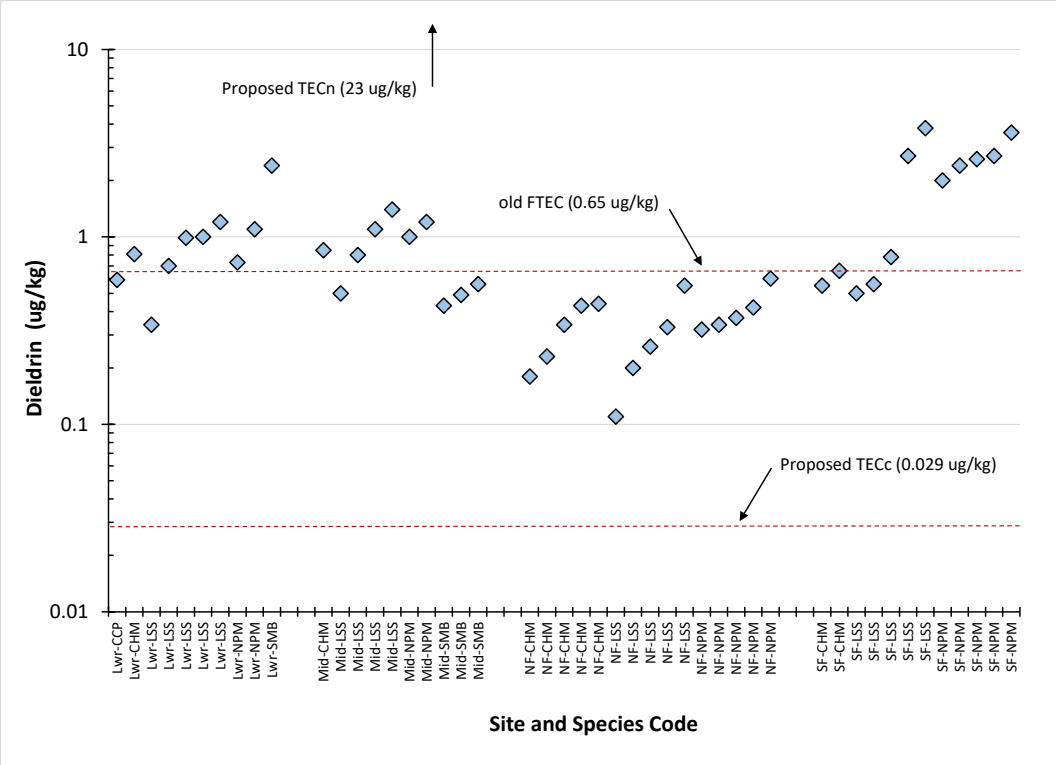

Figure 2. Results for dieldrin in fish from the Palouse River in 2005.

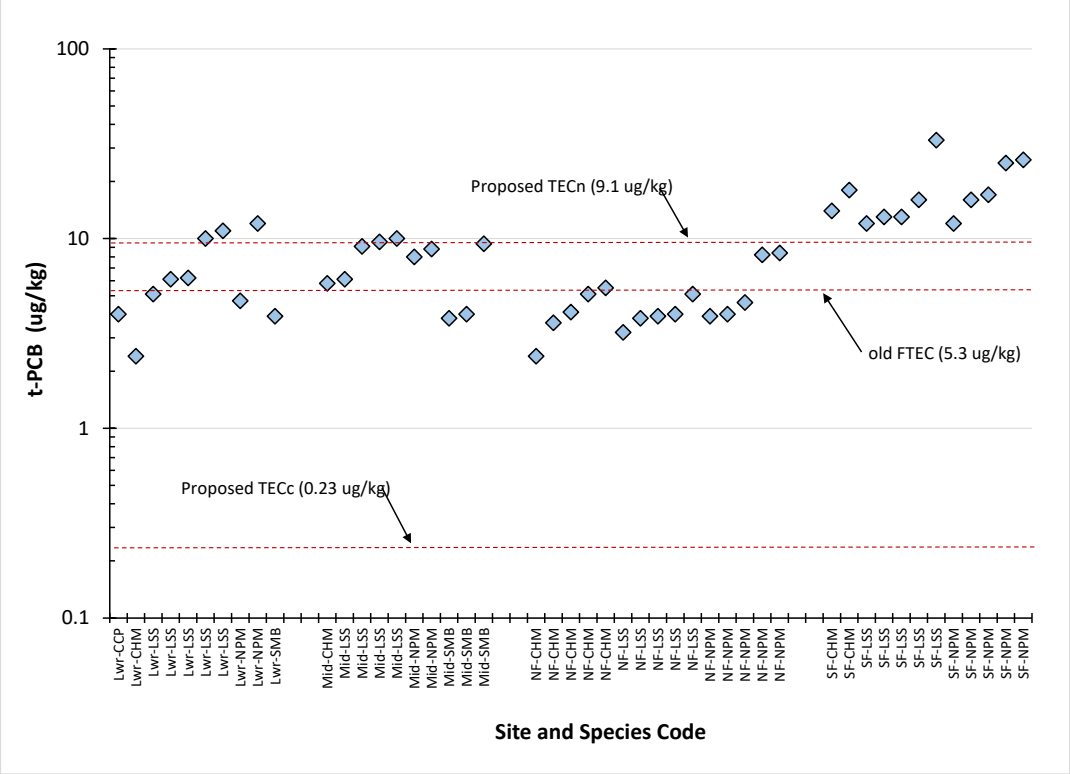

Figure 3. Results for t-PCBs in fish from the Palouse River in 2005.

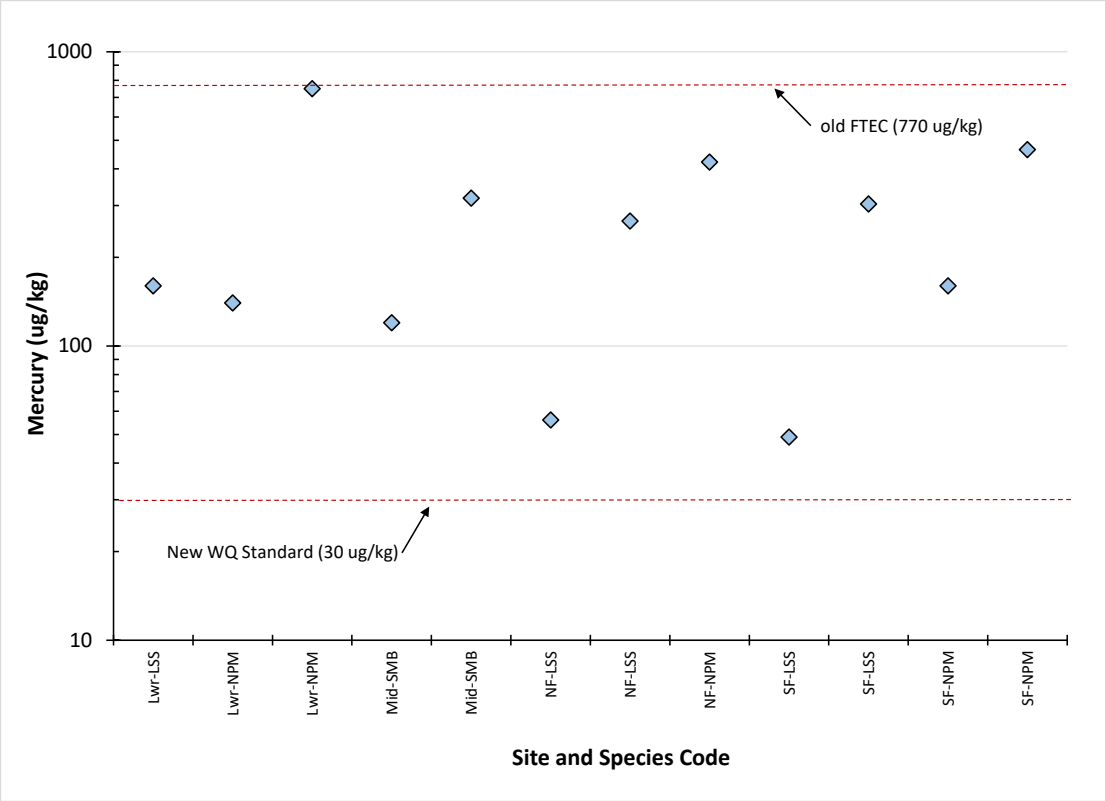

Figure 4. Results for mercury in fish from the Palouse River in 2005.

3.2.3 Parameters of interest and potential sources

The primary target analytes for long term trend assessment are chlorinated pesticides (CPs) and PCB compounds. Other contaminants for which there are little or no historical data will be characterized as well, such as mercury, polybrominated diphenyl ethers (PBDEs), and polychlorinated dibenzo-p-dioxins and –furans (PCDD/Fs).

3.2.4 Regulatory criteria or standards

When a water cleanup plan is created (i.e., an EPA-approved TMDL), Category 5 listings are re-assigned as Category 4A listings. Category 4A listings indicate that full implementation of the cleanup plan is expected to result in the standards being met. Table 2 shows the most recent WQA Category 4A listings for 4,4'-DDE, dieldrin, and PCBs. Dioxin (as 2,3,7,8-TCDD) is also a concern because of the elevated concentrations of the dioxin Toxicity Equivalent (TEQ). This concern resulted in a Category 2 listing.

Table 2. Category 4A and Category 2 listings for fish tissue from the Palouse River.

Location	Listing ID	Category (2014)	Parameter	Sample Year	Species not Meeting WQS	NHD Reach Code	EIM Location ID
Palouse R near Hooper	52048	4A	Dieldrin	2005	CHM, LSS, NPM, SMB	17060108000023	34PAL-LWRFISH
	52680	4A	PCBs	2005	LSS, NPM		
	51623	2	2,3,7,8-TCDD TEQ	2005	NPM		
Palouse R near Winona	8818	4A	Dieldrin	1994	NPM	17060108000179	PALRAW
	8820	4A	PCBs	1994	NPM		
Palouse R ~3 mi NNW of Diamond	52047	4A	Dieldrin	2005	CHM, LSS, NPM	17060108000201	34PAL-MIDFISH
	52679	4A	PCBs	2005	CHM, LSS, NPM		
South Fork near Albion	51746	4A	4,4'-DDE	2005	LSS, NPM	17060108000220	34PAL-SFFISH
	52050	4A	Dieldrin	2005	CHM, LSS, NPM, SMB		
	52682	4A	PCBs	2005	CHM, LSS, NPM		
	51624	2	2,3,7,8-TCDD TEQ	2005	NPM		
Palouse R near Elberton	52681	4A	PCBs	2005	NPM	17060108000287	34PAL-NFFISH
	51622	2	2,3,7,8-TCDD TEQ	2005	NPM		

WQS - Water Quality Standards
NHD – National Hydrography Dataset
Species Codes: CHM - Chiselmouth, LSS - Largescale sucker, NPM - Northern pikeminnow, SMB - Smallmouth bass

Amendments to Washington's water quality standards (Ecology, 2016a) were adopted in 2016 after the TMDL work and Implementation Plan for the Palouse River were developed. Ecology's Rule Implementation Plan (Ecology, 2016b) provides guidance and tools to entities involved with implementing the TMDL transition towards meeting the new water quality standards. For example where a TMDL has been formally approved (such as for the Palouse River), the TMDL and original water quality targets are kept in place, implementation continues as scheduled, and monitoring results are compared to targets as well as the new water quality standards. If TMDL Effectiveness Monitoring shows that the new standards are not being met, then the TMDL would be amended in order to address the new standards.

TMDL Effectiveness Monitoring is a fundamental component of any TMDL implementation activity. It measures to what extent the water body has improved and whether it has been brought into compliance with the state water quality standards. Effectiveness monitoring takes a holistic look at TMDL implementation, watershed management plan implementation, and other watershed-based cleanup efforts. Success may be measured against TMDL load allocations or targets, correlated with baseline conditions or desired future conditions.

While not a formal Effectiveness Monitoring project, the 2018 FFCMP can contribute to such an effort. The 2018 fish tissue monitoring will determine if the original TMDL targets (old water quality standards) for fish tissue and the new water quality standards are being met. Other elements of formal Effectiveness Monitoring, such as monitoring wastewater treatment plant effluent or the implementation of agricultural Best Management Practices (BMPs) are beyond the scope of the 2018 FFCMP effort. Ecology's guidance for formal Effectiveness Monitoring (Collyard and Onwumere, 2013) presents a strategy for monitoring the effectiveness of TMDLs and other pollution control plans.

Some important actions have been taken to address toxic pollutants in the watershed. For example, stormwater, wastewater treatment plants, and abandoned landfills were evaluated for their potential as sources of contaminants (Lubliner, 2006, 2009; Coots, 2017). Local governments have been working to improve wastewater and stormwater systems, as well as working with private landowners to reduce erosion on farmlands and implement BMPs to protect water quality (Snouwaert, 2018). Because dieldrin and PCBs are not currently being manufactured or used, it is expected that natural attenuation will play a large role in reducing the presence of these chemicals.

A partial accounting of pollution control actions for toxics in the Palouse River was tabulated by Ecology's Eastern Regional Office (Snouwaert, 2018) and transferred to the TMDL Implementation Tracking Table (Appendix A, Table A-1,) from the Implementation Plan (Johnson, et al, 2007). This table was created to record the status of all actions recommended by the TMDL. A more complete Tracking Table would become one element of a formal Effectiveness Monitoring effort. While incomplete at this time, the Tracking Table shows the nature of information that is needed for determining the effectiveness of the TMDL. The report on the 2018 fish monitoring can include Ecology's tracking of TMDL implementation efforts.

4.0 Project Description

4.1 Project goals

The goal of the 2018 monitoring effort is to develop a robust data set of contaminant concentrations in fish from the Palouse River in order to:

- Characterize temporal trends by comparisons to historical and future data.
- Compare results to old and new water quality standards.
- Inform water quality management efforts such as the current TMDL for the river.
- Support fish consumption risk assessments by health jurisdictions.

4.2 Project objectives

The objectives of the 2018 sampling include collecting fish of the same species and size ranges that were collected in the past; and then summarizing results to meet the goals described above. Table 3 shows the sites, target species, and target number of analyses of composite samples for each suite of analyses.

Table 3. Sample plan and estimated laboratory costs, FFCMP 2018.

Sites	Target Species	Number of Composite Samples for Each Analysis					
		Hg	PBDE, lipid	Cl Pest HR GC/MS	PCB congeners HR GC/MS	PCDD/Fs HR GC/MS	
Palouse R, mainstem nr Hooper (34PAL-LWRFISH)	CHM or NPM	3	5	5	5	3	
	LSS	3	5	5	5		
Palouse R, mainstem nr Diamond (34PAL-MIDFISH)	CHM or NPM	3	5	5	5	3	
	LSS	3	5	5	5		
Palouse R, "North Fork" (34PAL-NFFISH)	CHM or NPM	3	3	3	3	3	
	LSS	3	3	3	3		
Palouse R, South Fork (34PAL-SFFISH)	CHM or NPM	3	5	5	5	3	
	LSS	3	5	5	5		**Totals**
Total # field sample analyses		24	36	36	36	12	144
Total # lab QC analyses		4	4	3	3*	2*	11
Total # analyses		28	40	39	36	12	155
Cost per analysis		$ 50	$ 275	$ 1,125	$ 750	$ 625	
Subtotal costs		$ 1,400	$ 11,000	$ 43,875	$ 27,000	$ 7,500	**$ 90,775**

* The charge for lab duplicates and Certified Reference Material analyses are rolled into the price/sample.
Species Codes: CHM – Chiselmouth, LSS – Largescale sucker, NPM – Northern pikeminnow.

Actual numbers of samples to be analyzed may be adjusted depending on success of fish collection work in 2018: past FFCMP collections have met about 60-80% of the target number of fish. If target species are not found in desired numbers or size ranges, other species may be collected if adequately abundant.

4.3 Information needed and sources

The previous studies (described above) and associated data were obtained from Ecology project files and Ecology's EIM database. This information was reviewed to guide development of project objectives and the sampling plan. Contaminants assessed in fish from previous studies focused mainly on CPs and PCBs. Limited sampling has been done for other contaminants, such as PBDEs, PCDD/Fs, and mercury. This project will use data collected through past monitoring efforts conducted by Ecology as described above to characterize temporal trends.

5.0 Organization and Schedule

5.3 Organization chart

Table 4. Organization of project staff and responsibilities, FFCMP 2018.

EAP Staff	Title	Responsibilities
Jessica Archer EAP-SCS 360-407-6698	Client	Provides internal review of the QAPP, addendums, and reports. Approves the final QAPP and addendums.
Keith Seiders Toxics Studies Unit EAP-SCS 360-407-6689	Project Manager and Principal Investigator	Writes the QAPP, addendums, and reports. Reviews historical data and develops sample strategy for different sites on annual basis. Works with laboratories to obtain analytical services. Reviews, analyzes, and interprets data. Guides field assistants in various roles and tasks.
Patti Sandvik Toxics Studies Unit EAP-SCS 360-407-7198	Field and EIM Lead, Project Assistant	Leads efforts for sample collection, processing, and transportation of samples to the laboratory. Ensures that field and processing information is recorded. Enters field and laboratory data into EIM. Compiles and summarizes historical and current-year data. Assists report effort.
Debby Sargeant Toxics Studies Unit EAP SCS 360-407-6775	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, addendums, and reports. Approves the final QAPP and addendums. Manages budget and staffing needs.
Chad Atkins ERO WQP 509-329-3499	Supervisor, ERO WQP Watershed Unit, Acting	Helps coordinate ERO staff (e.g. Palouse River TMDL Coordinator) and stakeholder involvement. Approves this addendum to the QAPP.
Adriane Borgias ERO WQP 509-329-3515	Supervisor, ERO WQP	Helps coordinate ERO staff and stakeholder involvement. Approves this addendum to the QAPP.
George Onwumere EAP-EOS 509-454-4244	Supervisor, EOS, Central Regional Office	Helps coordinate ERO EAP staff involvement as needed. Approves the final QAPP and addendum.
Alan Rue EAP-Manchester Environmental Lab 360-871-8801	Laboratory Director	Approves the final QAPP and addendum. Oversees all operations at MEL regarding in-house analyses and processes for contracting analyses to commercial labs.
Tom Gries EAP-QA 360-407-6327	Ecology Quality Assurance Officer, Acting	Reviews the draft QAPP and addendums. Approves the final QAPP and addendums.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
EOS: Eastern Operations Section
ERO: Eastern Regional Office
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section
WQP: Water Quality Program

5.4 Proposed project schedule

Table 5. Schedule for completing field, laboratory, and report tasks, FFCMP 2018.

Field and laboratory work	Due date	Lead staff
Field work completed	June 2018	Patti Sandvik
Sample processing completed	August 2018	Patti Sandvik
Ecology lab analyses completed	February 2019	MEL, Alan Rue
Contract lab analyses completed	February 2019	MEL, Alan Rue
Environmental Information System (EIM) database		
EIM user study ID	FFCMP18	
Product	Due date	Lead staff
EIM data loaded	May 2019	Patti Sandvik
EIM data verification	June 2019	To be determined
EIM complete	July 2019	Patti Sandvik
Final report		
Author lead / Support staff	Keith Seiders / Patti Sandvik	
Schedule		
Draft due to supervisor	April 2019	
Draft due to client/peer reviewer	May 2019	
Draft due to external reviewer(s)	May 2019	
Final (all reviews done) due to publications coordinator	June 2019	
Final report due on web	July 2019	

An "Approval to Begin Sampling" was issued in May based on the draft Addendum. The more formal approval and publication process of the final Addendum may occur after sampling begins.

5.5 Budget and funding

This project is funded by the Environmental Assessment Program. The FFCMP has most of the time of two staff assigned to the FFCMP project. Laboratory analytical costs are estimated at approximately $91,000 (Table 3).

6.0 Quality Objectives

6.1 Data quality objectives

The data quality objective (DQO) for this project is to collect adequate numbers of appropriate fish and have them analyzed for various contaminants which will meet measurement quality objectives (MQOs) that are described below and that are comparable to previous study results.

6.2 Measurement quality objectives

6.2.1 Targets for precision, bias, and sensitivity

The MQOs for project results, expressed in terms of acceptable precision, bias, and sensitivity, are described in Table 6. With the exception of MQOs for analysis of chlorinated pesticides, they are the same as listed in the original QAPP.

Table 6. Measurement quality objectives, FFCMP 2018.

Parameter	Analytical Method	Lab Duplicate (as RPD)	Lab Control Sample (% recovery)	Surrogates (% recovery)	Matrix Spike/Spike Duplicate (% recovery)
Mercury	EPA 245.6 (CVAA)	0%-20% (for results > 5x RL)	85%-115%	NA	75%-125%; RPD limit 20%
Chlorinated pesticides	SGS AXYS MLA-028 (HR GC/MS)	0%-40%	Per method for OPR, Internal Standards, and Labeled Compounds each sample & 1/batch [a]	NA	NA
PCB congeners	EPA 1668C (HR GC/MS)	0%-40%	Per method for OPR, Internal Standards, and Labeled Compounds each sample & 1/batch [a]	NA	NA
PCDD/Fs	EPA 1613B (HR GC/MS)	0%-40%	Per method for OPR, Internal Standards, and Labeled Compounds each sample & 1/batch	NA	NA
PBDEs	EPA 8270 (SIM); MEL SOP 730104	0%-40%	50%-150%	50%-150%	50%-150%; RPD limit 40%
Lipids	MEL SOP 730009	0%-20%	NS	NA	NA

a – Labeled compounds in each sample and Ongoing Precision and Recovery standards in each batch.
CVAA: Cold Vapor Atomic Absorption
HR GC/MS: High Resolution Gas Chromatography/Mass Spectrometry
OPR: Ongoing Precision and Recovery
RL: Reporting Limit
RPD: Relative percent Difference

6.3 Acceptance criteria for quality of existing data

Data collected through past monitoring efforts conducted by Ecology, following approved QAPPs and QAPP Addenda, were reviewed to assess their usability in this project and deemed acceptable. Items that were reviewed included:

- Project reports and plans.
- Analytical methods.
- Sample collection locations, timing, and sample processing.
- Target species, size ranges, and sample numbers.

7.0 Study Design

7.1 Study boundaries

The study boundaries are the same as those in the 2005 study (Johnson, 2007). Figure 5 shows the target sampling locations in the Palouse River watershed for the 2018 effort.

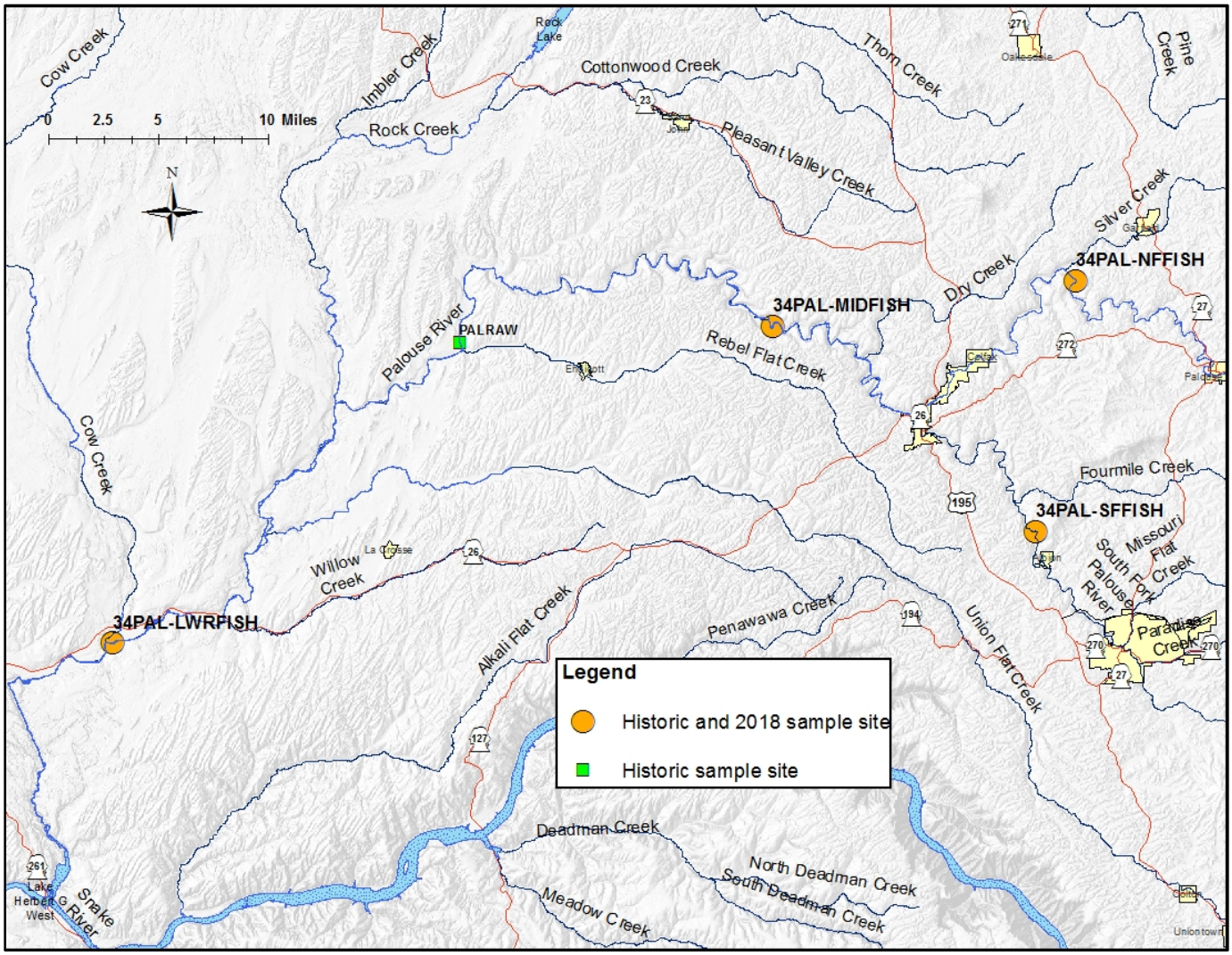

Figure 5. Proposed sampling locations in the Palouse River, FFCMP 2018

7.2 Field data collection

7.2.1 Sampling locations and frequency

Table 7 shows location and species information for sites that were sampled in 2005. The 2018 effort will target these same areas of the Palouse River in May and June, as was done in the 2005 study. The target species will be chiselmouth (*Arocheilus alutaceus*), largescale sucker (*Catostomus macrocheilus*), and northern pikeminnow (*Ptychocheilus oregonensis*): these species were collected in the greatest numbers in 2005. Only three samples of smallmouth bass (*Micropterus dolomieui*) from two sites were collected in 2005 so this species will be collected only if they are abundant and target species are lacking. While collecting fish in 2018, the size ranges for each site and species may be adjusted in order to obtain sufficient numbers of fish to improve representativeness and comparability.

7.2.2 Field parameters and laboratory analytes to be measured

For the long-term monitoring strategy at selected sites in the target watersheds, multiple replicates of composite) for each species at each site are anticipated to provide an adequately robust data set that will meet project objectives. Review of field replicate data from previous FFCMP work showed that variance is inconsistent and can be high for organic contaminants, ranging up to 100% Relative Percent Difference (RPD) for PCBs, DDTs, and PCDD/Fs. A sample size of five composite samples should reduce the variability associated with the mean and median tissue concentrations and improve the ability to determine change among sample results over time. The use of three to five fish of the same species and similar size in each composite sample also helps reduce variability and improve comparability to historical results.

The 2018 sampling will attempt to collect fish of the same species and size ranges that were collected in the past. Actual numbers of samples to be analyzed may be adjusted depending on success of fish collection efforts: past FFCMP efforts have met about 60-80% of the target number of fish. If target species are not found in desired numbers or size ranges, other species may be collected if adequately abundant. Table 3 (page 13) shows the sites, target species, and target number of analyses of composite samples for each suite of analyses.

Table 7. Location and species information for sampling, FFCMP 2018.

Location Description	NHD Reach Code	EIM Location ID	RM	EIM Latitude	EIM Longitude	EIM Location Description	Size range of fish from 2005 TMDL study: as total length (mm)			
							CHM	LSS	NPM	SMB
Palouse R. near Hooper; ~ 6 mi NNE of Palouse Falls SP	1706010-8000023	34PAL-LWRFISH*	19.6	46.7590	-118.1479	Centroid location of a quarter-mile stretch of the Palouse River spanning the old highway 26 bridge near the town of Hooper.	180-220	340-450	190-490	170-210
Palouse R. ~ 3 mi NNW of Diamond; near Frank Feenan Rd at Shields Rd; ~ 9 mi NW of Colfax	1706010-8000201	34PAL-MIDFISH	77.8	46.9528	-117.5042	Centroid location of a half-mile stretch of the Palouse River spanning Shields Rd bridge.	190-260	420-460	190-260	160-260
Palouse River near Elberton, upstream of Silver Cr. Confluence; ~ 10 mi NE of Colfax	1706010-8000287	34PAL-NFFISH	na	46.9750	-117.2108	Centroid location of a 15.7 mile stretch of the North Fork Palouse River between the Glenwood Rd bridge and the Westacott Rd bridge.	200-230	190-450	220-400	-
South Fork Palouse R. just downstream of Albion; ~ 8 mi SE of Colfax	1706010-8000220	34PAL-SFFISH	na	46.8108	-117.2583	Centroid location of a 15.8 mile stretch of the South Fork Palouse River between Risbeck and the Pullman WWTP discharge.	190-260	200-470	200-400	-

* This is the same location as the EIM Location ID "PALOUSERIVER" for the 1984 study: the two locations are about 25 meters apart.
EIM: Environmental Information Management database
RM: River mile
EIM Latitude and Longitude datum is NAD83 HARN
Species Codes: CHM - Chiselmouth, LSS - Largescale sucker, NPM - Northern pikeminnow, SMB - Smallmouth bass.

8.0 Sampling Procedures

8.1 Invasive species evaluation

Invasive or unwanted aquatic species may be encountered during fish collections for this project. Environmental ethics and Washington law (RCW 77.15.290) prohibits transport of fish, wildlife, and aquatic plants from one location to another. Sample collection efforts for this project will follow the Ecology Environmental Assessment Program's SOP to Minimize the Spread of Invasive Species (Parsons et al., 2018) and Washington Department of Fish and Wildlife's Invasive Species Management Protocols (Tweit et al., 2012). For this year's target sites, the New Zealand mudsnail, an invasive species of extreme concern, is not known to be present.

8.2 Measurement and sampling procedures

Samples will be collected and processed as described in SOPs for this project (Sandvik, 2010a, 2010b, 2010c). Fish collection methods may include the use of gillnets, seines, electrofishing, and angling. Federal and state scientific collection permits provide guidance for minimizing the disturbance of anadromous salmon and steelhead that may be present. These include the current or revised National Marine Fisheries Permit # 1386-R9, U.S. Fish and Wildlife Service Permit # TE058381-8, and Washington Department of Fish and Wildlife Permit SANDVIK 18-158.

8.3 Containers, preservation methods, holding times

Table 8 reproduces from the original QAPP information about sample containers, preservation, and holding times for fish tissue samples.

Table 8. Containers, preservation, and holding times for samples, FFCMP 2018.

Parameter	Sample Container	Minimum Amount Required (wet weight)	Preservation	Holding Time
Mercury	2 oz. precleaned glass jar w/teflon lid	5g	freeze, -10° C	6 months to extraction, then 28 days to analysis
Chlorinated Pesticides	4 oz. precleaned glass jar w/teflon lid	30g, 60g preferred	freeze, -10° C	1 year to extraction, then 40 days to analysis
PCB congeners	4 oz. precleaned glass jar w/teflon lid	30g, 60g preferred	freeze, -10° C	1 year to extraction, then 40 days to analysis
PCDD/Fs	4 oz. precleaned glass jar w/teflon lid	30g, 60g preferred	freeze, -10° C	1 year to extraction, then 40 days to analysis
PBDEs	4 oz. precleaned glass jar w/teflon lid	30g, 60g preferred	freeze, -10° C	1 year to extraction, then 40 days to analysis
Lipids	4 oz. precleaned glass jar w/teflon lid	30 g	freeze, -10° C	1 year to extraction, then 40 days to analysis

9.0 Laboratory Procedures

9.1 Lab procedures table

The analytical methods were selected to be comparable to past monitoring results and to recently proposed thresholds for evaluating compliance with water quality standards. Analyses for lipids, mercury, and PBDEs will be conducted by the Ecology Manchester Environmental Laboratory (MEL). Analyses by High Resolution Gas Chromatography/Mass Spectrometry (HR GC/MS) for PCB congeners, PCDD/Fs, and chlorinated pesticides will be done by an accredited laboratory through a contract managed by MEL. Both MEL and the contract laboratories are expected to meet the QC requirements of the analytical methods being used and any other requirements specified by MEL or the Project Officer in the Statement of Work part of the contract.

Table 9 shows the parameters to be analyzed, analytical methods, desired reporting limits, ranges of expected results, and current draft thresholds for evaluating compliance with water quality standards. The only substantive change from the original QAPP is for the chlorinated pesticides, which will be analyzed using a high resolution GC/MS method similar to EPA Method 1699.

Analytical methods need to be adequately sensitive to compare to proposed tissue threshold concentrations that will be used in the Water Quality Assessment. Fish tissue is a challenging matrix and presents various interferences that often raise reporting limits for six chlorinated pesticides. These pesticides are aldrin, alpha-BHC, dieldrin, heptachlor, heptachlor epoxide, and toxaphene. These pesticides were identified in Table D-1 of the original QAPP as possibly needing extra effort by labs to achieve desired reporting limits (Seiders, 2013).

Table 10 shows the target analytes for SGS (Société Générale de Surveillance) AXYS's method MLA-028 with: reporting limits, typical reporting limits for the low resolution EPA Method 8081, proposed water quality standard threshold values for chemicals in fish tissue, and expected range of results for Palouse River fish.

Table 11 shows the required quantitation and detection limits for dioxins and furans in fish tissue for the FFCMP 2018.

9.4 Laboratories accredited for methods

All laboratories performing analyses for this project are accredited for the methods they will use. In order to obtain results that can be compared to the proposed threshold values to be used in the Water Quality Assessment, an HR GC/MS method for CPs and toxaphene will be used. The laboratory SGS AXYS Analytical, in Sidney BC is currently accredited by Ecology for performing method 'AXYS MLA-028'. This method has been used in past studies by Ecology in order to obtain results that meet project objectives.

Table 9. Laboratory measurement methods for fish tissue samples, FFCMP 2018.

Parameter	Methods, Reporting Limits, and Sample Number				Water Quality Standard Thresholds		
	Number of Samples and Arrival Date [a]	Expected Range of Results [b]	Reporting Limits [c]	Analytical and Preparation Methods	Draft TECc 2018	Draft TECn 2018	Old FTEC 2016
Mercury	24, September 2018	10 - 1000 ug/kg	17 ug/kg	EPA 245.6 (CVAA)	30 ug/kg [d]		770 ug/kg
Chlorinated pesticides (CPs)	36, September 2018	Varies by analyte: see Table 10	Varies by analyte: see Table 10	AXYS MLA-028 (HR GC/MS)	See Table 10		
PCB congeners	36, September 2018	0.005 - 2 ug/kg, depending on congener	0.003-0.01 ug/kg	EPA 1668C (HR GC/MS)	0.23 ug/kg [e]	9.1 ug/kg [e]	5.3 ug/kg [e]
PCDD/Fs	12, September 2018	0.005 - 1.0 ng/kg: see Table 11	0.015 - 0.2 ng/kg: see Table 11	EPA 1613B (HR GC/MS)	-	0.32 pg/g [f]	0.07 pg/g [f]
PBDEs	36, September 2018	0.1 - 50 ug/kg	0.10 - 2.6 ug/kg; PBDE 209 1.9 - 4.3 ug/kg	EPA 8270 (SIM); MEL SOP 730104	-	-	-
Lipids	36, September 2018	0.1 - 6%	0.10%	MEL SOP 730009	-	-	-

[a] MEL will be informed of actual numbers and arrival dates after completion of the sampling and processing efforts.

[b] Values reflect historical data from the study area.

[c] Value reflects typical ranges from historical analyses

[d] This mercury concentration is a tissue-based water quality criterion (40CFR131.45) rather than a TEC.

[e] The TEC uses the same summation approach to PCB concentrations as the water quality standard :total PCBs equals the sum of all congener or all isomer or homologue or Aroclor analyses

[f] The water quality criterion (40 CFR 131.45) is for the single dioxin congener 2,3,7,8-TCDD. For purposes of the water quality assessment Policy 1-11 his threshold is also applied to the Toxic Equivalent (TEQ) for 2,3,7,8-TCDD. The TEQ is the sum of the products of all detected congeners multiplied by their respective congener-specific Toxicity Equivalent Factor (TEF).

TECc = Tissue Equivalent Concentration for carcinogenic effects.

TECn = Tissue Equivalent Concentration for non-carcinogenic effects.

FTEC: Fish Tissue Equivalent Concentration (previously used threshold for water quality standards compliance).

Table 10. Characteristics of chlorinated pesticides to be analyzed using HR GC/MS for the FFCMP 2018 (ug/kg wet weight).

Analyte	CAS #	AXYS MLA-028 MDL	AXYS MLA-028 typical SDL	EPA 8081: Typical RL (for FFCMP, extract split)	Draft TECc (2018)	Draft TECn (2018)	Old FTEC (2016)	Expected range of results for 2018
2,4'-DDD	53-19-0	0.004	0.02	0.5 - 1.0	-	-	-	ND - 1.0
2,4'-DDE	3424-82-6	0.004	0.02	0.5 - 1.0	-	-	-	ND - 1.0
2,4'-DDT	789-02-6	0.006	0.02	0.5 - 1.0	-	-	-	ND - 1.0
4,4'-DDD	72-54-8	0.003	0.02	0.5 - 1.0	1.9	230	45.0	0.1 - 5
4,4'-DDE	72-55-9	0.007	0.02	0.5 - 1.0	2.7	230	31.6	0.5 - 50
4,4'-DDT	50-29-3	0.006	0.02	0.5 - 1.0	1.3	230	31.6	0.1 - 5
Aldrin	309-00-2	0.008	0.02	0.5 - 2.0	0.027	14	0.654	ND - 1.0
alpha-BHC (alpha-HCH)	319-84-6	0.008	0.02	0.5 - 2.0	0.073	3700	1.69	ND - 0.5
beta-BHC (beta-HCH)	319-85-7	0.007	0.02	0.5 - 1.0	0.25	-	5.98	ND - 1.0
Chlordane, total (sum of 5 addends)	-	0.018 [t]	0.02 [t]	0.4 [t] - 1.0 [t]	1.3	230	8.0	ND [t] - 5.0 [t]
cis-Chlordane (alpha-Chlordane)	5103-71-9	0.008	0.02	0.5 - 1.0	c	c	c	ND - 1.0
cis-Nonachlor	5103-73-1	0.018	0.02	0.5 - 1.0	c	c	c	ND - 2.0
delta-BHC (delta-HCH)	319-86-8	0.003	0.05	0.5 - 1.0	-	-	-	ND - 1.0
Dieldrin	60-57-1	0.005	0.05	0.5 - 2.0	0.029	23	0.654	ND - 5.0
Endosulfan I	959-98-8	0.022	0.05	1.0 - 2.0	-	2700	540	ND - 1.0
Endosulfan II	33213-65-9	0.033	0.05	1.0 - 2.0	-	2700	540	ND - 1.0
Endosulfan Sulfate	1031-07-8	0.017	0.05	1.0 - 2.0	-	2700	540	ND - 1.0
Endrin	72-20-8	0.012	0.05	1.0 - 2.0	-	140	3216	ND - 1.0
Endrin Aldehyde	7421-93-4	0.033	0.05	1.0 - 2.0	-	140	3216	ND - 1.0
Endrin Ketone	53494-70-5	0.012	0.05	0.5 - 1.0	-	-	-	ND - 1.0
Heptachlor	76-44-8	0.007	0.02	0.5 - 2.0	0.11	46	2.35	ND - 1.0
Heptachlor Epoxide	1024-57-3	0.010	0.05	0.5 - 2.0	0.083	5.9	1.23	ND - 1.0
Hexachlorobenzene	118-74-1	0.004	0.01	0.5 - 1.0	0.45	370	6.69	ND - 2.0
Lindane (gamma-BHC, -HCH)	58-89-9	0.007	0.02	0.5 - 1.0	-	2100	8.19	ND - 2.0
Methoxychlor	72-43-5	0.002	0.10	0.5 - 1.0	-	-	-	ND - 2.0
Mirex	2385-85-5	0.007	0.02	0.5 - 2.0	-	-	-	ND - 2.0
Oxychlordane	27304-13-8	0.015	0.02	0.5 - 1.0	c	c	c	ND - 1.0
Toxaphene **	8001-35-2	A	0.10	2.0 - 10	0.42	160	9.56	ND - 5.0
trans-Chlordane (gamma-Chlordane)	5103-74-2	0.006	0.02	0.5 - 1.0	c	c	c	ND - 2.0
trans-Nonachlor	39765-80-5	0.008	0.02	0.5 - 1.0	c	c	c	ND - 2.0

(See notes on next page)

Notes for Table 10

Bolded analytes are those of particular interest because of past detections, 303d listings, or not previously analyzed.
A: MDL not applicable for this multi-component mixture since detectability is based on detection of single components in the mixture.
C: Addend for "Chlordane, total"
CAS: Chemical Abstract Service
FTEC: Fish Tissue Equivalent Concentration
MDL: Method Detection Limit
ND: Non detect
SDL: Sample Detection Limit
T: as sum of 5 addends
TECc: Tissue Equivalent Concentration for Carcinogenic Effects
TECn: Tissue Equivalent Concentration for Non-Carcinogenic Effects
** AXYS MLA-028 uses the term "Technical toxaphene"

Table 11. Required quantitation and detection limits for dioxins and furans in fish tissue to be analyzed using HR GC/MS for the FFCMP 2018 (pg/g wet weight).

Congener	CAS Number	Quantitation Limit	Detection Limit
2,3,7,8-TCDD	1746-01-6	0.03	0.015
1,2,3,7,8-PeCDD	40321-76-4	0.03	0.03
1,2,3,4,7,8-HxCDD	39227-28-6	0.1	0.07
1,2,3,6,7,8-HxCDD	57653-85-7	0.1	0.03
1,2,3,7,8,9-HxCDD	19408-74-3	0.1	0.04
1,2,3,4,6,7,8-HpCDD	35822-46-9	0.2	0.04
OCDD	3268-87-9	0.5	0.2
2,3,7,8-TCDF	51207-31-9	0.05	0.02
1,2,3,7,8-PeCDF	57117-41-6	0.1	0.06
2,3,4,7,8-PeCDF	57117-31-4	0.05	0.05
1,2,3,4,7,8-HxCDF	70648-26-9	0.1	0.06
1,2,3,6,7,8-HxCDF	57117-44-9	0.1	0.07
1,2,3,7,8,9-HxCDF	72918-21-9	0.1	0.07
2,3,4,6,7,8-HxCDF	60851-34-5	0.1	0.08
1,2,3,4,6,7,8-HpCDF	67562-39-4	0.2	0.1
1,2,3,4,7,8,9-HpCDF	55673-89-7	0.2	0.1
OCDF	39001-02-0	0.5	0.2

10.0 Quality Control Procedures

Table 12. Laboratory quality control sample types and frequencies, FFCMP 2018.

Parameter	Analytical Method	Lab Duplicates	Lab Control Standards	Surrogates	MS/MSD	Method Blanks
Mercury	EPA 245.6 (CVAA)	1/ batch [a]	1/batch	NA	1/batch	1/batch
Chlorinated pesticides	AXYS MLA-028 (HR GC/MS)	1/batch	each sample & 1/batch [c]	NA	NA	1/batch
PCB congeners [b]	EPA 1668C (HR GC/MS)	1/batch	each sample & 1/batch [c]	NA	NA	1/batch
PCDD/Fs [b]	EPA 1613B (HR GC/MS)	1/batch	each sample & 1/batch [c]	NA	NA	1/batch
PBDEs	EPA 8270 (SIM); MEL SOP 730104	1/batch	1/batch	each sample	1/batch	1/batch
Lipids	MEL SOP 730009	1/batch	1/batch	NA	NA	1/batch

[a] "Batch" is defined as up to 20 samples analyzed together.

[b] Includes one analysis of Certified Reference Material for the project (CARP-2).

[c] Labeled compounds in each sample and Ongoing Precision and Recovery standards in each batch.

15.0 References

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16.0 Appendices

Appendix A. TMDL Implementation Tracking

Table A-1. Implementation Tracking Table from the TMDL (modified).

Who	Action	Timeline and Reference* for Completed Actions												
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Future
ECY EAP	Sample Palouse River and South Fork Palouse river Fish to determine tissue concentrations												X	
ECY EAP	Assess levels of PCBs and dieldrin in influent and effluent of WWTPs.	L	L								C			
ECY WQP	Issue municipal stormwater permit to city of Pullman and WSU													
ECY WQP	Provide stormwater technical assistance													
ECY WQP	Monitor permit implementation by reviewing annual reports													
ECY WQP	Track progress of activities outlined in plan													
ECY WQP	Investigate further monitoring to locate sources of dieldrin and PCBs (if adaptive management is needed)													
ECY WQP	Incorporate WLAs in NPDES permits													
Pullman	Implement requirements of Phase II municipal stormwater permit													
Pullman	Require Erosion and Sediment Control plans for land altering activities and building permits													
Pullman	Continue to train engineering and building division personnel as Certified Erosion and Sediment Control Leads (CESCL)													
Pullman	Increase annual storm drain pipe maintenance													
Pullman	Revise City's Design Standards to reference the *Stormwater Management Manual for Eastern Washington*													
Pullman	Complete storm drain computer mapping project													

Who	Action	Timeline and Reference* for Completed Actions												
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Future
Pullman	Meet conditions of NPDES wastewater permit													
Pullman	Other - not specified in original Tracking Table									A				
Colfax	Meet conditions of NPDES wastewater permit													
Albion	Meet conditions of NPDES wastewater permit													
WSU	Implement requirements of Phase II municipal stormwater permit													
WSU	Proactively removing all PCB sources on campus to a level below Federal and Washington state regulations													
WSU	Illicit discharge detection program													
WSU	Computerized mapping system of existing stormwater lines, catch basin locations and drainage areas													
WSU	Overseeing construction project one acre or greater than require Construction Stormwater NPDES permits													
WSU	Video inspection and repair all storm sewer lines													
WSU	Street and parking lot maintenance													
WCRHD	Investigate an abandoned landfill and incinerator along the South Fork Palouse River to determine if they are sources	L	L											
CDs	Report number of acres converted to conservation tillage or BMP projects that significantly reduce erosion													
CDs	Seek additional funding opportunities to support this action													
CDs	Other - not specified in original Tracking Table				F	F	F,G		E	D	B,H			

* References are explained in Table A-2.

Table A-2. Details on Implementation Actions from Table A-1.

Ref.	Activity	Description	Sponsor - Partners	Timeframe	Status
A	City of Pullman purchasing Ordinance	Ordinance requiring the purchase of materials with lowed PCB concentrations	City of Pullman	2015	Adopted? When take effect?
B	Weber South Fork Palouse and Four Mile Creek Restoration	50 foot wide buffer along 6700 feet of South Fork Palouse River and Four Mile Creek. Bio-engineered bank stabilization structures along 300 ft of Four Mile Creek. At Shawnee Parvin Road.	Palouse Conservation District	2016	Permitting and SEPA Feb/2016
C	Albion WWTP monitoring	Evaluate PCBs and dieldrin in WWTP and compare to TMDL interim waste load allocation (WLA)	Ecology - EAP	2016	Study published (Coots, 2017)
D	Kammerzell Conservation Easement	113.6 acres of riverine wetland, sloped wetlands and upland habitat protected in a conservation easement. Includes 9430 linear feet along South Fork Palouse River. Plant community being enhanced with additional native riparian plants and livestock will be excluded.	Palouse Land Trust	2015	Easement signed summer 2015; restoration work to follow.
E	Browne Riparian Buffer	Install 50 foot buffer along approximately 3000 ft of South Fork Palouse River near state line	Palouse Conservation District	2014	6/2014 - 2495 trees & shrubs planted in mulch fabric for buffer and 1800 willows planted into stream banks
F	South Fork Palouse Implementation Grant	Riparian plantings - need numbers/locations	Palouse Conservation District	2010-2012	
G	Wetland/Riparian enhancement	Whitmore Wetland Enhancement and Livestock Exclusion: 1500 ft of exclusion fencing along Missouri Flat Creek, hardened crossing, wetland enhancement and placement of large woody debris to enhance fish habitat and floodplain connectivity. Approximately 5.5 acres in wetland/riparian restoration.	Palouse Conservation District	2012	As of 11/21/14 - N side of Missouri Flat Creek has 50' wide 204 ft long buffer, south side has 35' wide 318 long buffer.

Ref.	Activity	Description	Sponsor - Partners	Timeframe	Status
H	Paradise Creek Bank Stabilization & Buffer	Minor bioengineered bank stabilization and buffer plantings along Paradise Creek (7.75 acres/450 stream feet)	Palouse Conservation District	2016-2018	Permitting and SEPA May/2016
L	Monitor WWTPs and abandoned landfills	Evaluate PCBs and dieldrin in WWTPs (Colfax, Palouse, and Pullman) and compare to TMDL interim waste load allocations (WLA); evaluate PCBs and dieldrin at two abandoned landfills	Ecology - EAP	2007-2008	Study published (Lubliner, 2009)
X	Fish sampling	Sample fish in mainstem and South Fork to determine tissue concentrations of dieldrin, PCBs, and other contaminants	Ecology - EAP	2018	Sample collection planned for mid-May into June, 2018

EAP: Environmental Assessment Program

Appendix B. 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.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Effectiveness Monitoring: An effectiveness monitoring evaluation is an essential component of TMDLs and Water Cleanup Plans because it determines to what extent the actions to control pollution have attained the goals of watershed restoration. Formal effectiveness monitoring evaluation addresses four fundamental questions with respect to restoration or implementation activity: (1) Is the restoration or implementation work achieving the desired objectives or goals? (2) How can restoration or implementation techniques be improved? (3) Is the improvement sustainable? (4) How can the cost-effectiveness of the work be improved?

Fish Tissue Equivalent Concentration (FTEC): The FTECs is a tissue contaminant concentration previously used by Ecology to determine whether surface water human health criteria were being met. The FTEC was an interpretation of Washington's surface water quality criterion for a specific chemical for the protection of human health (National Toxics Rule: Federal Register Vol. 57 No. 246 pp. 60848, 1992; Federal Register Vol. 64 No. 216 pp. 61182 1999). Fish tissue sample concentrations that were lower than the FTEC suggested that criteria for a specific contaminant were being met. Where a FTEC was not met (i.e., concentration of a chemical in fish tissue is greater than the FTEC), that water body was then placed into Category 5 during Washington's periodic Water Quality Assessment (https://ecology.wa.gov/Water-Shorelines/Water-quality/Water-improvement/Assessment-of-state-waters-303d). Category 5 listings become part of Washington's 303(d) list during the assessment process. The FTEC was calculated by multiplying the contaminant-specific Bio-Concentration Factor (BCF) times the contaminant-specific Water Quality Criterion found in the National Toxics Rule.

Pollution: Contamination or other alteration of the physical, chemical, or biological properties of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

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.

TEC: Tissue Exposure Concentration. Concentration of a toxic chemical in edible fish and/or shellfish tissue which, when exceeded, indicates that adverse human health effects could potentially occur if such tissues were consumed regularly over of time. The TEC is a tissue concentration threshold used by Ecology to help determine whether the designated use of harvest of fish and shellfish is supported in a waterbody. When the concentration of a pollutant in fish and/or shellfish tissue is greater than the TEC, this indicates that the designated use of harvest could potentially be impaired, and thus the waterbody can be assessed as not meeting water quality standards for the State of Washington, and be placed on the Clean Water Act 303(d) list. The TECs of pollutants are rooted in the human health criteria equations and are expressed as stand-alone tissue concentrations that relate to exposure of a pollutant through the consumption of fish and/or shellfish. The TECs for carcinogenic (TECc) and non-carcinogenic (TECn) effects differ because the underlying assumptions associated with exposure, toxicity, and risk/hazard with the two types of health effects differ. For example, the TECc assumes a daily exposure over a 70 year period while the TECn can assume a daily exposure over a 7-70 year period, depending on the pollutant. Some carcinogens also have non-cancer health effects above certain concentrations so these chemicals will have both TECc and TECn values. Calculation of TECs:

- TECc = (Risk level) x (Body weight) ÷ (Cancer slope factor) x (Fish consumption rate).
- TECn = (Reference dose) x (Body weight) ÷ Fish consumption rate.

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.

Trend: A meaningful change or difference that can be measured and differentiated from measurement error. Often used in the context of time (temporal trend) or space (spatial trend).

Water Quality Assessment (WQA): Washington's Water Quality Assessment lists the water quality status for water bodies in the state. This assessment meets the federal requirements for an integrated report under Sections 303(d) and 305(b) of the Clean Water Act. The assessed waters are grouped into categories that describe the status of water quality. The 303(d) list comprises those waters that are in the polluted water category, for which beneficial uses– such as drinking, recreation, aquatic habitat, and industrial use – are impaired by pollution.

Water Quality Standards: Water quality standards consist of designated uses, numeric and narrative criteria, and anti-degradation components. These components work together to protect the health of surface waters in Washington.

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

CCP	Common carp (*Cyprinus carpio*)
CP	Chlorinated pesticide
DDE	Dichloro-diphenyl-dichloroethylene
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
FFCMP	Freshwater Fish Contaminant Monitoring Program
FTEC	Fish tissue equivalent concentration
Health	Washington State Department of Health
LSS	Largescale sucker (*Catostomus macrocheilus*)
MEL	Manchester Environmental Laboratory
MS/MSD	Matrix Spike / Matrix Spike Duplicate
NPM	Northern pikeminnow (*Ptychocheilus oregonensis*)
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PCDD/F	Polychlorinated dibenzo-p-dioxin and -furan
RCW	Revised Code of Washington
SMB	Smallmouth bass (*Micropterus salmoides*)
t-PCB	Total PCBs
t-PBDE	Total PBDEs
SOP	Standard Operating Procedure
TCDD	2,3,7,8-tetra-chlorinated dibenzo-p-dioxin
TECc	Tissue Exposure Concentration for carcinogenic effects
TECn	Tissue Exposure Concentration for non-carcinogenic effects
TEQ	Toxicity equivalent
TMDL	Total Maximum Daily Load
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WQA	Water Quality Assessment

Units of Measurement

g	gram, a unit of mass
kg	kilograms, a unit of mass equal to 1,000 grams
mg	milligram
ng/kg	nanograms per kilogram (parts per trillion)
ug/kg	micrograms per kilogram (parts per billion)
pg/g	pictograms per gram (parts per trillion)