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Quality Assurance Project Plan

Spokane and Troutlodge Fish Hatchery PCB Evaluation

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Quality Assurance Project Plan

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March 2016

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EAP: Environmental Assessment Program
WQP: Water Quality Program

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2.0 Abstract

The Spokane River Toxics Task Force has been identifying sources of polychlorinated biphenyls (PCBs) to the Spokane River with the goal of reducing PCB inputs to the Spokane River. Previous studies have identified PCB contamination in fish raised in hatcheries. Several studies have correlated PCB concentrations in fish tissue to concentrations in hatchery feed.

This proposed study will investigate PCB concentrations in hatchery fish from Troutlodge, a facility in Soap Lake, WA, and the Washington Department of Fish and Wildlife's (WDFW) Spokane Fish Hatchery, located on the Little Spokane River. In addition, effluent from the Spokane Fish Hatchery will be evaluated for PCBs. PCB concentrations will also be measured in settleable solids and fish food from the Spokane Fish Hatchery. A PCB annual load contribution estimate from hatchery fish from both hatcheries and effluent from the Spokane hatchery to the Spokane River will be calculated.

In order to determine concentrations of PCBs in hatchery fish being removed from the river, two composites of fish collected from the Spokane River will be analyzed for PCBs. An attempt will be made to collect fish during the fall from the same age class as those collected in the spring from the hatcheries.

3.0 Background

The Spokane River Regional Toxics Task Force (SRRTTF) has been investigating sources of polychlorinated biphenyls (PCBs) to the Spokane River with the goal of reducing PCB inputs to the river. One of many potential sources of PCBs suggested by the Task Force may be hatchery trout that are planted to the river. A 2006 study conducted by Washington Department of Ecology (Ecology) (Serdar et al., 2006) identified a concentration of 6.5 ug/kg in hatchery trout from the Spokane Fish Hatchery and 14.4 ug/kg in fish fillets from the Troutlodge facility. Another potential contributor of PCBs may be the effluent discharged from the Spokane Fish Hatchery to the Little Spokane River, a tributary to the Spokane River.

Approximately 170,000 rainbow trout are planted annually to the Spokane River. The fish planted to the impounded section of the Spokane River, known as Lake Spokane, are raised in two different hatcheries. Troutlodge in Soap Lake, WA is a Washington State fish health certified supplier that provides approximately 105,000 of the trout planted to the Spokane River, while the Washington Department of Fish and Wildlife's Spokane Fish Hatchery rears the remaining 50,000 from fertilized eggs supplied by Troutlodge. Avista, an investor-owned utility that operates hydroelectric projects on the Spokane River, plants about 15,000 of the 170,000 trout planted annually to the river. Approximately 9,000 trout are planted by Avista at Plese Flats, while around 6,000 are planted at Upper Falls. The fish planted by Avista are reared at the Troutlodge facility.

Hatchery trout are planted to the Spokane River as catchables, which are generally 5 fish to a pound at the time they are moved to the lake. These fish are triploid−they have an extra set of chromosomes. Triploid trout cannot reproduce because they cannot produce viable gametes. This reduces the possibility that these hatchery fish will interbreed with native populations.

This Quality Assurance Project Plan (QAPP) will describe the procedures and methodology that will be used to evaluate the PCB contributions to the Spokane River from hatchery fish and effluent from the Spokane Hatchery.

3.1 Study area and surroundings

The study area consists of a Washington Department of Fish and Wildlife (WDFW) trout hatchery located in Spokane County. Some water and sediment samples will be collected from a slough that carries hatchery effluent from the hatchery to the Little Spokane River. Fish will also be collected from the Troutlodge hatchery located in Soap Lake.

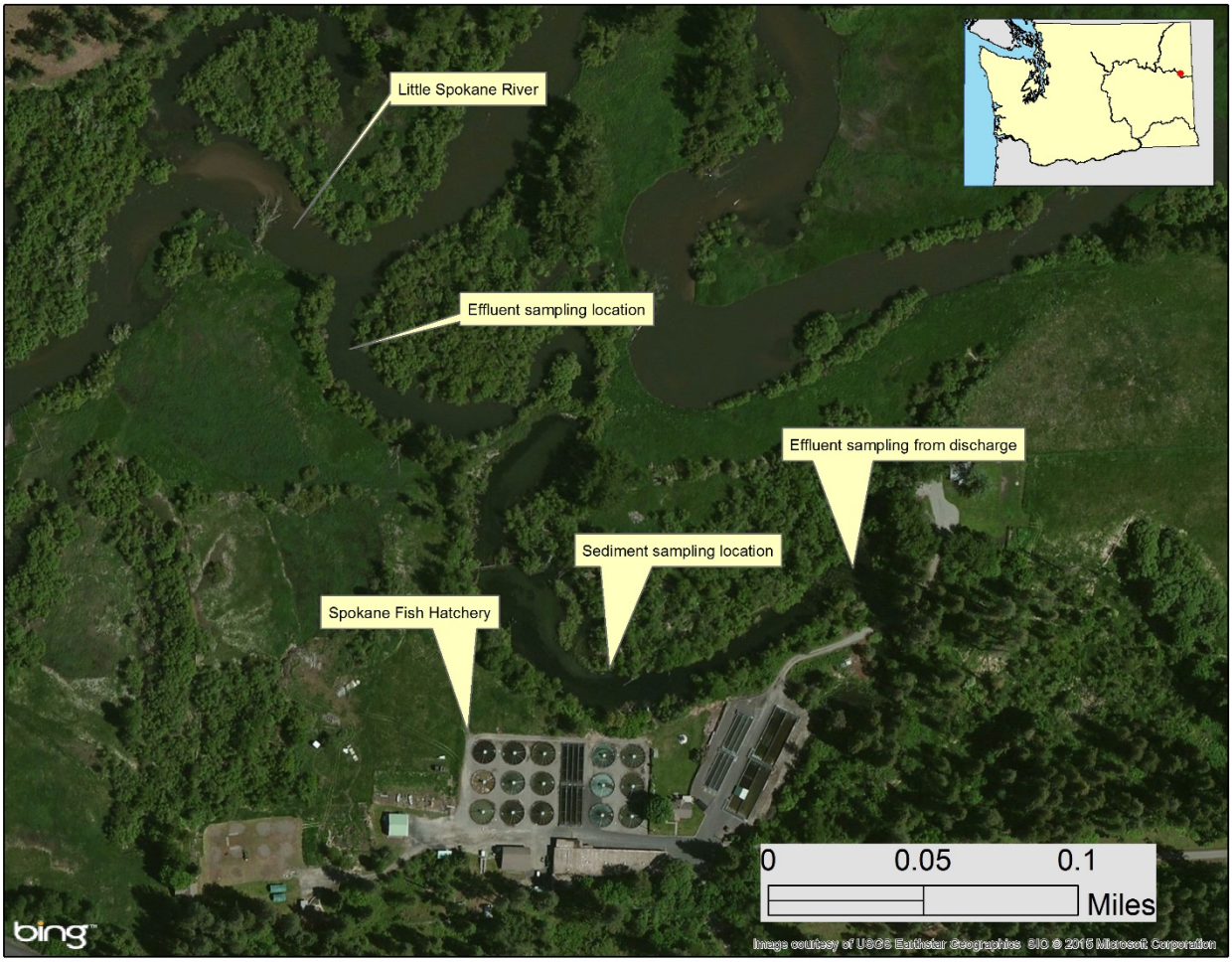

Figure 1. Study area for the Spokane Fish Hatchery PCB evaluation.

3.1.1 Logistical problems

- Access to the hatchery facility for sampling and fish collection will need to be coordinated with WDFW personnel.
- Fish collection at Troutlodge Fish Hatchery will need to be coordinated with hatchery personnel.
- Water sampling will need to be conducted during a period of discharge.
- Fish collected from the Spokane River should be from the same age class as the rainbow trout collected from the hatcheries.

3.1.2 History of study area

High Levels of PCBs have been detected in Spokane River fish tissue and water (Seiders et al., 2014). Concerns have been raised that hatchery fish and effluent may be one of many sources contributing PCBs to the Spokane River.

The Spokane Fish Hatchery was constructed in 1934. It is one of the largest rainbow trout brood-stock facilities in Washington State. Trout from this hatchery are planted to the Spokane River in an impounded section of the river called Lake Spokane, previously known as Long Lake. The hatchery discharges effluent to the Little Spokane River under the Upland Fin-Fish Hatching and Rearing National Pollutant Discharge Elimination System (NPDES) General Permit. The 2010 permit has been administratively extended. The 2015 draft NPDES is currently in the review process.

The Spokane hatchery raises rainbow, cutthroat, German brown, and Eastern brook trout. Kokanee salmon are also raised at the facility. These fish are planted to lakes all over eastern Washington. The Spokane hatchery also supplies more than 7 million eggs to other Washington hatcheries.

3.1.3 Parameters of interest

PCBs are the parameters of interest for this study. Samples will be analyzed for all 209 PCB congeners.

3.1.4 Results of previous studies

Numerous studies have investigated PCB concentrations in fish tissue from trout hatcheries (Horowitz et al., 2007; Carline et al., 2001). The one most relevant to this study is a 2006 Ecology study that sampled rainbow trout from 10 Washington State hatcheries and analyzed the tissue for a suite of organic contaminants (Serdar et al., 2006). The 2006 Ecology study measured a PCB concentration of 6.5 ug/kg in a composite of hatchery rainbow trout fillets from the Spokane Fish Hatchery and 14.4 ug/kg in fillets from the Troutlodge hatchery. Fish feed from the Spokane hatchery was analyzed during the same study and yielded a result of 16.4 ug/kg.

3.1.5 Regulatory criteria or standards

The regulatory criterion for PCBs in edible fish tissue is 5.3 ug/kg. Limited comparisons will be made to this criterion, since it is based on fillet samples to gauge negative impacts to human health. Fish for this study will be analyzed as whole fish. Fish collected from the Spokane River at Lake Spokane will also be analyzed as whole fish.

Whole fish are being used, since they better reflect body burdens and overall inputs to the river. PCB concentrations are usually higher in whole fish than in fillets (Amrhein et al., 1999).

The regulatory criterion for PCBs in water is 170 pg/L. Washington State regulatory criteria for PCBs in sediment (WAC 173-204) describes a sediment cleanup objective of 110 ug/kg.

4.0 Project Description

4.1 Project goals

The goal of this project is to estimate the PCB load contributed to the Spokane River by fish planted from both the Troutlodge and Spokane hatcheries and by effluent from the Spokane Fish Hatchery.

4.2 Project objectives

This project has the following objectives:

- Analyze PCBs in whole fish from the Spokane Fish Hatchery and the Troutlodge Fish Hatchery.
- Analyze PCBs in effluent collected from the discharge from the Spokane Fish Hatchery and the end of the slough that drains effluent to the Little Spokane River.
  - Two separate loads will be calculated, a "worst case scenario", the load coming directly from Spokane hatchery discharge pipes, and the load emptying from the drainage slough to the Little Spokane River.
  - The drainage slough load estimate will be added to the estimated load from hatchery fish to estimate the total PCB load contributed to the Spokane River from local hatchery operations.
- Analyze PCBs in fish food and TOC and TSS in water to evaluate potential differences in PCB concentrations in hatchery effluent.
- Analyze PCBs in sediment collected from the slough that drains effluent from the Spokane Fish Hatchery to the Little Spokane River.
- Calculate an estimate of the annual PCB load contributed to the Spokane River in hatchery effluent and fish.
- Collect and analyze PCB concentrations in hatchery rainbow trout collected from the Spokane River at Lake Spokane.

4.3 Information needed and sources

Not applicable.

4.4 Target population

- Water, solids and fish leaving the Spokane Fish Hatchery.
- Fish feed used by Spokane Fish Hatchery.

- Hatchery fish from Troutlodge that will be planted to the Spokane River.
- Hatchery fish collected from the Spokane River (at Lake Spokane).

4.5 Study boundaries

Study boundaries encompass the Spokane Fish Hatchery and the slough that drains hatchery effluent to the Little Spokane River.

Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) numbers for the study area

- WRIA - 55-Little Spokane
- HUC number - 17010308

4.6 Tasks required

Fieldwork

The following tasks will be conducted in the field:

- Collect rainbow trout samples from the Spokane and Troutlodge hatcheries.
- Collect hatchery trout from the Spokane River from the same age class as fish collected from the hatcheries.
- Coordinate with hatchery personnel to collect fish food PCB samples representing the month preceding water sample collection.
- Collect seasonal (3) whole water samples of Spokane hatchery effluent to be analyzed for PCBs, TSS and TOC. Every PCB water sample will have a duplicate sample collected as the entire sample volume will be consumed for analysis. This will allow for re-analysis if required.
  - The spring and summer samples will be collected to represent discharge during raceway cleaning operations, fall samples will be collected to represent typical discharge (not collected during raceway cleaning).
- Acquire effluent discharge volume estimates from Spokane hatchery personnel.
- Measure flow from the end of the slough that drains effluent to the Little Spokane River.
- Collect sediment samples from the drainage slough in fall, 2016. Let sediment settle overnight and carefully decant overlying water to increase % solids and reduce detection limits.

Laboratory and Office

The following additional tasks will be conducted:

- Process (composite and homogenize) fish samples to send to the contract laboratory for PCB analysis.
- Process (composite and homogenize) fish food samples. Prior to homogenization fish food will need to be ground to a fine powder using a mortar and pestle, grinder, or other processing equipment.
- Evaluate data for quality.
- Analyze data and prepare report.
- Distribute draft report to WDFW and SRRTTF for review and comment.
- Enter data into Environmental Information Management system (EIM).
- Verify accuracy of EIM data.

4.7 Practical constraints

Not applicable.

4.8 Systematic planning process

This QAPP will be sufficient to address the planning process.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Adriane Borgias Water Quality Program Eastern Regional Office Phone: 509-329-3515	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Michael Friese Toxics Studies Unit SCS Phone: 360-407-6737	Project Planner	Designs study and authors the QAPP.
To Be Determined	Project Manager and Principal Investigator	Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Siana Wong SCS Phone: 360-407-6432	Field Assistant	Helps collect samples and records field information.
Brandee Era-Miller Toxics Studies Unit SCS Phone: 360-407-6765	Acting Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Jessica Archer SCS Phone: 360-407-6698	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Tom Mackie Eastern Operations Phone: 509-454-4244	Section Manager for the Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Joel Bird Manchester Environmental Laboratory Phone: 360-871-8801	Director	Reviews and approves the final QAPP.
Karin Feddersen	Quality Assurance Coordinator	Reviews draft QAPP, coordinates with Contract Lab.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section

5.2 Special training and certifications

Standard Operating Procedures to be followed during this project

- EAP007 - Resecting Finfish Whole Body, Body Parts or Tissue Samples
- EAP009 - Collection, Processing, and Preservation of Finfish Samples
- EAP024 - Estimating Streamflow
- EAP040 - Freshwater Sediment Sampling
- EAP070 - Procedures to Minimize the Spread of Invasive Species
- EAP090 - Decontamination of Sampling Equipment for Use in Collecting Toxic Chemical Samples

5.3 Organization chart

See section 5.1 and Table 1.

5.4 Project schedule

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

Field and laboratory work	Due date	Lead staff
Field work completed	November 2016	Michael Friese
Laboratory analyses completed	January 2017	
Environmental Information System (EIM) database		
EIM Study ID	mifr003	
Product	Due date	Lead staff
EIM data loaded	March 2017	Siana Wong
EIM data entry review	April 2017	To Be Determined
EIM complete	May 2017	Siana Wong
Final report		Lead staff
Author lead / Support staff		To Be Determined
Schedule		
Draft due to supervisor	February 2017	
Draft due to client/peer reviewer	March 2017	
Draft due to external reviewer(s)	April 2017	
Final (all reviews done) due to publications coordinator	May 2017	
Final report due on web	June 2017	

5.5 Limitations on schedule

Timing of sampling will need to be carefully coordinated to be sure fish are collected before planting:

- WDFW fish (3 composites from Troutlodge, 3 from Spokane Fish Hatchery) collected before spring planting end of May 2016. One sample will be split and analyzed as a duplicate from each hatchery.
- Avista fish from Troutlodge (2 composites) collected before July 4 planting and 2 composites collected before fall planting.
- Fish feed samples composited to represent the month preceding effluent sampling.
- Effluent samples collected seasonally (spring, summer, and fall).
- Sediment sample collected during fall sampling, 2016.
- All sampling will be coordinated with hatchery personnel.
- Fish collected from Spokane River (2 composites) collected during fall to represent age class planted during spring of 2016.

5.6 Budget and funding

Table 3. Project budget and funding.

Fish	Samples	QA	Cost	Subtotal	MEL	Contract
Percent lipids	12	2†	45	630		630
PCB Congeners	12	2†	800	11200		11200
Fish Feed						
Percent lipids	3	1†	45	180		180
PCB Congeners	3	1†	800	3200		3200
Water	Samples	QA	Cost	Subtotal		
TOC	6	2‡	45	360	360	
TSS	6	2‡	12	96	96	
PCB Congeners	6Θ	3×Θ	800	7200		7200
			Water Total	6866		
Sediment						
PCB Congeners	1	1†	800	1600		1600
				MEL Subtotal	456	
				Contract Subtotal		24010
				Grand Total		24466

† Duplicate. ‡ 1 Duplicate, 1 Blank × 2 Duplicates, 1 Blank

Θ All PCB water samples including QA will be collected as duplicates, for re-analysis if necessary.

6.0 Quality Objectives

6.1 Decision quality objectives

Decision Quality Objectives (DQOs) are not applicable.

6.2 Measurement quality objectives

Table 4. Measurement quality objectives (MQOs).

Analyte	Lab Control Standards (%Recovery)[1]	Laboratory Duplicates (RPD)[2]	Internal Standard Recoveries[4] (%Recovery)	Lowest Concentration of Interest
Fish Tissue				
PCB congeners	50-150%	≤50%	25-150%	NA 0.005 ug/Kg, ww
Lipids	NA	≤20%	NA	0.1%
Fish Food				
PCB congeners	50-150%	≤50%	25-150%	NA 0.005 ug/Kg, dw
Water				
PCB Congeners	50-150%	≤50%	25-150%	1 pg/L
TSS	80-120%	≤20%	NA	1 mg/L
TOC	80-120%	≤20%	NA	0.10%
Sediment				
PCB Congeners	50-150%	≤50%	25-150%[5]	1 ug/Kg, dw

1 The isotopic dilution method used allows for correction for recovery of $^{13}C_{12}$ labeled congeners.
2 Relative percent difference.
3 Not applicable.
4 Labeled compounds.
TSS: Total suspended solids
TOC: Total organic carbon
Ww: wet weight
Dw: dry weight

6.2.1 Targets for precision, bias, and sensitivity

6.2.1.1 Precision

Precision is a measure of the variability in results of replicate measurements due to random error. Laboratory precision is usually estimated by the analysis of laboratory duplicates (splits) and control samples. Results provide an estimate of analytical precision and matrix homogeneity. Precision of the entire sampling and analysis process can be assessed by analysis

of field replicates, which are defined as two samples collected independently at the same time and place. Targets for precision, bias, and sensitivity are shown in Table 4.

Overall precision for water samples will be assessed by collection and analysis of field replicates.

Precision of fish samples will be evaluated by comparing lab duplicates.

Sediment sample precision will be evaluated using a field duplicate.

Replicates and duplicates are different by their collection methods. Replicates are collected with one sample following another as close to the same time and place as possible. Fish laboratory duplicates (splits) will be created from a single composite of whole fish, homogenized and apportioned between two sample jars at the same time. Following selection of fish to composite and homogenization of sample tissue to a uniform color and consistency the homogenate can be divided into two sample jars for independent analysis.

6.2.1.2 Bias

Bias is the systematic error due to contamination, sample preparation, calibration, or the analytical process. Most sources of bias are minimized by adherence to established protocols for the collection, preservation, transportation, storage, and analysis of samples. The isotopic dilution method used to analyze for PCBs (EPA 1668C) requires spiking of labeled congeners into each sample. The method allows for correction of the concentration of target compounds corresponding to the recovery of labeled congeners.

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a method to detect a substance. Expectations of sensitivity for this project will be based on the quantitation limit (QL). Often the method detection limit (MDL) is used to describe sensitivity.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

Comparability of study results will be ensured by using standard operating procedures and adhering to established data quality criteria consistent with other studies analyzing PCBs. Detection limits will be equal to or better than previous investigations of PCBs.

6.2.2.2 Representativeness

The sampling design was planned to obtain PCB data representative of fish planted from Troutlodge and Spokane Hatcheries as well as effluent from the Spokane hatchery. Representativeness will be ensured by using appropriate sampling, sample size, and sample handling procedures.

Fish samples will be composites of 5 individual whole fish. The sediment sample will be a multiple grab collected and composited from at least 3 representative locations. Composites will be collected for sediment and fish to reduce the variability and better reflect average PCB concentrations.

Water samples will be collected by compositing 4 separate 0.6 liter samples collected throughout the day. This will account for temporal variation in PCB concentrations in hatchery effluent. Seasonal variability will be accounted for by collecting 3 seasonal water samples. The busiest times of the year at the Spokane hatchery are April- May when the spring catchable plants are ready to be planted, and October, when it is time to plant fall fry. The effluent collection will be coordinated so 2 of the samples are collected during the busiest times of the year while raceways are being cleaned to potentially represent the highest PCB concentrations. Another effluent sample will be collected during base flow to represent lower PCB concentrations.

During each sampling event 2 sets of water samples (in duplicate) will be collected. Duplicate water samples will be collected for every sample, including QA samples in case re-analysis is necessary. The first set of water samples will be collected directly from or from very close to a discharge pipe. This sample will characterize the total PCB in hatchery effluent. The second sample will be collected from where the drainage slough empties into the Little Spokane River. This sample will characterize the PCB load that makes it to the Little Spokane River. It is expected that a significant percentage of the PCB load will settle out in the slough while attached to suspended solids. The concentration of the samples collected from the end of the slough closest to the Little Spokane River will be used to calculate the estimated PCB load contributed to the Spokane River. Ecology personnel will measure discharge from the drainage slough in order to be able to calculate the PCB load.

6.2.2.3 Completeness

Completeness can be defined as the need to collect enough valid data to allow decisions to be made for which the study was designed. The goal of completeness is to collect and analyze 100% of the samples described in the quality assurance plan.

7.0 Sampling Process Design (Experimental Design)

7.1 Study design

This study is designed to evaluate PCB loads contributed to the Spokane River from hatchery fish planted from Troutlodge and Spokane fish hatcheries and from effluent discharged from the Spokane Fish Hatchery.

7.1.1 Field measurements

Effluent discharge volume data will be provided by WDFW personnel. Flow through the effluent drainage slough will be measured by Ecology personnel following procedures described in the SOP- Estimating Streamflow. No other field measurements will be necessary to complete this project.

7.1.2 Sampling location and frequency

Fish

Fish samples will be collected from both hatcheries by Ecology personnel during the spring and fall of 2016. It is important to evaluate PCB loads in fish from both hatcheries to judge variability in fish planted to the river from different hatcheries. Concentrations of PCBs in fish feed fluctuate dramatically depending on PCB concentrations in the fish meal used to formulate the feed (Maule et al., 2006). The varying PCB concentrations in feed are likely to result in variable PCB concentrations in hatchery fish from the two hatcheries as it is presumed both hatcheries are acquiring food from different sources.

Fish sampling will involve collecting fish from Troutlodge and the Spokane Fish Hatchery. Fish are planted to the Spokane River during different times of the year. To characterize PCB contamination in all of the different groups of fish planted, samples will be collected from each batch just prior to planting. Towards the end of May 2016, 15 rainbow trout will be collected from Troutlodge and the Spokane Fish Hatchery to represent the fish that will be planted to Lake Spokane. These fish will be processed as whole fish into composites of 5 fish each, resulting in two samples from each hatchery. One sample from each hatchery will be split and analyzed as a replicate for quality assurance. Just before July 4, fish are planted to Upper Falls and Plese Flats from the Troutlodge hatchery. Two composites will be analyzed from this group of fish. The last group of fish are planted annually during the fall to Upper Falls. Two more composites will be analyzed from this group of fish.

The small sample size from the hatcheries should be sufficient to meet the data needs of this project. A large sample size is not necessary for statistical analysis, and the fish from each sampling event will all have been raised in the exact same environment and fed the exact same food. The sample size is sufficient to represent the population.

Fish will also be collected from the Spokane River during the fall of 2016. Only adipose marked rainbow trout will be collected, indicating the fish are of hatchery origin. Every effort will be made to attempt to collect hatchery rainbow trout from the same age class as the fish planted in spring of 2016. Extra trout (20-30 total) will be collected from Lake Spokane to ensure fish from the right age class are analyzed. The Principal Investigator will consult with WDFW biologists before fish collection to establish which size range of fish should be targeted. Otoliths and scales will be aged by WDFW scientists to verify age class before compositing and analysis. These fish will characterize the concentrations of PCBs in rainbow trout being removed from the Spokane River by anglers, natural predators, or any other means.

The small sample size of fish samples collected from Lake Spokane will give a general idea of PCB concentrations in the fish after they have been in the wild for about 4 months. Sample size of Lake Spokane rainbow trout will be sufficient to meet the data needs of this project.

Water

The effluent from the Spokane hatchery will be sampled seasonally to evaluate another potential PCB source to the Spokane River. These samples will be time weighted, composited from 4 simple grabs that will be collected throughout the course of raceway cleaning operations. Effluent will be collected for 2 samples during the busiest times of the year. The first water sample will be collected from hatchery discharge during April or May−just before catchable (3 per pound or larger) trout are planted. Another sample will be collected during October−just before fall fry are planted to other Washington lakes. The other water sample will be collected during normal hatchery operations from typical daily discharge (not during raceway cleaning). Additional samples will be collected during each sampling event to be analyzed for Total Organic Carbon (TOC) and Total Suspended Solids (TSS). Differences in these ancillary parameters may help to explain variability in PCB concentrations in hatchery effluent.

Fish Feed

Samples of fish food will be composited weekly during each month preceding effluent sampling. Knowing the PCB concentration in feed may help to explain differences in effluent concentration.

Sediment

A sediment sample will be collected from the slough that drains water discharged from the hatchery to the Little Spokane River, a tributary to the Spokane River. The sediment sample will be a composite representative of the slough, collected with a ponar grab, sediment dredge, or stainless scoops. The sediment sample will be collected once during the fall sampling operations. The composited sample will be split to be analyzed as a field duplicate. The sediment sample will be evaluated to determine if PCB concentrations in the slough are detrimental to aquatic life.

7.1.3 Parameters to be determined

- PCBs
- TOC
- TSS

7.2 Maps or diagram

See Figure 1.

7.3 Assumptions underlying design

Not applicable.

7.4 Relation to objectives and site characteristics

Not applicable.

7.5 Characteristics of existing data

Composites of hatchery fish fillets were collected and analyzed for PCBs in a previous Ecology study (Serdar et al., 2006). The data from this project is not directly comparable to the current study as the previous study analyzed composites of fillets, and the current study will analyze composites of whole fish.

The same Ecology study collected samples of fish food from several state hatcheries. Fish food was collected from the Spokane hatchery but not from the Troutlodge hatchery. Results of relevant food and tissue analysis are shown in Table 5.

Table 5. Existing data on PCB concentrations in hatchery fish food and fish tissue.

Sample Location	Matrix	Result (ug/Kg)	Qualifier	Method
Troutlodge	Tissue	14.4	J	EPA 1668C
Spokane Fish Hatchery	Tissue	6.5	J	EPA 1668C
Spokane Fish Hatchery	Fish Feed	16.4	J	EPA 1668C

8.0 Sampling Procedures

8.1 Field measurement and field sampling SOPs

Field SOPs are listed in section 5.2.

8.2 Containers, preservation methods, holding times

Table 6. Containers, preservation, and holding time.

Parameter	Sample Size	Container[1]	Preservation	Holding Time
Fish				
PCB Congeners	30g minimum, 60g preferred	Certified 4 oz Glass w/Teflon Lid Liner	freeze, -10 °C	1 year to extraction, then 1 year to analysis
Lipids	30g minimum, 60g preferred	Certified 4-oz Glass w/Teflon Lid liner	freeze, -10 °C	1 year to extraction, then 40 days to analysis
Fish Food				
PCB Congeners	30g minimum, 60g preferred	Certified 4 oz Glass w/Teflon Lid Liner	freeze, -10 °C	1 year to extraction, then 1 year to analysis
Sediment				
PCB Congeners	Minimum 50g do not overfill jars	8-oz Glass	Cool to 4 °C or Freeze -10 °C	1 year to extraction, 1 year to analysis
Water				
PCB Congeners	1 Gallon	Certified ~2.5 L Glass	Cool to 4 °C	1 year to extraction, then 40 days to analysis
TOC	2-60 mL	60 mL Poly	1:1 HCl to pH<2; cool to ≤6 °C	28 Days
TSS	1 L	1 L Poly	Cool to ≤6 °C	7 Days

[1] Certified sample containers provided by Manchester Environmental Laboratory (MEL) or their contract laboratory.
TOC: Total organic carbon.

8.3 Invasive species evaluation

Ecology personnel working on this project are required to be familiar with and follow the procedures described in SOP EAP070 – Minimizing the Spread of Invasive Species.

The sample area is an Area of Moderate Concern. This is a part of Washington State documented as not having established New Zealand Mud Snails or other species of extreme concern. These areas may have other invasive species, including plants, animals, fish, invertebrates, and fish pathogens.

Procedures will be followed to reduce the possibility of moving any potentially harmful organism out of or into the watershed.

8.4 Equipment decontamination

Sediment samples will be collected with a pre-cleaned petite ponar, dredge, or stainless spoons and scoops. Sediments will be composited in pre-cleaned stainless bowls.

Fish processing equipment will be decontaminated between samples.

Equipment used to grind and homogenize fish food samples will be cleaned between samples.

Cleaning will be completed following the guidance contained in SOP EAP090 *Decontamination of Sampling Equipment for Use in Collecting Toxic Chemical Samples*.

8.5 Sample ID

Study samples will be assigned unique individual IDs prior to sample collection.

8.6 Chain-of-custody, if required

Chain of custody will be maintained for all samples throughout the project.

8.7 Field log requirements

Field data will be recorded in a bound, waterproof notebook on Rite in the Rain paper. Corrections will be made with single line strikethroughs, initials, and date.

The following information will be recorded in the project field log:

- Name and location of project
- Field personnel names
- Sequence of events

- Any changes or deviations from the QAPP or SOPs
- Environmental conditions
- Date, time, site location, ID, and description of each sample
- Identity of QC samples collected
- Unusual circumstances that might affect interpretation of results

8.8 Other activities

Not Applicable. Necessary activities are detailed in other sections of this QAPP.

9.0 Measurement Methods

9.1 Field procedures table/field analysis table

Field procedures are described in SOPs (see section 5.2).

9.2 Lab procedures table

Table 7. Analytical method, estimated quantification limits, and sample details.

Matrix	Analysis	Method	EQL	Expected Range of Results	Estimated Timeframe	# of Samples	QC samples	Total Samples
Whole Fish	PCB	EPA1668C	0.003-0.01 ug/Kg ww	0.005-300 ug/Kg	End of October, 2016	12	2	14
Whole Fish	% Lipids	EPA1668C	N/A	0.1-15%	End of October, 2016	12	2	14
Fish Food	PCB	EPA1668C	0.003-0.01 ug/Kg dw	0.005-100	End of October, 2016	3	1	4
Water	PCB	EPA1668C	1.0 pg/L	1-1,000 pg/L	Spring, Summer, Fall, 2016	6	3	9
Water	TOC	SM 5310B	1 mg/L	1-10 mg/L	Spring, Summer, Fall, 2016	6	1	5
Water	TSS	SM 2540D	1 mg/L	1-100 mg/L	Spring, Summer, Fall, 2016	6	1	5
Sediment	PCB	EPA1668C	1 ug/Kg dw	1-500 ug/Kg	Summer or Fall, 2016	1	1	2

9.2.1 Analyte

- PCB congeners
- Total Organic Carbon (TOC)
- Total Suspended Solids (TSS)

9.2.2 Matrix

- Fish
- Fish feed
- Water
- Sediment

9.2.3 Number of samples

See Table 7.

9.2.4 Expected range of results

See Table 7.

9.2.5 Analytical method

See Table 7.

9.2.6 Sensitivity/Method Detection Limit (MDL)

Estimated Quantification Limits are in Table 7.

9.3 Sample preparation method(s)

Cleanup and extraction methods are documented in EPA Method 1668C.

9.4 Special method requirements

Not applicable.

9.5 Lab(s) accredited for method(s)

An accredited laboratory will be contracted to perform PCB congeners by HRMS. MEL is accredited to perform TOC and TSS.

10.0 Quality Control Procedures

10.1 Table of field and laboratory QC required

Included in Table 8 below is information on quality control (QC) samples to be analyzed. These may include laboratory blanks, duplicates, laboratory control samples, or labeled compounds. Evaluation criteria as MQOs are included for QC samples as the expectations for fully useable data.

Table 8. Laboratory quality control samples for fish, sediment, and water.

Parameter	Method Blank	Transfer Blank	Check Standard	Duplicates	Labeled Compounds	OPR[1] Standards
Fish Tissue						
PCB Congeners	1/batch	--	1/batch	1/12 samples	all samples	each batch
Lipids	1/batch	--	1/batch	1/12 samples	--	--
Fish Food						
PCB Congeners	1/batch	--	1/batch	1/3 samples	all samples	each batch
Sediment						
PCB Congeners	1/batch	--	1/batch	1/2 samples	all samples	each batch
Water						
PCB Congeners	1/batch	1	1/batch	1/6 samples	all samples	each batch
TOC	1/batch	1	1/batch	1/6 samples	--	--
TSS	1/batch	1	1/batch	1/6 samples	--	--

[1] Laboratory Control Standard

10.2 Corrective action processes

When a significant number of analytical results fall outside established MQOs, the laboratory analyst will contact the project manager for guidance on how to proceed. This may entail re-running samples, application of a clean-up method, or following recommendations listed under the analytical method for corrective action. Any departure from the normal analytical method will be documented by the laboratory analyst. Method departures will be described in detail in the data package from the laboratory and the study report.

11.0 Data Management Procedures

11.1 Data recording/reporting requirements

All field data and observations will be recorded in notebooks on waterproof paper. The information contained in field notebooks will be transferred to Excel spreadsheets after return from the field. Data entries will be independently verified for accuracy by another member of the project team.

Case narratives included in the data package from MEL will discuss any problems encountered with the analyses, corrective action taken, changes to the requested analytical method, and a glossary for data qualifiers. Laboratory QC results will also be included in the data package. This will include results for surrogate recoveries, laboratory duplicates, matrix spikes, and laboratory blanks. The information will be used to evaluate data quality, determine if the MQOs were met, and act as acceptance criteria for project data.

Field and laboratory data for the project will be entered into Ecology's EIM system. Laboratory data will be downloaded directly into EIM from MEL's data management system. Data from contract laboratories will be submitted in electronic format for inclusion into EIM.

11.2 Laboratory data package requirements

The laboratories will provide a standard deliverable package after completing their work. The laboratories will provide all relevant quality control data. The data package will be delivered electronically via email.

11.3 Electronic transfer requirements

See section 11.2.

11.4 Acceptance criteria for existing data

Not applicable.

11.5 EIM/STORET data upload procedures

All result transmittals from laboratories must be provided in an electronic data deliverable (EDD) format that meets Ecology requirements for loading to EIM.

12.0 Audits and Reports

MEL participates in performance and system audits of their routine procedures. Results of these audits are available upon request.

A draft report of the study findings will be completed by the principal investigator in October 2016 and a final report in January 2017. The report will include, at a minimum, the following:

- Map showing all sampling locations.
- Coordinates of each sampling site.
- Description of field and laboratory methods.
- Documentation of any deviations from this QAPP.
- Discussion of data quality and the significance of any problems encountered.
- Summary tables of the chemical and physical data.
- An estimate of annual PCB contribution to the Spokane River.
- Results compared from PCBs in sediment to available freshwater sediment criteria.
- Recommendations for follow-up actions, based on study results.
- Complete set of chemical and physical data in the Appendix.
- Results of analysis of PCB concentration in rainbow trout sampled from the Spokane River.

Upon study completion, all project data will be entered into Ecology's EIM system.

12.1 Number, frequency, type, and schedule of audits

An audit will not be required for this project.

12.2 Responsible personnel

There will be no audits for this project. Other responsibilities are detailed in section 5.1.

12.3 Frequency and distribution of report

This report will be produced and generated once.

12.4 Responsibility for reports

See section 5.1.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

The principal investigator is responsible for the final acceptance of the project data. The complete data package, along with MEL's written report, will be assessed for completeness and reasonableness. Based on these assessments, the data will either be accepted, accepted with qualifications, or rejected and re-analysis considered.

13.2 Lab data verification

Data verification is a process conducted by producers of data. Normally a MEL unit supervisor or an analyst experienced with the method verifies laboratory data. It involves a detailed examination of the data package using professional judgment to determine whether the MQOs have been met.

Data verification involves examining the data for errors, omissions, and compliance with QC acceptance criteria. MEL's SOPs for data reduction, review, and reporting will meet the needs of the project. Data packages, including QC results for analyses conducted by MEL, will be assessed by laboratory staff using the EPA Functional Guidelines for Organic Data Review.

MEL staff will provide a written report of their data review which will include a discussion of whether (1) MQOs were met, (2) proper analytical methods and protocols were followed, (3) calibrations and controls were within limits, and (4) data were consistent, correct, and complete, without errors or omissions.

13.3 Validation requirements, if necessary

Independent data validation will not be required.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining whether project objectives have been met

After the project data have been reviewed and verified, the principal investigator will determine if the data are of sufficient quality to make determinations and decisions for which the study was conducted. The data from the laboratory's QC procedures, as well as results from laboratory control standards and duplicates, and labeled standard recoveries, will provide information to determine if MQOs have been met. A review of sample results will be performed following each of the seasonal sampling events to assess the need for modifications to the sampling or analysis program. Laboratory and QA staff familiar with assessment of data quality may be consulted. The project final report will discuss data quality and whether the project objectives were met. If limitations in the data are identified, they will be noted.

Some analytes will be reported near the detection capability of the selected methods. MQOs may be difficult to achieve for these results. MEL's SOP for data qualification and best professional judgment will be used in the final determination of whether to accept, reject, or accept the results with qualification. The assessment will be based on a review of laboratory QC results. This will include assessment of laboratory precision, contamination (blanks), accuracy, matrix interferences, and the success of laboratory QC samples meeting MQOs.

14.2 Data analysis and presentation methods

An estimate of total PCB (t-PCB) load to the Spokane River from fish plants and hatchery effluent will be calculated. There will be two sets of loading data calculated from hatchery effluent concentrations.

The first loading estimate will quantify the amount of t-PCB leaving the Spokane hatchery through discharge pipes. This estimate will be calculated using PCB concentrations in effluent samples (ug/L) multiplied by a discharge estimate provided by hatchery staff (cubic feet per second(cfs)), times a unit conversion factor (2.45). This equation will provide an estimate of t-PCB g/day in hatchery effluent.

Discharge (cubic feet per second) x concentration (ug/L) x 2.45= grams/day

The second load estimate will use the PCB concentration in the water sampled from the drainage slough after solids have settled out from effluent. A sample will be collected from where the drainage slough connects to the Little Spokane River. The concentration of that sample (ug/L) will be multiplied by a discharge volume (cfs), times a conversion factor of 2.45. This equation will produce an estimate of the t-PCB load that makes it to the Little Spokane River. This load will be added to the t-PCB load in hatchery fish to estimate a total load to the Spokane River from the hatchery fish and effluent that are contributed by hatchery operations.

The PCB load contributed by the hatchery fish planted to the Spokane River will be calculated by multiplying the average PCB concentration in fish samples (ug/kg) by the mass of fish planted (kg). Different loads will be calculated from the sample data from Troutlodge and the Spokane hatchery. The mass of fish leaving each hatchery facility will be estimated by multiplying the number of fish from each facility by the average fish weight from each hatchery. Numbers and average weights of fish will be provided by hatchery personnel.

14.3 Treatment of non-detects

Results for PCB congeners that are not detected at the practical quantitation limit (PQL) or estimated detection limit (EDL), whichever is higher, will not be included in PCB totals. Only detected congeners will be included in PCB sample totals.

14.4 Sampling design evaluation

The sample size for whole fish composites are sufficient to characterize PCB contributions. Sediment and water sample numbers are sufficient for this level of screening. Additional sampling for source assessment may occur at another phase of this project if PCB contamination is determined to be an issue in fish, effluent, or sediment. The project schedule provides sufficient time to evaluate analytical results and adapt the project plan between sampling events if needed.

14.5 Documentation of assessment

This will occur in the final report.

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16.0 Figures

The figures in this QAPP are inserted after they're first mentioned in the text.

17.0 Tables

The tables in this QAPP are inserted after they're first mentioned in the text.

18.0 Appendix. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Broodstock: A sexually mature population of fish used for breeding purposes.

Effluent: An outflowing of water from a natural body of water or from a human-made structure. For example, the treated outflow from a wastewater treatment plant.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

Total suspended solids (TSS): Portion of solids retained by a filter.

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
EDL	Estimated detection limit
EQL	Estimated quantification limit
EIM	Environmental Information Management database
Et al.	And others
Hcl	Hydrochloric acid
HRMS	High Resolution Mass Spectrometry
HUC	Hydrologic unit code
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
NPDES	National pollution discharge elimination system
NTR	National Toxics Rule
OPR	Ongoing precision and recovery
PCB	Polychlorinated biphenyls
PQL	Practical quantification limit
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RPD	Relative percent difference
SOP	Standard operating procedures
SRM	Standard reference materials
SRRTTF	Spokane River Toxics Task Force
TOC	Total organic carbon
TSS	(See Glossary above)
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees Celsius
cfs	cubic feet per second
dw	dry weight
g	gram
L	liter
mg/L	milligrams per liter
mL	milliliter
oz	ounce
pg/L	picograms per liter (parts per quadrillion)
ug/L	micrograms per liter (parts per billion)
ug/kg	micrograms per kilogram (parts per billion)
ww	wet weight

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010)

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy. (USGS, 1998)

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella. (Kammin, 2010)

Bias: The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process. (USGS, 1998)

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. (Ecology, 2004)

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards, but should be referred to by their actual designator, e.g., CRM, LCS. (Kammin, 2010; Ecology, 2004)

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

Continuing Calibration Verification Standard (CCV): A QC sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run. (Kammin, 2010)

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system. (Kammin, 2010; Ecology 2004)

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean. (Kammin, 2010)

Data Integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading. (Kammin, 2010)

Data Quality Indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity. (USEPA, 2006)

Data Quality Objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions. (USEPA, 2006)

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010)

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment, and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability and integrity,

as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier, data is usable for intended purposes.
- J (or a J variant), data is estimated, may be usable, may be biased high or low.
- REJ, data is rejected, cannot be used for intended purposes (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set. (Ecology, 2004)

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero. (Ecology, 2004)

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis. (USEPA, 1997)

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport. (Ecology, 2004)

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples. (Kammin, 2010)

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples. (USEPA, 1997)

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects. (Ecology, 2004)

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness. (USEPA, 2006)

Measurement result: A value obtained by performing the procedure described in a method. (Ecology, 2004)

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed. (EPA, 1997)

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples. (Ecology, 2004; Kammin, 2010)

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero. (Federal Register, October 26, 1984)

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010)

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all "parameters." (Kammin, 2010; Ecology, 2004)

Population: The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

Quality Assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

Quality Control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data. (Ecology, 2004)

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

[Abs(a-b)/((a + b)/2)] * 100

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled. (USGS, 1998)

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

Sample (statistical): A finite part or subset of a statistical population. (USEPA, 1997)

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit. (Ecology, 2004)

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method. (USEPA, 1997)

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency. (USEPA, 1997)

Split sample: A discrete sample that is further subdivided into portions, usually duplicates. (Kammin, 2010)

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis. (Kammin, 2010)

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning. (USEPA, 2006)

References for QA Glossary

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