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State of Washington

Quality Assurance Project Plan

Pyrethroids in Freshwater Sediments of King County

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Publication Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

This plan is available on Ecology's website at www.ecy.wa.gov/biblio/1103101.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, RCOO12.

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Author and Contact Information

Paul D. Anderson
P.O. Box 47600
Environmental Assessment Program
Washington State Department of Ecology
Olympia, WA 98504-7710

For more information contact:
Communications Consultant, phone 360-407-6834.

Washington State Department of Ecology - www.ecy.wa.gov/

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

Quality Assurance Project Plan

Pyrethroids in Freshwater Sediments of King County

February 2011

Approved by:

Signature:	Date: January 2011
Julie Lowe, Client, Water Quality Program, Program Development Services	
Signature:	Date: January 2011
Kathleen Emmett, Client's Unit Supervisor, Water Quality Program, Program Development Services	
Signature:	Date: January 2011
Bill Moore, Client's Section Manager, Water Quality Program, Program Development Services	
Signature:	Date: January 2011
Randy Coots, Project Manager, EAP	
Signature:	Date: January 2011
Paul D. Anderson, Author/Principal Investigator, EIM Data Engineer, EAP	
Signature:	Date: January 2011
Dale Norton, Author's Unit Supervisor, EAP	
Signature:	Date: January 2011
Will Kendra, Author's Section Manager, EAP	
Signature:	Date: January 2011
Robert F. Cusimano, Section Manager for Project Study Area, EAP	
Signature:	Date: January 2011
Stuart Magoon, Director, Manchester Environmental Laboratory, EAP	
Signature:	Date: January 2011
Bill Kammin, Ecology Quality Assurance Officer	

Signatures are not available on the Internet version.
EAP: Environmental Assessment Program.
EIM: Environmental Information Management database.

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Abstract

In Washington State, there is very little information about concentrations of pyrethroid insecticides in sediment. Several states have investigated and found levels of pyrethroids that sometimes exceed toxicological endpoints. These studies also found that pyrethroid pesticides are most commonly found in urbanized areas with higher concentrations of residential and commercial properties.

This study is designed to provide quantitative data on pyrethroids in areas where they likely are used and to determine if the quantities present are likely to have a toxicological effect on sediment-dwelling organisms. If toxicological effects on sediment-dwelling organisms are likely, then pyrethroids may be considered in future stormwater monitoring and permitting.

To determine concentrations of pyrethroids in sediment, samples will be collected from 20 creeks in western King County. Analysis for pyrethroids will be limited to ten currently used pyrethroid insecticides of greatest concern to urban areas (bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, phenothrin, resmethrin, and tralomethrin) and the synergist piperonyl butoxide. In addition to pyrethroid samples, total organic carbon and grain size samples will also be collected. These parameters will help determine how the pyrethroids are partitioned in the sediment.

Background

Pyrethroids are synthetic compounds similar to pyrethrum, a natural insecticide derived from flowers of the genus Chrysanthemum. In recent years, use of products containing pyrethroids by homeowners and the agricultural industry has substantially increased. This increase can be attributed to the curtailed use of organophosphate pesticides due to concerns over human toxicity and the withdrawal of most products that contain chlorpyrifos and diazinon (Ding et al., 2010; Weston et al., 2005).

Most consumer insect treatments available for residential and commercial use include pyrethroids as the active ingredient. Pyrethroids are in common products such as pet sprays and shampoos, household insecticides, mosquito repellents, and lice treatment for humans. Many products containing pyrethroids also contain piperonyl butoxide (PBO). PBO is used to enhance the toxicity of pyrethroids and other insecticides by blocking natural detoxification pathways (Amweg et al., 2006).

As a group, pyrethroids have low water solubility, high octanol-water partition coefficients (K_{ow}), and a strong affinity for sediment particulate matter (Todd and Wohlers, 2003). Pyrethroids are strongly sorbed to sediments of natural water systems that contain large amounts of silt and clay particles (Laskowski, 2002).

Supporting Data

Studies recently conducted on pyrethroid residues in California (Weston et al., 2005; Weston et al., 2009; and Weston and Lydy, 2010), Texas (Hintzen et al., 2008), and Illinois (Ding et al., 2010) have shown the presence of pyrethroids in urban stream sediments at toxic levels. Some pyrethroids have been found at concentrations that are many times higher than acutely toxic levels (Weston et al., 2009). With the potential presence of PBO, toxicity levels could be even higher (Amweg et al., 2006).

Even with the potential for widespread use there is little if any information on levels of pyrethroids in sediments of urban streams in Washington. An unpublished study by Weston (2010) reported that four pyrethroids were found in two areas of Washington (Table 1). There is no information on concentrations of PBO in sediments in Washington.

Table 1. Frequency of detection for bifenthrin, cypermethrin, deltamethrin, and permethrin in two areas of Washington (Weston, 2010).

Area	Bifenthrin	Cypermethrin	Deltamethrin	Permethrin
Puget Sound	27%	0%	5%	9%
Vancouver	14%	14%	0%	0%

Logistics

One of the most heavily urbanized areas in Washington is King County. Based on the research from other states, urban streams in King County would be the most likely place to find measureable concentrations of pyrethroids in sediment. King County covers a large area with the western region being the most heavily developed. The high number of streams in this area drains residential, commercial, and industrial lands. In order to cover a diverse set of streams the study area will be fairly large and include private and public property. Most logistically challenging will be obtaining permission to enter sites that are only accessible through private property and finding sites with adequate amounts of fine-grained sediment.

Toxicological Endpoints

Currently there are no water quality standards for pyrethroids. Available toxicity values from Environmental Protection Agency (EPA) pesticide registration documents and other scientific studies will be used for comparison. These toxicity values range widely depending upon how the studies were conducted. Only toxicity endpoints from studies using standard EPA protocols will be considered. Four out of the ten pyrethroids (cypermethrin, permethrin, phenothrin, and resmethrin) have available registration documents. Of these four, only the registration documents for cypermethrin contain the toxicity endpoints needed for this study.

The percent of fine grains and the amount of organic carbon in sediments influences the bioavailability and toxicity of pyrethroids (Holmes et al., 2008; Maund et al., 2002). Organic carbon normalization has been shown to make LC_{50} values less variable and more applicable to other sediments (Amweg et al., 2005; Di Toro et al., 1991). Di Toro et al. (1991) also state that toxicity values that are not adjusted to organic carbon are not a good estimate of chemical activity. Since there are no state or federal water quality criteria for pyrethroids and this study is being conducted at a screening level, both dry weight and organic carbon normalized toxicity values are presented. This will allow for a broader comparison of available toxicity values to the results of this study.

Table 2 presents available acute and chronic toxicity values expressed on a dry weight and organic carbon normalized basis for the ten pyrethroids being studied. Acute toxicity values represent median lethal concentrations (LC_{50}); chronic toxicity values represent lowest observable effect concentrations (LOEC). With the exception of cypermethrin, the toxicity values presented in Table 2 are averages from a single study that used standard EPA protocols to determine sediment toxicity values for Hyalella azteca (Amweg et al., 2005). Cypermethrin toxicity values are from the EPA reregistration eligibility decision (RED) (EPA, 2008). The chronic toxicity value for cypermethrin is not a LOEC. Instead EPA presents the chronic toxicity value as a No Observed Adverse Effect Concentration (NOAEC).

Organic carbon normalized data for cypermethrin are not available. No toxicity values are available for phenothrin, resmethrin, and tralomethrin in sediment.

Table 2. Acute (LC_{50}) and chronic (LOEC) toxicity values expressed on a dry weight and organic carbon normalized basis for the ten pyrethroids being studied.

Chemical	Acute (mg/Kg)		Chronic (mg/Kg)	
	(dw)	(OC)	(dw)	(OC)
bifenthrin	12900	0.52	8232	0.35
cyfluthrin	13700	1.08	7618	0.62
cypermethrin[1]	3600	N/A	590[2]	N/A
deltamethrin	9900	0.79	10403	0.89
esfenvalerate	41800	1.54	16274	0.61
lambda-cyhalothrin	5600	0.45	2277	0.19
permethrin	200700	10.8	132126	8.4
phenothrin	N/A	N/A	N/A	N/A
resmethrin	N/A	N/A	N/A	N/A
tralomethrin	N/A	N/A	N/A	N/A

[1]Acute and chronic toxicity values from the EPA registration document.
[2]Chronic value is an NOAEC instead of an LOEC.
dw: dry weight.
OC: organic carbon.
N/A: not available.
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Project Description

Currently, there is little data available on environmental concentrations of pyrethroids in Washington. The primary goal of this study is to collect screening level information on the presence and concentration of pyrethroid insecticides in freshwater sediments from creeks that are highly impacted by urban stormwater.

To help focus the acquisition of relevant data this study will sample for ten currently used pyrethroid insecticides of greatest concern to urban areas and the synergist PBO (San Francisco Estuary Project, 2008; Jennings, personal communication). The ten pyrethroid insecticides are: bifenthrin, cyfluthrin, cypermethrin, deltamethrin, esfenvalerate, lambda-cyhalothrin, permethrin, phenothrin, resmethrin, and tralomethrin.

The data will be used to determine if pyrethroid concentrations found in urban stream sediments have the potential to cause toxicity to sediment dwelling organisms. Ultimately, this data may be used to develop protocols for sediment monitoring for pyrethroids in future stormwater monitoring and permitting.

The most likely pathway for pyrethroids to contaminate sediments in streams is transport during storm events. Surface run-off will carry pyrethroids to stormwater collection systems and streams. During typical pesticide application periods (spring and summer), the best time to sample for pyrethroids in sediments is shortly after a storm event when rains have eased or stopped and streamflows have decreased.

This study will have sampling that occurs during the winter wet season when very little outdoor application of pesticides will occur. The timing of sampling also means that there will have been several storm events that washed the majority of the pyrethroid residues into streams that receive stormwater. For the timing of the study and the type of contaminant, tying sampling to a storm event likely would not provide any significant advantage. Therefore sampling will occur when streamflows are low enough to access fine-grained sediments that have been deposited during storm events. Sampling will be conducted in December.

To provide broad spatial coverage of urbanized King County, 20 sites will be sampled once and analyzed for the target pyrethroid insecticides. The sites will be located in Water Resource Inventory Areas (WRIAs) 8 and 9. Sites will be chosen in areas with streams that are highly impacted by stormwater. Figure 1 shows the location of King County and WRIAs 8 and 9 in Washington. Figure 2 shows the sampling locations in WRIAs 8 and 9.

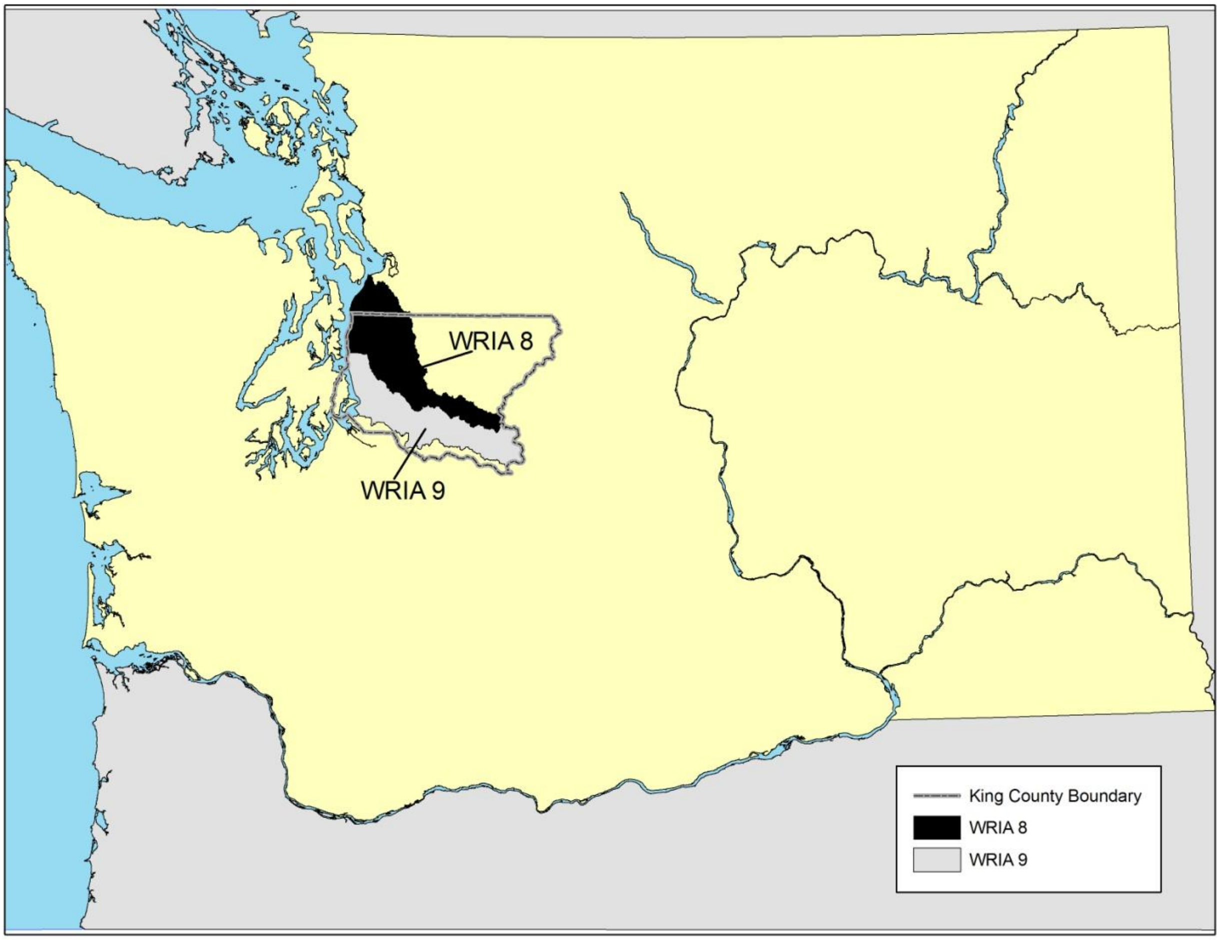

Figure 1. Location of King County and WRIAs 8 and 9 in Washington.

Figure 2. Sampling locations within WRIAs 8 and 9.

Organization and Schedule

The following people are involved in this project. All are employees of the Washington State Department of Ecology.

Table 3. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Julie Lowe PDS Water Quality Program Phone: (360) 407-6470	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Randy Coots Toxics Studies Unit SCS Phone: (360) 407-6690	Project Manager	Reviews the QAPP. 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.
Paul D. Anderson Toxics Studies Unit SCS Phone: (360) 407-7548	Principal Investigator	Writes the QAPP. Helps collect samples and records field information. Enters data into EIM.
Debby Sargeant Toxics Studies Unit SCS Phone: (360) 407-6139	Field Assistant	Helps collect samples and records field information
Dale Norton Toxics Studies Unit SCS Phone: (360) 407-6765	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Will Kendra 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.
Robert F. Cusimano Western Operations Section Phone: (360) 407-6596	Section Manager for the Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Stuart Magoon Manchester Environmental Laboratory Phone: 360- 871-8801	Director	Approves the final QAPP.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

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

Table 4. 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	December 2010	Randy Coots
Laboratory analyses completed	March 2011	
Environmental Information System (EIM) database		
EIM user study ID	RCOO12	
Product	Due date	Lead staff
EIM data loaded	May 2011	Paul D. Anderson
EIM quality assurance	June 2011	Tanya Roberts
EIM complete	July 2011	Randy Coots
Final report		
Author lead / Support staff	Randy Coots /Paul D. Anderson	
Schedule		
Draft due to supervisor	April 2011	
Draft due to client/peer reviewer	May 2011	
Final (all reviews done) due to publications coordinator	June 2011	
Final report due on web	July 2011	

Quality Objectives

Quality objectives for this project are to obtain data of sufficient quality and quantity so that the data can be used to (1) assess the concentration and distribution of pyrethroid insecticides in sediments of urban and suburban streams and (2) determine if the concentrations of pyrethroids are high enough to have toxic effects on sediment dwelling organisms based upon toxicological endpoints. These objectives will be achieved through careful planning, sampling, and adherence to procedures described in this Quality Assurance (QA) Project Plan.

Ecology's Manchester Environmental Laboratory (MEL) will perform all analyses for the study except for analysis of grain size. MEL and its contractors are expected to meet all of the quality control requirements of the analytical methods being used in this project. Routine quality control tests for precision and accuracy will meet project needs. The analytical measurement quality objectives (MQO) that will be used are shown in Table 5.

Table 5. Laboratory measurement quality objectives.

Parameter	Laboratory Control Samples	Duplicate Samples	Matrix Spike Samples	Matrix Spike Duplicate Samples	Surrogate Standards
	% recovery	RPD	% recovery	RPD	% recovery
Pyrethroids	50-150	≤40	50-150	±40	50-150
TOC	75-125	≤25	N/A	N/A	N/A
Grain Size	N/A	≤25	N/A	N/A	N/A

N/A: not applicable.
RPD: relative percent difference.
TOC: total organic carbon.

Sampling Process Design

This study is designed to be a screening level study to assess the occurrence and extent of pyrethroid contamination in urban and suburban stream sediment from areas with a high potential for detection. Sediment samples will be collected once at 20 sites in King County for ten commonly available pyrethroid insecticides and the synergist PBO. In addition to pyrethroids, samples for total organic carbon (TOC) and grain size will be collected. Pyrethroids are non-polar compounds that have high K_{ow} values that make them preferentially partition to the organic carbon fraction of sediments (Amweg et al., 2005).

Fine-grained sediments (silt and clay-sized material) are chemically active (Owens et al., 2005) which allows for adsorption of chemicals like pyrethroids. TOC and grain size data will allow for normalization of sediment concentrations and aid in the interpretation of data. The temperature of the sediment at each collection site will be measured to help determine the potential toxicity of pyrethroids to benthic organisms. Sediment temperature is important because pyrethroid toxicity increases as temperature decreases (Holmes et al., 2008; Weston and Lydy, 2010).

All samples collected in the field will be analyzed in the laboratory. Sampling will occur in December. The sites were chosen for the following characteristics:

- They have potential for impacts from residential, commercial, or light industrial areas where use of pyrethroids is likely.
- The depositional area targeted for sediment collection receives stormwater discharge.
- They are highly impacted by stormwater during rain events.
- Sediment in depositional areas contains fine material such as silt and clay.

The 20 creeks selected for sampling are listed in Table 6. Locations are subject to change depending upon the availability of sediment.

Sites were chosen based upon recommendations by King County, suggestions from other local jurisdictions using selection criteria, and field reconnaissance. Even with field reconnaissance, conditions may change before sampling occurs. If initial locations are not viable when sampling occurs, field staff will explore upstream and downstream to find a suitable sampling location. In the event that a secondary site must be chosen, staff carefully will avoid disturbing sediment upstream of the sample area so the site is not contaminated. Secondary sites can be selected by looking for sites from the bank or other places where the creek bottom is visible. Since sampling may occur in areas adjacent to private property, staff will obtain permission before entering.

Table 6. Sampling locations and descriptions.

Station Name	Latitude	Longitude	Description
Bear Creek	47.7366	-122.07944	Bridge on NE 95th Street (East of Avondale Rd NE)
Coal Creek	47.5732	-122.18994	Downstream of crossing on Skagit Key near old staff gauge
Cottage Lake Creek	47.7156	-122.09019	Downstream of bridge on Burke-Gilman Trail
Eden Creek	47.6155	-122.06828	In pool just downstream of culvert under E Lake Sammamish Parkway NE
Forbes Creek	47.6972	-122.20996	East side of Old Market Street Trail near the bridge crossing on 98th Avenue NE
Idylwood Creek	47.6431	-122.10291	Upstream of footbridge in Idylwood Park
Issaquah Creek	47.5521	-122.04789	Upstream of bridge on SE 56th Street
Juanita Creek	47.7114	-122.21021	Upstream of bridge on NE 124th Street
Kelsey/ Mercer Creek	47.6025	-122.17467	Downstream of culvert under Westbound Lake Hills Connector Road
Lewis Creek	47.5707	-122.09234	Upstream of bridge on 185th Place SE
Little Bear Creek	47.7583	-122.16076	Upstream of culvert under 134th Avenue NE
Longfellow Creek	47.567	-122.36683	Upstream of bridge crossing at Brandon Street
May Creek	47.5282	-122.20432	Near the mouth
McAleer Creek	47.7514	-122.28098	Downstream of culvert under Bothell Way NE
NF Issaquah Creek	47.5462	-122.04163	At crossing with E Lake Sammamish Trail
North Creek	47.7748	-122.18482	Upstream side of bridge on second crossing of North Creek Parkway
Pipers Creek	47.7115	-122.37668	Upstream of bridge of the closed road in Carkeek Park
Springbrook Creek	47.4659	-122.23261	Downstream of bridge on SW 16th
Thornton Creek	47.696	-122.27590	Upstream of footbridge over creek at Mathews Beach Park
Yarrow Creek	47.644	-122.20275	Downstream of culvert under NE Points Drive

NF: North Fork.

Sampling Procedures

Table 7 lists the sample size, container, preservation, and holding time for each parameter. Sample containers will be obtained from MEL.

Table 7. Sample size, container, preservation, and holding time for each parameter (MEL, 2008).

Parameter	Sample Size	Container	Preservation	Holding Time
Pyrethroids	250 g	8 oz glass/Teflon lid	Cool to ≤6°C/Freeze	14 days/6 months
TOC	25 g	2 oz glass/Teflon lid	Cool to ≤6°C/Freeze	14 days/6 months
[1]Grain Size	100 g	8 oz plastic jar	Cool to ≤6°C	6 months

[1]Grain size is the percent gravel, sand, silt, and clay.
TOC: total organic carbon.

All samples will be located and positions recorded using a handheld global positioning system (GPS) following Ecology SOP EAP013 *Standard Operating Procedure for Determining Coordinates Via Hand-held GPS Receivers* (Janisch, 2006). Where appropriate, positions relative to fixed stream bank structures will also be recorded. In addition, pictures will be taken of the sampling location with key reference points shown.

Sample Collection

Collection of surface sediments for pyrethroids, TOC, and grain size will be performed according to Ecology SOP EAP040 *Standard Operating Procedure for Obtaining Freshwater Sediment Samples* (Blakley, 2008). A field log for each station will be completed recording information that is consistent with Ecology SOP EAP040. Sediment temperature will also be recorded in the field log.

Hladik et al. (2009) recommends the best method for collection of sediment for pyrethroid analysis is manual grab samples using stainless steel spoons or scoops. When possible, stainless steel spoons or scoops will be used for sediment collection. If target sediments are located in deeper water, a 0.02 square meter stainless steel petite ponar grab sampler will be used. In accordance with Ecology SOP EAP040, the top two cm of depositional sediment will be sampled at each location to reflect recently deposited material. Enough sediment will need to be available to fill the necessary sample containers.

After collection and homogenization, sediment will be placed in labeled sample containers. The sample containers will then be sealed in plastic bags to protect the samples from contamination during transport to the laboratory. All samples will be placed in coolers on ice or in a refrigerator at 4°C until transported to the laboratory. Chain of custody will be maintained throughout collection, storage, and transport to the laboratory.

Decontamination Procedures

Stainless steel spoons and bowls used to collect and manipulate the sediments for analysis will be pre-cleaned following the Ecology SOP described in EAP040 (Blakley, 2008). One change to the procedure will be made for this project: methanol will be used in place of the acetone and hexane rinse. A USGS report on the collection of pyrethroids in water and sediment (Hladik et al., 2009) deems methanol to be effective at removing surface-associated pyrethroids. Methanol is considered a safer solvent than acetone and hexane. Also, using just one solvent will reduce the amount of waste generated during decontamination.

Invasive Species Decontamination

Field staff will follow decontamination standard operating procedures described in EAP071 *Standard Operating Procedures to Minimize the Spread of Invasive Species from Areas of Moderate Concern* (Ward et al., 2010).

Measurement Procedures

Field

Temperature will be measured in the field using an alcohol-filled glass thermometer. This thermometer will be checked against a National Institute of Standards and Technology (NIST) thermometer to ensure accuracy. If the glass thermometer is found to deviate from the NIST thermometer, the temperature readings from the glass thermometer will be adjusted accordingly. To measure sediment temperature the thermometer will be placed in the sediment near the collection site. The thermometer will be allowed to equilibrate before the temperature is read and recorded in field logs. Care will be taken to place the thermometer in a location where it will only contact sediment.

Laboratory

Laboratory measurement procedures are presented in Table 8. Except for grain size analysis, MEL will perform all laboratory analyses for the study according to current SOPs. Columbia Analytical Services will perform grain size analysis using the method selected for this project. MEL recently developed the methods for extracting and analyzing pyrethroids in sediment, modifying existing methods.

Table 8. Sediment measurement methods.

Analysis	Expected Range of Results	Reporting Limit	Sample Preparation Method	Analytical Method
Pyrethroids	0-50 mg/Kg	2.5 - 12.5 mg/Kg	EPA 3541	EPA 8270[1]
TOC	<1-20 mg/Kg	0.1% carbon	N/A	PSEP 1986
Grain size	N/A	N/A	N/A	PSEP 1986

[1]Method 8270 was modified by Manchester Environmental Laboratory for quantification of pyrethroids.
N/A: not applicable.
PSEP: Puget Sound Estuary Program.
SM: Standard Methods.
TOC: total organic carbon.

Quality Control Procedures

Staff will carefully follow the standard operating procedures listed in the *Sampling Procedures* section of this QA Project Plan to avoid contamination of samples. Staff will take copies of the QA Project Plan and standard operating procedures into the field for reference.

Sediment Samples

In addition to following standard operating procedures, staff will collect field quality control (QC) samples (Table 9). These field QC samples will consist of replicates which staff will submit blind to MEL using different sample numbers and identification.

Staff will collect four split replicate samples at randomly selected sites. This will ensure adequate QC sample coverage at 20%.

Replicates will be used to estimate sampling and laboratory variability. Staff will prepare these replicates by filling two separate sample containers from the same homogenized grab sample.

Table 9. Field quality control samples and associated data quality objectives.

Parameter	Replicate	Data Quality Objective (RPD)
Pyrethroids	4	±50
TOC	4	±25
Grain size	4	±25

RPD – relative percent difference.
TOC – total organic carbon.

Laboratory

Manchester Environmental Laboratory will follow the methods listed in Table 10 and any associated laboratory SOPs. Laboratory QC will consist of laboratory control samples (LCS), method blanks, laboratory duplicates, matrix spike/matrix spike duplicates (MS/MSD), and surrogate spikes (Table 10). Staff will identify two MS/MSD pairs at randomly selected sites.

Table 10. Laboratory quality control samples.

Parameter	Lab Control Samples	Method Blank	Laboratory Duplicate	Matrix Spike	Matrix Spike Duplicate	Surrogate Spike
Pyrethroids	1/batch	1/batch	1/batch	1/batch	1/batch	1/batch
TOC	1/batch	1/batch	1/batch	N/A	N/A	1/batch
Grain size	N/A	N/A	1/batch	N/A	N/A	N/A

A batch is defined as 20 or fewer samples.
N/A: not applicable. TOC: total organic carbon.

The laboratory costs are estimated to be $14,546.40 (Table 11) and represent a 50% discount by MEL.

Table 11. Cost estimate (price reflects 50% MEL discount).

Analysis	Samples			Price per Sample ($)	Total ($)
	Regular	QC	Total		
Pyrethroids	20	8	28	375.00	10500.00
TOC	20	4	24	43.60	1046.40
Grain size (contract laboratory)	20	4	24	100.00	2400.00
Data review (25% of cost)	20	4	24	25.00	600.00
				Project Total:	14546.40

QC: quality control.
TOC: total organic carbon.

Data Management Procedures

All field data and observations will be recorded in notebooks on waterproof paper. When field work is complete, the information in the field notebooks will be transferred to Excel spreadsheets. 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. The data package will also include laboratory QC results. This will include results for LCS, method blanks, laboratory duplicates, matrix spikes, and surrogate spike recoveries. The information will be used to evaluate data quality, determine if the MQOs were met, and act as acceptance criteria for project data.

The data engineer will enter field and laboratory data for the project into Ecology's EIM system. Laboratory data will be downloaded directly into EIM from MEL's data management system. Contract laboratories will submit data in electronic format for inclusion into the EIM system. The project manager will review all data and then the data engineer will enter it into EIM.

Audits and Reports

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

The project manager will complete a draft report of the study findings in April 2011 and a final report in July 2011. The report will compare results of pyrethroid samples to toxicological endpoints to determine if there is potential for toxicity to sediment-dwelling organisms.

The report will include, at a minimum, the following:

- Map showing all sampling locations and any other pertinent features of the study area.
- Coordinates of each sampling site.
- Description of field and laboratory methods.
- Discussion of data quality and the significance of any problems encountered.
- Summary tables of the chemical and physical data.
- Results of the toxic contaminants related to toxicological endpoints.
- Complete set of chemical and physical data.

Upon study completion, all project data will be entered into Ecology's EIM system. Public access to electronic data and the final report for the study will be available through Ecology's Internet homepage (www.ecy.wa.gov).

Data Verification

Data verification is a detailed, quality assurance-based review of a data set. Verification of laboratory data is normally performed by a MEL unit supervisor or an analyst experienced with the method. It involves a detailed examination of the data package using professional judgment to determine whether the measurement quality objectives have been met.

MEL will verify that (1) methods and protocols specified in this QA Project Plan were followed; (2) all calibrations, checks on quality control, and intermediate calculations were performed for all samples; and (3) the data are consistent, correct, and complete, with no errors or omissions. Evaluation criteria will include the acceptability of instrument calibration, procedural blanks, check standards, recovery and precision data, and appropriateness of any data qualifiers assigned. MEL will prepare written data verification reports based on the results of their review. A case summary can meet the requirements for a data verification report.

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

Data Quality (Usability) Assessment

After the project data have been reviewed and verified, the principal investigator will determine if the data are of sufficient quality to make decisions for which the study was conducted. The data from the laboratory's QC procedures, as well as results from field replicates, laboratory duplicates, and surrogate recoveries, will provide information to determine if MQOs have been met. Following analysis by laboratory and quality assurance staff familiar with assessment of data quality, sample results will be reviewed. 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 parameters 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 field replicates, along with laboratory QC results. This will include assessment of laboratory precision, contamination (blanks), accuracy, matrix interferences, and the success of laboratory QC samples meeting control limits.

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Appendix. Glossary, Acronyms, and Abbreviations

Glossary

Acute: Effects through a single or short-term exposure.

Chronic: Effects over an extended period, usually upon repeated or continuous exposure.

Endpoint: The result of a study conducted to determine how dangerous a substance is to the target population or organism.

K_{ow}: The ratio of the concentration of a chemical octanol and in water at equilibrium and at a specific temperature. Octanol is an organic solvent that is used as a surrogate for natural organic matter.

LC_{50}: A statistically- derived concentration of a substance that can be expected to cause death in 50% of test animals. It is usually expressed as the weight of substance per weight or volume of water, air, or sediment.

LOEC: The lowest test concentration at which adverse effects are observed in test organisms at a specific time of observation.

NOAEC: The highest tested concentration of a substance at which no adverse effects are observed in test organisms at a specific time of observation.

Parameter: A physical, chemical, or biological property whose values determine environmental characteristics or behavior.

Partition: A part or portion that something has been divided.

Pyrethroid: A synthetic chemical compound similar to the naturally-occurring pyrethrins produced by chrysanthemums.

Sorb: To take up and hold, as by absorption or adsorption.

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 snowmelt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Toxicity: The degree to which a substance can harm an organism.

Acronyms and Abbreviations

Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GPS	Global Positioning System
K_{ow}	Octanol water partition coefficient
LC_{50}	Median lethal concentration
LCS	Laboratory control sample
LOEC	Lowest observable effect concentration
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
MS/MSD	Matrix spike/matrix spike duplicate
NIST	National Institute of Standards and Technology
NOAEC	No observable adverse effect concentration
OC	Organic carbon
QA	Quality assurance
QC	Quality control
RED	Registration Eligibility Decision
RPD	Relative percent difference
SM	Standard methods
SOP	Standard operating procedures
TOC	Total organic carbon
USGS	U.S. Geological Survey
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees centigrade
g	gram, a unit of mass
mg/Kg	milligrams per kilogram (parts per million)
mg/Kg OC	milligrams per kilogram organic carbon (parts per million)
oz	ounce