DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

Hylebos Waterway Crab Tissue Study, Occidental Chemical Corporation

June 2023

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COVER PHOTO: A dock on the Hylebos Waterway at Occidental property.
PHOTO BY MEGHAN ROSEWOOD-THURMAN.

Quality Assurance Project Plan

Hylebos Waterway Crab Tissue Study, Occidental Chemical Corporation

by Meghan Rosewood-Thurman

June 2023

Approved by:

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Signatures are not available on the Internet version.
EAP: Environmental Assessment Program
HWTR: Hazardous Waste and Toxics Reduction Program
SWRO: Southwest Regional Office.

Disclaimer

The data quality objective of this study is to assess the presence or absence of contaminants in edible shellfish tissue as a result of the historical contamination at the Occidental Chemical Corp. site in Tacoma, Washington.

The data from this study are not to be used to determine if shellfish harvested from the Hylebos Waterway is safe for consumption or used as the sole deciding factor to influence the seafood consumption advisory for the Hylebos Waterway.

The Department of Ecology assumes no responsibility or claims from a third-party use of the outcome of this study. If new or additional information becomes available which differs from the study result and understanding presented in this publication, the author and reviewers disclaims any responsibility to update this publication.

1.0 Table of Contents

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2.0 Abstract

During 2023, the Washington State Department of Ecology (Ecology) will complete a focused study to look for legacy toxic chemicals (toxics) that have been discontinued or banned in the United States (US). Occidental Chemical Corporation (Occidental) had past industrial operations located next to the Hylebos Waterway, and Ecology is working with Occidental to address toxics created by these operations. If people eat crab from the Hylebos Waterway, they might ingest these legacy toxics.

The location for sampling is at the mouth of Hylebos Waterway on the northeast side of Commencement Bay in the Port of Tacoma. This study will see if the toxic chemicals in the Hylebos Waterway can get into crab that are eaten by people in the community.

Previous studies from the US Environmental Protection Agency (EPA) have identified volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs) in sediments and in crab caught within Hylebos Waterway near the Occidental site; however, the crab tissue study was missing details on how the sampling happened. Ecology will repeat a crab tissue study and document each detail to see if toxics exist in crab "butter" and crab "meat" or if they are absent.

The results of this study will also provide information for EPA's Government Performance and Response Act (GPRA) Performance Track for the CA 725 milestone[1]. This work is within the goals of the Environmental Performance Partnership Agreement (PPA) between Ecology and EPA. The study results will be documented, reported, and integrated into the PPA Work Plan.

[1] https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100YUB4.txt

3.0 Background

3.1 Introduction and problem statement

The focus of the 2023 Hylebos Waterway crab tissue study is to confirm the absence or presence of contamination from the Occidental site in consumable crab species through collection of target species, lab analysis, and quantification. Ecology intends to sample crab to (1) identify the presence of contaminants of concern and (2) determine if they exist above "practical quantitation limits" or the detection limits of the lab analytical methods. Collecting this data will demonstrate if volatile organic compounds (VOCs) or semi-volatile organic compounds (SVOCs) are present in the target species that community members use as a food source.

The data from this study will inform Ecology and EPA if the CA 725 human health milestone for the Resource Conservation and Recovery Act (RCRA)[2] Corrective Action Performance Track has been achieved. This milestone is one of the EPA's priorities under the Government Performance and Response Act (GPRA). The GPRA requires that EPA, and authorized states such as Washington, are advancing corrective action cleanups to achieve key indicators for progress. Achieving this milestone fulfills goals in the two-year Environmental Performance Partnership Agreement (State Fiscal Years 2022-2023 July 1, 2021 – June 30, 2023).[3] In this agreement Ecology will work towards these common goals:

- Tracking RCRA closure, post closure, and corrective action work to meet RCRA Workplan commitments necessary for achieving the GRPA goal.
- Further integrating environmental justice into core RCRA activities.

The Environmental Performance Partnership Agreement (PPA) specifies that Ecology will submit an annual RCRA Work Plan to EPA, and report the progress each quarter, in both a mid-year review and an end-of-the-year report. EPA requires Ecology to document the milestone achievements in the public record and in EPA public databases. The 2023 project will be described specifically in the annual RCRA Work Plan, and the progress reports will be distributed at quarterly RCRA Managers Meetings between EPA and Ecology.

3.2 Study area and surroundings

Located on the eastern-most peninsula that extends into Commencement Bay at the mouth of the Puyallup River, the Occidental site is formally defined within an Agreement on Consent with EPA and Ecology's Hazardous Waste and Toxics Reduction Program (HWTR). A vicinity figure shows the site (Figure 1).

The roughly 12-square-mile area of EPA's Superfund Commencement Bay/Nearshore Tideflats (CB/NT) includes several waterway problem areas and adjoining uplands as described by the CB/NT site Record of Decision (EPA, 1989). Segment 5 of the mouth of the Hylebos Problem Area includes the Occidental site where impacted sediments were dredged and disposed of during 2003-2005 (CRA, 2015), or excavated and capped during 2007-2008 (Hart Crowser, 2013). This work was performed under the scope of the Mouth of Hylebos Consent Decree (EPA, 2005b).

[2] https://www.epa.gov/rcra/resource-conservation-and-recovery-act-rcra-overview
[3] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://apps.ecology.wa.gov/publications/documents/2101002.pdf

Figure 1. Site vicinity and property boundary.

3.3 Site Contamination

In the development of the Remedial Investigation for the site, contaminants of concern (COCs) were established based on historical processes, prior investigations, and characterizations under EPA's scope of work for their Agreement on Consent with Occidental. The COCs are presented in the Remedial Investigation and Feasibility Study Reports available at Ecology's Occidental Project website, Occidental Chemical Corp - (4326) (wa.gov).[4]

The primary COCs at the site are those associated with the production of chlorinated solvents. These include CVOCs, and, to a lesser degree, SVOCs. The principal CVOCs found in contaminated soil and groundwater at the site include tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride (VC), and dichloroethene (DCE). The SVOCs include hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), and pentachlorophenol (PCP). The unique chemical signature ties back to the Occidental contamination.

[4] https://apps.ecology.wa.gov/cleanupsearch/site/4326#site-documents

In addition to contamination from the chlorinated solvents and their degradation byproducts listed in the previous paragraph, there are also areas with elevated pH levels in soil and groundwater and a high-density groundwater plume caused by elevated levels of dissolved minerals, including silica. The high-pH and high-density groundwater plumes are co-mingled at some locations with the CVOC plumes.

To define the nature and extent of contamination on the environment, investigations have been conducted across the Occidental site. The chemical characterization of soil, groundwater, porewater, and sediment is based on the analytical data obtained during the various investigations summarized in the approved Remedial Investigation Report (CRA, 2015) and Anchor Report (Anchor QEA, 2016). Within the list of COCs are identified specific VOCs and SVOCs that are indicators of contamination from the Occidental site. These specific COCs will be the focus of this 2023 study.

Past management operations on the property generated hazardous waste. Waste management practices included wastewater treatment (settling) ponds, settling barges, landfills, disposal pits, and waste piles. In total, 17 separate historic waste management areas have been identified on the property. Detailed discussions of these waste management areas and the chemicals associated with them are presented in the Remedial Investigation Report (CRA, 2015).

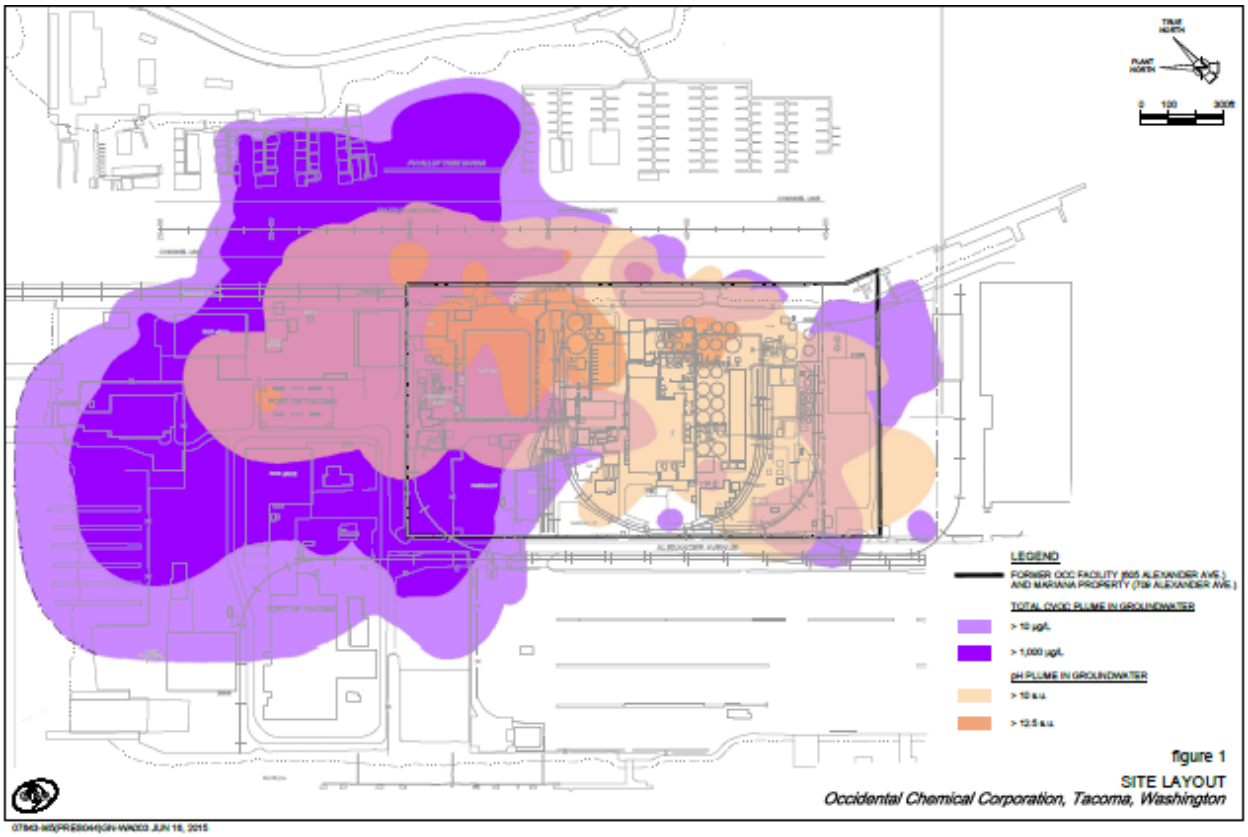


Figure 2. Occidental contaminant plumes.

Data from past studies indicate the plumes do not encounter shallow sediments within the Hylebos Waterway with the exception of one near-shore location where contaminants exceed screening levels. However, there are isolated seeps on the Occidental property shoreline and one location along the Occidental property embankment where high-pH groundwater entered the Hylebos Waterway in the past. The contaminated groundwater plume extends under the Hylebos Waterway and is found at depth on the northeast side of the Hylebos Channel, beneath property owned by the Puyallup Tribe of Indians.

Other crab and fish studies indicate that these species travel within a limited range around Commencement Bay (Carey et al., 2014; EPA, 1982; West et al., 2012). Therefore, sampling will be focused in and around the mouth of the Hylebos, near the Occidental Site and in areas where the contaminant plume is documented. However, it is noted that these food species travel into the waterway and out into the bay depending on tides and other factors.

Once the remediation is implemented at the Occidental site, Ecology will continue to evaluate the plume and the impacts to sediments by periodic groundwater compliance monitoring.

3.2.1 History of study area

- Prior to 1920: Undeveloped tidal mudflats.
- 1920-1936: Area filled with dredge material as part of an upland expansion project.
- 1929-2002: Occidental Chemical Corporation (Occidental) and its predecessors make chemicals. Other owners and operators during this period include the US Navy, US Defense Plant Corporation, Todd Shipyards, and Pioneer Americas.
- 1981: EPA conducted the first chemical contaminant survey in edible, non-salmonid fish and crab in Commencement Bay
- 1988-2004: EPA conducted a RCRA Facility Investigation and later activities to investigate the site.
- 2005: Ecology and EPA issued a Statement of Work for the Administrative Order on Consent. These documents guide site investigation activities.
- 2006-2008: Occidental demolished former manufacturing facilities.
- 2005-Present: Occidental conducted many investigations to assess impacts to on-site and off-site soil, groundwater, sediment, and soil vapor.

3.2.2 Summary of previous studies and existing data

In 1981, EPA conducted a study to investigate chemical contaminants in crab and non-salmonid fish tissues in Commencement Bay and found that specimens from Commencement Bay had higher contaminant levels than those collected from Discovery Bay (EPA, 1982). No chlorinated butadienes were found in any of the specimens at the limit of detection; however. hexachlorobenzene (HCB) was detected in fish and crabs from the Hylebos Waterway. Additionally, chlorinated pesticides Dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethane (DDD), and dichlorodiphenyldichloroethylene (DDE) were found in specimens from the Hylebos Waterway.

One recommendation from the 1981 study was to investigate the presence of pentachloropropene as well as other unidentified halogenated compounds in the Hylebos Waterway. EPA also conducted a sediment survey in this waterway in 1994; however, the survey results are not available.

In 2002, EPA announced that contaminated sediments in the Hylebos Waterway would be dredged and properly disposed of, due to documented contamination in fish and shellfish. Cancerous lesions, adverse changes to genetic material and reproductive cycles, elevated toxic chemicals (toxics), and chemical stress were all present in species found in the waterway.

The Washington State Department of Health issued a fish consumption advisory for the Marine Area 11[5], recommending:

- Commencement Bay Waterways (Thea, Foss, Blair, and **Hylebos** Waterways) - **Do not eat crab, shellfish, or bottom-feeding fish.**
- Inner Commencement Bay - Limit flatfish* to two servings per month.
- Outer Commencement Bay (boundary between Boathouse Marina and Brown's Point) - Limit flatfish to one serving per week.

** Flatfish include English Sole, Starry Flounder, and Rock Sole.*

In 2005, EPA commissioned the Washington Department of Fish and Wildlife (WDFW) to conduct a targeted fish collection near the Occidental property. WDFW identified a potential human pathway exposure risk for PCE in the tissue of the hepatopancreas of crab. The study concluded that cooking tissues would eliminate the risk. However, some individuals who consume the "crab butter," or hepatopancreas, do so raw (uncooked). The study also found consistent detections of PCE, TCE, and hexachlorobutadiene in many of the samples. The data from this WDFW study has not been located; however, a memo from 2005 (Appendix A) has prompted this 2023 Ecology crab tissue study for edible species in the Hylebos Waterway.

In 2012, WDFW analyzed toxic contaminants in crabs and prawn in Puget Sound (West et al. 2012). The study concluded that all contaminant concentrations in the hepatopancreas of Dungeness crab and head tissue of spot prawn were higher (as much as 36 times) than their corresponding muscle tissue (Cary et al., 2014).Additional studies have investigated impacts of contaminants and injury to fish, but there is a considerable data gap for shellfish studies in the Hylebos Waterway (Collier et al., 1997; O'Neill, S.M. and West, J.E., 2009; Stehr et al., 2000)

In 2016, Anchor QEA conducted a Sediment Pore Study monitoring the upwelling of contaminated groundwater into surface sediments (Anchor QEA, 2016). They investigated potential volatile organic compounds in sediments adjacent to the Occidental property. The investigation determined that most volatile organic compounds were below detection levels. Only one parameter, vinyl chloride, reported in one sample (adjacent to the northern end of the shoreline, near the embankment on Occidental's property), had the potential to exceed the screening level.

[5] https://doh.wa.gov/community-and-environment/food/fish/advisories/puget-sound/marine-area-11

Several studies had investigated VOCs in marine biota using a purge and trap method for collecting VOCs along with Gas Chromatography/Mass Spectrometry (GC/MS) and found that apart from the priority VOCs, several other VOCs turned up unexpectedly in these samples (Roose and Brinkman, 1998a). Another study individually analyzed liver and muscle tissue to determine the inter-species and inter-specimen variability. The results showed considerable variability within tissues of the same species; however, the concentrations of the VOCs appeared to be normally distributed (Roose and Brinkman, 1998b).

In 2016, Anchor QEA conducted a Sediment Pore Study, monitoring the upwelling of contaminated groundwater into surface sediments (Anchor QEA, 2016). They investigated potential volatile organic compounds in sediments adjacent to the Site. The investigation determined that most volatile organic compounds were below detection levels. Only one parameter, vinyl chloride, reported in one sample (adjacent to the northern end of the site's shoreline near the embankment), had the potential to exceed the screening level. The Occidental Chemical Corporation site on Ecology's website[6] has additional resources, project updates, the Agreed Order the Cleanup Action Plan and contact details.

During the public involvement processes with Ecology and consultations with stakeholders, concerns about impacts to human health from ingestion of fish and shellfish were shared with the Puyallup Tribe and other Tacoma residents. People raised concerns about the food chain, fish health, and tribal members who use Commencement Bay for traditional food sources. A public survey documented incidences[7] from both the Tacoma Pierce County Health Department (TPCHD) and other individuals who do not heed the fish advisory and continue to procure fish from the Hylebos Waterway for food.

The concern was that if the Occidental embankment has ongoing uncontrolled releases of contaminated groundwater to porewater that contain COCs, these chemicals may be ingested and accumulated by resident species (e.g., fish) that are used by humans for food.

3.2.3 Parameters of interest and potential sources

In 2016, Anchor QEA (Anchor QEA and GHD, 2016) published a report summarizing sample collection and analytical results for surface sediment and near-surface porewater in the mouth of Hylebos Waterway adjacent to the Occidental Site. Three sampling programs were conducted: surface sediment sampling, subsurface porewater grab sampling and polyethylene diffusion bag (PDB) porewater. Table 1 lists the contaminants and where they were detected.

[6] https://apps.ecology.wa.gov/cleanupsearch/site/4326

[7] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://apps.ecology.wa.gov/publications/documents/1804022.pdf

Table 1. Anchor QEA sediment study results for Occidental containments, 2016.

Volatile Organics	Sediment	Piezometer	PDBs	Total Detections
1,2-Dichloroethene, cis-	1	12	38	51
1,2-Dichloroethane		3	30	33
Vinyl chloride		5	19	24
1,2-Dichloroethene, trans-		9	14	23
Trichloroethene (TCE)	1	2	13	16
Chloromethane		2	4	6
1,1-Dichloroethane		5		5
1,1-Dichloroethene		1	2	3
Tetrachloroethene (PCE)			3	3
1,1,1-Trichloroethane				
1,1,2,2-Tetrachloroethane				
1,1,2-Trichloroethane				
Chloroethane				

In addition to the contaminants listed in Table 1, site-related contaminants that have also been detected above screening levels in sediments adjacent to the Occidental site include the SVOCs 1,2,4 trichlorobenzene, bis(2 ethylhexyl)phthalate, hexachlorobenzene, hexachlorobutadiene, and pentachlorophenol. These contaminants were not evaluated in the Anchor QEA 2016 Report.

In 2020, an agreed order was published between Ecology and Occidental Chemical Corporation (OCC) for corrective action, which includes groundwater extraction to pump contaminants and reversing the plumes (Figure 2). As of 2023, the Executive Summary in the draft Cleanup Action Plan (in progress) lists early actions to address these plumes. Remedies include aggressively pumping groundwater to remove volatile organic compounds, installing a vertical barrier wall to contain shallow site contaminants, and covering the site with a membrane liner to limit further dispersal. The draft Cleanup Action Plan will be out for public comment in October 2023.

3.2.4 Regulatory criteria or standards

Ecology will provide data and project updates to the Puyallup Tribe, TPCHD, and WDFW, as well as to the Washington Department of Health to inform their fish advisory for Commencement Bay.

The results of this 2023 Ecology crab tissue study will also provide information for EPA's GPRA Performance Track for the CA 725 milestone. Depending on results of the study, Ecology can determine whether the milestone is achieved. This work is within the goals of the PPA between Ecology and EPA, and will be documented, reported, and integrated into the PPA Work Plan. The plan is mutually tracked and will be adjusted as needed by mutual agreements between the EPA and Ecology's HWTR.

4.0 Project Description

Ecology's Hazardous Waste and Toxics Reduction Program (HWTR) site manager for the Occidental site will coordinate with Ecology's Environmental Assessment Program (EAP). A project manager from EAP's Toxics Studies Unit will lead the development of the study design, monitoring of target species, coordination with the laboratory, and reporting on results to meet the goals and objectives of the study. HWTR is responsible for reporting progress quarterly to EPA at the RCRA Managers Meetings, during the PPA mid-year review, and in the end-of-year report. The HWTR site manager will track the project budget and coordinate with the HWTR budget manager to make sure expenditures stay within the project budget.

Funds for the study are provided by EPA grants and other sources (see Budget, Table 6) that are passed through HWTR This QAPP will also be reviewed by HWTR's site manager and budget manager to verify that the project scope and approach will meet the terms of the federal grant. However, implementation of the monitoring study will be the sole responsibility of the EAP project manager.

EPA's role is primarily to provide the new grant funds for the project, as well as track progress and status under the terms of the PPA grant agreement. However, HWTR will also keep EPA's CB/NT Superfund project manager informed of the study progress.

4.1 Project goals

The goal of this study is to collect edible crab tissue to identify the presence of contaminants of concern (COCs) and detect if they exist within the laboratory analytical detection limits Collecting this data will demonstrate if volatile or semi-volatile organics are present in the target species that community members use as a food source.

4.2 Project objectives

- Consult with the HWTR Client (the Occidental property site manager) about project details, goals, and targets for the study.
- Collect tissue from crab to assess potential exposure pathways of SVOCs and VOCs to humans through edible crab tissues.
- Communicate and provide updates to the Occidental Corporation, gain access, and maintain safety requirements while visiting the contamination site.
- Communicate with the Puyallup Tribe to gain site access.
- Locate sampling sites upstream from the Occidental property and an additional reference sampling location at Shine Tidelands State Park in Port Ludlow or another suitable location with regular tidal flushing in Washington to establish background conditions.
- Collect crab tissue (Red Rock Crab, Dungeness Crab) at 10 to 14 stations along the mouth of the Hylebos waterway.
- Attempt to deploy crab pots in locations where SVOCs and VOCs from the previous pore sediment study were detected (Anchor QEA, 2016).

- Submit tissue samples to MEL within respective holding times. MEL will coordinate with the contract Lab, ALS in Kelso, Washington.
- Provide high quality toxics data and final report to the HWTR client.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 2 shows the responsibilities of those who will be involved in this project.

Table 2. Organization of project staff and responsibilities

Staff[1]	Title	Responsibilities
Kerry Graber HWTR, SWRO Phone: (360) 522-0535	Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Meghan Rosewood-Thurman TSU, EAP Phone: (360) 819 3566	Project Manager, Principal Investigator	Writes 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.
Alex Gipe TSU, EAP Phone: (360) 584-4447	Field Assistant	Captains the sampling boat, assists with sample collections and records field information.
Jim Medlen TSU, EAP Phone: (360) 480-6175	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, reviews project scope and budget, tracks progress, provides support for field resources, reviews draft QAPP, and approves final QAPP. Reviews the draft report too?
Jessica Archer SCS, EAP Phone: (360) 890-2721	Section Manager for the Project Manager	Approves the budget and approves the final QAPP.
Michelle Underwood HWTR. SWRO Phone: (360) 280-9375	Section Manager for the Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Dean Momohara MEL, EAP Phone: (360) 871-8801	Acting Director	Reviews and approves the final QAPP.
John Weakland MEL, EAP Phone: (360) 480-7515	MEL QA Coordinator	Reviews lab data package and data validation package to verify the statement of work requirements are met.
ALS, Kelso Contract Laboratory	Project Manager	Reviews draft QAPP, coordinates with MEL QA Coordinator
Samuel Iwenofu HWTR Phone: (360) 485-5487	HWTR QA Coordinator	Reviews the draft QAPP and recommends the final QAPP for approval.
Arati Kaza Phone: 360-407-6964	Ecology QA Officer	Reviews and approves the draft QAPP and the final QAPP.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
HWTR: Hazardous Waste and Toxics Reduction Program
MEL: Manchester Environmental Laboratory
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section
SWRO: Southwest Regional Office
TSU: Toxic Studies Unit

5.2 Special training and certifications

If staff will access docks or property on Occidental's land, they have been asked to participate in a safety briefing provided by the Geosyntec consultant. The project manager must coordinate with Geosyntec and wear proper safety equipment including hardhats, steel toed boots and safety glasses.

The steps listed in SOP number 8, Crab and Clam Tissue Processing (Tierra Solutions Inc., 2014) will be used when removing tissue and hepatopancreas for sample aliquots described in section 10, Quality Control.

5.3 Organization chart

N/A

5.4 Proposed project schedule

Tables 3 – 5 lists key activities, due dates, and lead staff for this project.

Table 3. Schedule for completing field and laboratory work.

Task	Due date	Lead staff
Field work	June 2023	Meghan Rosewood-Thurman
Laboratory analyses	June/July 2023	MEL
Contract lab data validation	Aug/Sept 2023	MEL Data Validator

Table 4. Schedule for data entry

Task	Due date	Lead staff
EIM data loaded*	December 2023	Meghan Rosewood-Thurman
EIM QA	January 2024	TBD
EIM complete	February 2024	Meghan Rosewood-Thurman

*EIM Project ID: OCCCRAB23
EIM: Environmental Information Management database

Table 5. Schedule for final report

Task	Due date	Lead staff
Draft to supervisor	April 2024	Meghan Rosewood-Thurman
Draft to client/ peer reviewer	April 2024	Meghan Rosewood-Thurman
Draft to external reviewers	May 2024	Meghan Rosewood-Thurman
Final draft to publications team	June 2024	Meghan Rosewood-Thurman
Final report due on web	October 2024	Meghan Rosewood-Thurman

5.5 Budget and funding

The budget (Table 6) includes development of the QAPP, field sampling labor, equipment and materials, sample analysis, data validation, and a data report. Ecology can provide additional funds to match the grant, supplement the completion of the project, and ensure there is a contingency for cost over-runs.

The source of the funds includes new federal grant money from EPA's Performance Partnership Agreement (PPA) for Ecology's authorized Resource Conservation and Recovery Act (RCRA) program. Ecology is adding funds from the existing, unspent federal RCRA PPA grant to supplement the project.

Table 6. Project budget and funding

Expenditure category	"New" RCRA PPA grant funds	Proposed State Match
SAP/QAPP Development		
Analysis of 14 – 20 samples of one or two food fish species - Includes VOCs and SVOCs	$50,000	
Materials, field equipment use charges, supplies, field hours procuring samples, sample prep and packing, shipping costs to labs		$16,667
Ecology's in-house (or contracted) data validation*		
Ecology-produced report/publication*		
Contingency for potential cost overruns*		
Total each column	$50,000	$16,667
Total Project Budget $66,667		

*A third source of funding, not included in Table 6, is from an agreement with Occidental to pay for Ecology's work on the cleanup of the Site under Agreed Order 16943 by charging a portion of the labor hours to a cost recovery code. The HWTR site manager, budget manager, and the EAP site manager will develop separate labor costs for covering QAPP review, data validation, internal peer review, publication, and contingency that will be allocated and charged to the cost recovery to supplement the study budget.

6.0 Quality Objectives

6.1 Data quality objectives [8]

EPA describes a seven-step data quality objectives (DQO) process [EPA, 2006 (EPA QA/G-4, Publication EPA/240/B-06/001)]. Most of the steps are addressed in other sections of this QAPP (e.g., defining the problem, identifying the type of data needed, describing the analytical approach, and designing data collection efforts). But the sixth step "establishes acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data. These criteria are known as performance or acceptance criteria, or DQOs." Project specific decision errors will be limited through the data validation process, listed in section 13.0, Data Verification.

The goal of this study is to collect edible crab tissue to identify the presence of contaminants of concern (COCs) and detect if they exist within the laboratory analytical detection limits. Collecting this data will demonstrate if volatile or semi-volatile organics are present in the target species that community members use as a food source.

To meet this main data quality objective (DQO) for this project, Ecology will collect 14-20 tissue samples from crab from the Hylebos waterway adjacent to the Occidental property and to have them analyzed for SVOCs and VOCs. The analysis will use standard methods to obtain toxic concentration data that meet measurement quality objectives (MQOs) described below. This process will provide a credible dataset for future decision-making processes.

6.2 Measurement quality objectives

The MQOs for this dataset include data quality indicators such as precision, bias, sensitivity, representativeness, comparability, and completeness. Analytical method descriptions, standard operating procedures (SOPs), and participating laboratories identify target MQOs for these indicators.

6.2.1 Targets for precision, bias, and sensitivity

The MQOs for project results, expressed in terms of acceptable precision, bias, and sensitivity, are described in this section and summarized in Table 7.

[8] DQO can also refer to ***Decision*** Quality Objectives. The need to identify Decision Quality Objectives during the planning phase of a project is less common. For projects that do lead to important decisions, DQOs are often expressed as tolerable limits on the probability or chance (risk) of the collected data leading to an erroneous decision. And for projects that intend to estimate present or future conditions, DQOs are often expressed in terms of acceptable uncertainty (e.g., width of an uncertainty band or interval) associated with a point estimate at a desired level of statistical confidence.

Table 7. Measurement quality objectives for SVOCs, Method SW8270E (for lab analyses of - tissue samples) for samples processed at MEL.

Parameter	Lab Dupli-cate (RPD)	Field Duplicate (RPD)	Matrix Spike Duplicate (RPD)	Lab Control Standard (%) Recovery	Matrix Spike (%) Recovery	Method Detection Limit µg/kg ww
Bis(2-Ethylhexyl)phthalate	40	40	40	50-150	50-150	6.24
Hexachlorobenzene	40	40	40	50-150	50-150	8.84
Pentachlorophenol	40	40	40	50-150	50-150	5.08
Naphthalene	40	40	40	50-150	50-150	7.08
2-Methylnaphthalene	40	40	40	50-150	50-150	7.64
1-Methylnaphthalene	40	40	40	50-150	50-150	6.64
2-Chloronaphthalene	40	40	40	50-150	50-150	3.94
Acenaphthylene	40	40	40	50-150	50-150	12.4
Acenaphthene	40	40	40	50-150	50-150	9.10
Dibenzofuran	40	40	40	50-150	50-150	12.1
Fluorene	40	40	40	50-150	50-150	9.60
Phenanthrene	40	40	40	50-150	50-150	7.42
Anthracene	40	40	40	50-150	50-150	9.44
Carbazole	40	40	40	50-150	50-150	5.18
Fluoranthene	40	40	40	50-150	50-150	4.68
Pyrene	40	40	40	50-150	50-150	6.38
Retene	40	40	40	50-150	50-150	9.98
Benz[a]anthracene	40	40	40	50-150	50-150	5.94
Chrysene	40	40	40	50-150	50-150	7.72
Benzo(b)fluoranthene	40	40	40	50-150	50-150	6.34
Benzo(k)fluoranthene	40	40	40	50-150	50-150	8.38
Benzo(a)pyrene	40	40	40	50-150	50-150	5.62
Indeno (1,2,3-cd)pyrene	40	40	40	50-150	50-150	9.10
Dibenzo(a,h)anthracene	40	40	40	50-150	50-150	5.74
Benzo(ghi)perylene	40	40	40	50-150	50-150	6.46

RPD – relative percent difference

Table 8. Measurement quality objectives for Method SW8260D (for lab analyses of tissue samples) for samples processed at ALS Kelso.

Parameter	Lab Dupli-cate (RPD)	Field Dupli-cate (RPD)	Matrix Spike Dupli-cate (RPD)	Lab Control Standard (% Recovery)	Matrix Spike (% Recovery)	Method Detection Limit µg/kgww
1,1,1,2-Tetrachloroethane	40	40	20	71-119	78-125	0.11
1,1,1-Trichloroethane (TCA)	40	40	20	59-146	73-130	0.11
1,1,2,2-Tetrachloroethane	40	40	20	60-128	70-124	0.13
1,1,2-Trichloroethane	40	40	20	72-118	78-121	0.15
1,1-Dichloroethane	40	40	20	59-137	76-125	0.12
1,1-Dichloroethene	40	40	20	64-152	70-131	0.25
1,1-Dichloropropene	40	40	20	52-142	76-125	0.13
1,2,3-Trichlorobenzene	40	40	20	52-138	66-130	0.19
1,2,3-Trichloropropane	40	40	20	53-134	73-125	0.45
1,2,4-Trichlorobenzene	40	40	20	57-136	67-129	0.13
1,2,4-Trimethylbenzene	40	40	20	65-132	75-123	0.054
1,2-Dibromo-3-chloropropane	40	40	20	55-127	61-132	0.4
1,2-Dibromoethane (EDB)	40	40	20	71-116	78-122	0.094
1,2-Dichlorobenzene	40	40	20	67-124	78-121	0.077
1,2-Dichloroethane (EDC)	40	40	20	65-121	73-128	0.07
1,2-Dichloropropane	40	40	20	71-121	76-123	0.13
1,3,5-Trimethylbenzene	40	40	20	66-132	73-124	0.092
1,3-Dichlorobenzene	40	40	20	69-128	77-121	0.094
1,3-Dichloropropane	40	40	20	72-118	77-121	0.12
1,4-Dichlorobenzene	40	40	20	69-125	77-126	0.086
2,2-Dichloropropane	40	40	20	50-138	67-133	0.098
2-Butanone (MEK)	40	40	20	54-116	51-148	0.9
2-Chlorotoluene	40	40	20	65-129	75-122	0.12
2-Hexanone	40	40	20	67-121	53-145	0.93
4-Chlorotoluene	40	40	20	51-134	72-124	0.088
4-Isopropyltoluene	40	40	20	61-132	73-127	0.064
4-Methyl-2-pentanone (MIBK)	40	40	20	69-126	65-135	1.8
Acetone	40	40	20	32-135	36-164	2.9
Benzene	40	40	20	68-122	77-121	0.054
Bromobenzene	40	40	20	71-124	78-121	0.088
Bromochloromethane	40	40	20	65-131	78-125	0.24
Bromodichloromethane	40	40	20	61-143	75-127	0.16
Bromoform	40	40	20	62-134	67-132	0.14
Bromomethane	40	40	20	22-180	53-143	0.2
Carbon Disulfide	40	40	20	55-141	63-132	0.092
Carbon Tetrachloride	40	40	20	51-135	70-135	0.094
Chlorobenzene	40	40	20	70-116	79-120	0.065
Chloroethane	40	40	20	51-122	59-139	0.74

Parameter	Lab Duplicate (RPD)	Field Duplicate (RPD)	Matrix Spike Duplicate (RPD)	Lab Control Standard (% Recovery)	Matrix Spike (% Recovery)	Method Detection Limit µg/kgww
Chloroform	40	40	20	61-137	78-123	0.11
Chloromethane	40	40	20	37-146	50-136	0.18
cis-1,2-Dichloroethene	40	40	20	62-138	77-123	0.12
cis-1,3-Dichloropropene	40	40	20	58-138	74-126	0.13
Dibromochloromethane	40	40	20	69-120	74-126	0.18
Dibromomethane	40	40	20	68-125	78-125	0.28
Dichlorodifluoromethane	40	40	20	38-160	29-149	0.12
Ethylbenzene	40	40	20	70-118	76-122	0.094
Hexachlorobutadiene	40	40	20	54-140	61-135	0.4
Isopropylbenzene	40	40	20	67-133	68-134	0.081
m,p-Xylenes	40	40	20	69-127	77-124	0.1
Methylene Chloride	40	40	20	65-122	70-128	0.16
Naphthalene	40	40	20	54-134	62-129	0.13
n-Butylbenzene	40	40	20	53-139	70-128	0.069
n-Propylbenzene	40	40	20	57-143	73-125	0.13
o-Xylene	40	40	20	69-124	77-123	0.081
sec-Butylbenzene	40	40	20	55-146	73-126	0.074
Styrene	40	40	20	62-135	76-124	0.14
tert-Butylbenzene	40	40	20	67-131	73-125	0.14
Tetrachloroethene (PCE)	40	40	20	66-126	73-128	0.16
Toluene	40	40	20	75-117	77-121	0.15
trans-1,2-Dichloroethene	40	40	20	63-127	74-125	0.12
trans-1,3-Dichloropropene	40	40	20	63-121	71-130	0.11
Trichloroethene (TCE)	40	40	20	67-126	77-123	0.15
Trichlorofluoromethane	40	40	20	51-140	62-140	0.085
Vinyl Chloride	40	40	20	54-127	56-135	0.18

RPD – relative percent difference

6.2.1.1 Precision

A total of 14-20 samples will be collected from Hylebos Waterway on or near the Occidental property, above the contaminated groundwater plumes. Each collected crab will provide two tissue samples, one for muscle and one for the hepatopancreas. Multiple crabs caught inside the same pot may be placed in the same sample jar if one crab does not yield adequate tissue to run the sample. It is predicted that Red Rock Crab will be collected. If Dungeness and Red Rock are caught in the same pot, the species will be processed separately.

6.2.1.2 Bias

Care will be taken to reduce bias by decontaminating equipment prior to use, limiting exposure to products that produce or contain VOCs and SVOCs, using stainless steel whenever possible, wrapping live crab in aluminum foil, running additional tissue samples of bait (organic chicken,

fish heads), processing samples in a controlled environment that is absent from engines and motors, using clean surfaces, immediately transferring tissues to glass vials, and keeping the samples chilled.

6.2.1.3 Sensitivity

The contract lab, ALS Kelso, will homogenize tissues in-house prior to sampling for VOCs; however, the volatile nature of the analytes will allow for some escapement. The process of homogenizing the sample may drive off some VOCs.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

There are few studies that have looked at VOCs in tissues and apart from the priority VOCs, several other VOCs turned up unexpectedly in these samples (Roose and Brinkman 1998a). The escapement has been compared to the typical method of cooking and eating as stated in the Memo, from the America's Fish Study (Appendix A). This study will follow EPA method 8260C purge and trap (Method 5032) for aqueous, solid, oil with Gas Chromatography/Mass Spectrometry (VD/GC/MS) to provide a complete a credible data package for decision making purposes.

For SVOCs in tissues, MEL will use prep method 3541 Automated Soxhlet Extraction and EPA method 8270E, Gas Chromatography/Mass Spectrometry (VD/GC/MS), to determine the concentration of semi volatile organic compounds in extracts prepared from tissue. All data packages will be verified for usability and credibility by a MEL data validator, described in section 13.0 Data Validation.

6.2.2.2 Representativeness

The sampling will follow current fishing and shellfishing regulations[9], available on WDFW's website. The area of interest is in Marine Area 11, Tacoma, and Vashon Island. The current guidance states that this marine area will open to crabbing in summer 2023.

Crab gear will have a "rot" cord to allow animals to escape if the gear goes missing. All gear will follow WDFW's regulations for mesh size, escape rings, and safety equipment. Crab pots will be secured to pilings upstream in front of, and downstream of, the Occidental property. Lead lines, marked buoys, and weighted cages will be used.

A go-pro camera will be secured to several deployments to observe visiting species that are drawn to the bait. Bait will be secured in metal cages, limiting exposure to plastic, rubber, or nylon coatings. Choice of bait will depend on availability, but fish heads or organic chicken parts will be used. Tissue from bait will also be processed for SVOCs and VOCs prior to crab sampling and processing.

Before sampling, staff will examine tide tables to determine mild periods that will draw crab to the baited pots. Pots may be deployed overnight, or for several hours, depending on the success of the gear and bait.

[9] https://wdfw.wa.gov/fishing/shellfishing-regulations/crab/seasons-areas/tacoma-vashon-island#season

Staff will select crabs that are of legal size and sex. Dungeness crab (*Cancer magister*, males only, 6 ¼") and Red Rock Crab (*Cancer productus*, male or female, 5") are the target species. All soft-shell crabs will be released.

6.2.2.3 Completeness

Ten to 14 locations will be selected for deploying crab pots. Achieving 95% of this goal will be acceptable for success with the study. However, there is potential for no species to be caught with baited and deployed pots. Having no aquatic visitors will also be valuable data, as contaminants, stormwater runoff, and vessel noise may contribute to aquatic animals avoiding the mouth of Hylebos Waterway.

6.3 Acceptance criteria for quality of existing data

The 2005 fish study memo (see Appendix A) indicated that crab species were impacted by contaminants from the Occidental site. This study has not been duplicated, and the data and results were never finalized and released by EPA. Fish studies since then have focused only on PCB and dioxin/furans and on one species, flatfish. (Flatfish are not targeted by Tacoma residents as a food species.) The latest project was a collaboration by EPA, WDFW, and Anchor QEA; results of this study have not yet been released to the public.

This 2023 study will repeat tissue collections for VOC and SVOCs using methods from similar tissue studies conducted in the Duwamish Waterway, WA and Newark Bay, NJ following the methods outlined in their QAPPs (Windward, 2017; Tierra Solutions Inc., 2014).

7.0 Study Design

7.1 Study boundaries

The specific area of focus for this study is Hylebos Waterway, between 709 Alexander Ave. and 605 Alexander Ave. Additional sites have been added upstream (Hylebos Waterway US; Figure 3), downstream (Commencement Bay DS), and one site located across the channel on Puyallup Tribal Land (3702 Marine View Drive). The Puyallup Tribe also owns the Chinook Marina at 4026 Marine View Drive at the upstream location. The sites are within Water Resource Inventory Area (WRIA) 10, and GPS coordinates have been identified for deploying crap pots (Figure 3; Table 9).

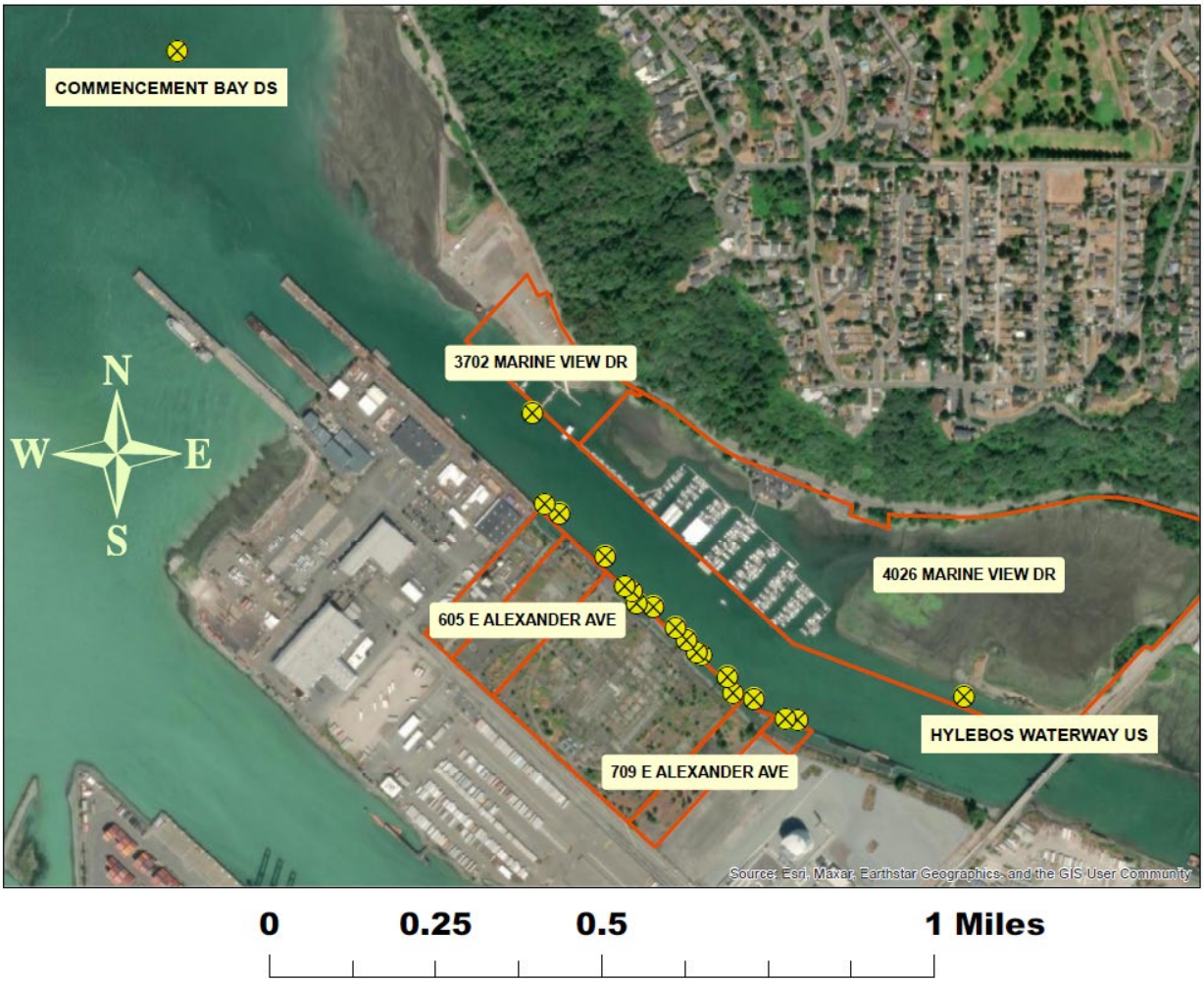


Figure 3. Map showing boundary of project study area.

7.2 Field data collection

The proposed sampling locations are listed in Table 9. The target sample collection is 14-20 samples; therefore, 10 sites in Table 9 will be selected to deploy crab pots.

Table 9. Potential sampling locations for the 2023 Occidental tissue study, with site ID, a description of where the pot will be deployed, and the coordinates.

Site Number	Description	Latitude (Decimal Degrees)	Longitude (Decimal Degrees)
01	LB 721 Dolphin	47.27834	-122.40002
02	LB 721 Dock	47.27836	-122.40029
03	LB 709 Dolphin	47.27866	-122.40097
04	LB US 605	47.27874	-122.40143
05	LB 605 US Walkway	47.27898	-122.40155
06	LB 605 US Dock 2	47.2793	-122.40211
07	LB 605 Dolphin at Dock 2	47.27934	-122.40221
08	LB 605 Dock 2 US	47.27953	-122.40244
09	LB 605 Dock 2 DS	47.27971	-122.40268
10	LB 605 Floating Dock	47.28002	-122.40316
11	LB 605 Dolphin between Dock 1 and 2	47.28007	-122.40353
12	LB 605 Between Dock 1 &2	47.28024	-122.40362
13	LB 605 Corner of Dock 1	47.28032	-122.40378
14	LB 605 Trident Boom Mid Dock 1	47.28076	-122.40421
15	LB 605 In Front GW Treatment	47.28139	-122.40521
16	LB 605 DS Corner of Trident	47.28153	-122.40553
17	OW Commencement Bay DS	47.2882	-122.41351
18	RB Puyallup Tribe Dock	47.28288	-122.40579
19	RB Hylebos Waterway US	47.2787	-122.39641

*LB= left bank, RB= right bank, OW= open water, DS= downstream, US= upstream

7.2.1 Sampling locations and frequency

Sampling will occur in June 2023 and continue until the target number of samples has been reached. The target population is crab that migrate through the Hylebos Waterway and are potentially exposed to contaminants in the sediments. Occidental has a unique contaminant signature; samples will be collected and analyzed to detect if this signature exists in edible tissue.

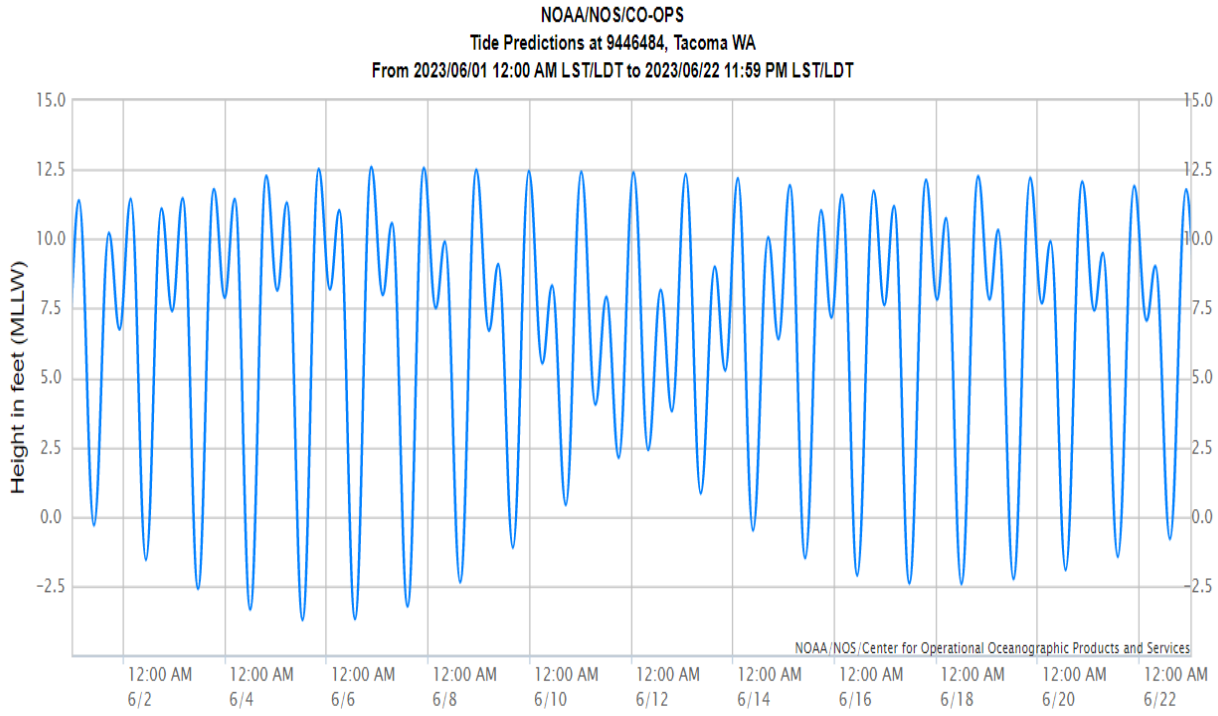
Because the analyte list is broad, it is possible that other chemical signatures from other properties may be detected. This data will be useful in future sampling studies along the Hylebos Waterway.

The sampling locations will be chosen based on ease of access, even spacing, and suitability for sampling the target species. Collecting 14-20 discrete samples of tissue from crab muscle and hepatopancreas tissue will verify the presence or absence of VOCs or SVOCs in edible tissues. A

"reference" or background site will be sampled to show differences in crab tissues that live outside Commencement Bay. A site near Port Ludlow at Shine Tidelands State Park has been chosen; however, if site access, weather, or other delays make it difficult to sample, another location with regular tidal flushing will be chosen.

Sampling must meet a minimum quantity of tissue for the selected laboratories to detect analytes. Crab muscle and hepatopancreas tissue will be composited in separate jars for each sampling site to obtain 25 grams of each tissue type.

Crab pots will be deployed prior to a strong outgoing tide. They will be left overnight and collected after a mild tidal cycle. An example of a preferred deployment time is presented in Figure 4. This table was generated from NOAA's Tide predictions website[10].



Note: The interval is High/Low, the solid blue line depicts a curve fit between the high and low values and approximates the segments between.
Disclaimer: These data are based upon the latest information available as of the date of your request, and may differ from the published tide tables.

Figure 4. Tide predications for the 2023 June sampling survey

Collecting 14-20 discrete samples of tissue from crab muscle and hepatopancreas tissue will inform Ecology and the EPA if the CA 725 human health milestone for the RCRA Corrective Action Performance Track have been achieved. If MEL and ALS Kelso detect analytes, Ecology will notify the Puyallup Tribe, TPCHD, WDFW, and the Washington Department of Health's fish advisory for Commencement Bay.

10 https://tidesandcurrents.noaa.gov/noaatidepredictions.html?id=9446484&units=standard&bdate=20230601&edate=20230622&timezone=LST/LDT&clock=12hour&datum=MLLW&interval=hilo&action=dailychart

7.2.2 Field parameters and laboratory analytes to be measured

See Tables 7 and 8 for a complete list of SVOCS and VOCs of interest.

7.3 Modeling and analysis design

N/A

7.4 Assumptions underlying design

The assumptions of this study indicate a potential for community members that rely on subsistence fishing of edible species, such as crab tissue and "Crab Butter" (the hepatopancreas) can be exposed to VOCs and SVOCs from the Hylebos Waterway that are a result of contamination from the Occidental property.

By catching crab in the Hylebos Waterway, we are assuming that these species frequent this area; therefore, discovering a unique chemical signature that ties back to the Occidental contamination will confirm the pathway. Ecology can then address plans to prevent human exposure in the future.

Crab move in and out of channels, based on food availability, predators, tidal cycles, and other life history traits. By setting pots baited with a food source, it is possible that we will collect crab that have been exposed to many other sources of contamination in Commencement Bay. The goal is to capture any contaminants and share the results with EPA and other collaborators.

7.5 Possible challenges and contingencies

Since the Hylebos Waterway includes several waterway problem areas and adjoining uplands as described by EPA's Superfund Commencement Bay/Nearshore Tideflats (CB/NT) site Record of Decision (EPA, 1989), the 12-square-mile area of the CB/NT includes areas where impacted sediments were dredged and disposed of in 2003-2005 (CRA, 2015) or excavated and capped in 2007-2008 (Hart Crowser, 2013). The habitat in the Hylebos Waterway may not be suitable for crab species to thrive; therefore, Ecology may not meet the required number of samples for the project.

For a contingency plan, EAP staff have coordinated with WDFW's TBiOS program to install mussel cages along the Hylebos Waterway, deploying in November 2023 and retrieving in January/February 2024.

7.5.1 Logistical problems

The Hylebos Waterway has frequent vessel traffic; therefore, Ecology will notify the Port of Tacoma prior to study deployment and retrieval. Additionally, sampling staff will need to notify the Puyallup Tribe if they are setting pots off Tribal docks and pilings. Prior to deployment of crab pots on Occidental's property, Geosyntec Consultants will provide required safety briefings to Ecology staff.

If weather or tide issues prevent sampling, EAP's project manager will select additional dates to collect tissue samples.

The following will all be crucial to the success of this 2023 study: Deploying in adequate tide conditions, attaching gear to pilings, and following WDFW's guidelines for crab pots. Also, safety is always the main priority for Ecology field staff; sample collections will be secondary to the health and safety of staff.

7.5.2 Practical constraints

Staff have funding available until September 2023. Contract laboratories will need to have a data package available before this deadline. If obtaining crab tissue samples is difficult, EAP's project manager will need to coordinate additional mussel collection and consult with the HWTR client about budgetary constraints.

7.5.3 Schedule limitations

EAP's project manager has coordinated with the following to ensure a positive outcome: EAP management, MEL lab staff, other experts in the area, local authorities, and Tribal staff. If fish or shellfish tissue is unavailable, the project manager will adjust the schedule to accommodate additional sampling to meet the target goals.

8.0 Field Procedures

8.1 Invasive species evaluation

Field staff will refer to SOP EAP070 (Parsons, 2023) before sampling and upon returning from the field to decontaminate, identify, and eliminate potential sources and pathways of invasive species transportation.

8.2 Measurement and sampling procedures

Ecology staff will follow field procedures for crab sampling in order to provide sufficient tissue mass for chemical analyses. Tissue mass requirements for each tissue type are listed in Table 10. The biological collections will occur in June 2023 (See section 7.2.1).

EAP's project manager has identified collection periods that coincide with the summer 2023 open crab season. The focus is to capture crab of legal carapace lengths from Commencement Bay and the mouth of the Hylebos Waterway. The sampling will focus on suitable locations to deploy crab pots, keeping in mind the safety of the crew, avoiding boat traffic lanes, and attaching pots to existing pilings, dolphins (a stack of pilings angled together), or docks to minimize the risks of losing gear. The crew will bait compliant pots with organic chicken parts onboard and cast overboard.

The minimum mesh size for crab pots is 1½", with two 4¼" minimum inside diameter escape rings in the upper half of the pot and are less than 13 cubic feet. All parts of ring nets and star traps will lie flat on the sea bottom and will not restrict free movement of crab until lifted. Pots will be covered by water at all times during deployments. Lead lines and marked buoys that are half red and half white in color will be attached to gear and be visible when fishing.

The field crew will deploy one crab trap per station for a duration of 24 hours. If additional crabs are needed to meet tissue requirements, an additional 24-hour deployment will occur. If no crabs

are collected at a site, an additional site will be selected and sampled. If crews do not successfully collect the target tissue types, corrective action will be used (see section 10.2). Crab traps will be decontaminated between locations with an ambient water rinse and, if necessary, brushing with ambient water.

Only male Dungeness crab with a minimum carapace length of 6.25" will be kept for analyses. Red Rock crab can be either male or female with a minimum carapace length of 5". Any soft-shell crabs will be released. Crew will haul up pots and select the largest individuals for analyses to ensure adequate tissue for lab processing. Crab will be wrapped in decontaminated aluminum foil, secured with tape, and placed on dry ice. Each crab will be labeled with the species type, location number, date, time of collection. Each crab will be brought back to an Ecology's sample processing lab for dissection within 24 hours of collection. See section 9.2 for sample preparation methods.

8.3 Containers, preservation methods, holding times

Table 10 presents additional sampling details.

Table 10. Sample containers, preservation, and holding times.

Parameter	Matrix	Minimum Quantity Required	Container	Preservative	Holding Time (prior to tissue removal)
VOCs	Tissue	25 g/sample	Small glass vial	None	Cool to 4 ± 2°C for no more than 48 hours on dry ice
SVOCs	Tissue	25 g/sample	Small glass vial	None	Cool to 4 ± 2°C for no more than 48 hours on dry ice

8.4 Equipment decontamination

Ecology staff will decontaminate tools and equipment that encounter the crab shell, tissue, and hepatopancreas based on the polarity of the analytes. VOCs are non-polar; methanol is the recommended solvent for decontamination. SVOCs can be both polar and non-polar; therefore. acetone is used for decontamination. More information can be found in the steps outlined in SOP EAP090 (Friese, 2020).

8.5 Sample ID

When sampling sites are confirmed, each location will receive a unique sample identifier that will associate to data collected at that specific location. The sample ID will be transferred to all labels and containers with this unique name/number. The sample number consists of a work order number from MEL followed by a numerical sequence (e.g., 2306025-01, -02, -03).

8.6 Chain of custody

As a standard practice, EAP staff will maintain a continuous chain of custody for all environmental samples collected, processed, and shipped to MEL and contract labs. At the request of the HWTR client, the EAP project manager will add a seal and ID number to track secure samples.

8.7 Field log requirements

Staff will use bound field logs that have waterproof, prenumbered pages, and will write with permanent, waterproof ink for all entries. Corrections will be made by striking a single line through, initial and dating the change. Staff will be reminded to not use correction fluid. The requirements for each sampling location include:

- Name and location of project
- Field personnel
- Sequence of events
- Any changes or deviations from the QAPP
- Environmental conditions
- Date, time, location, ID, and description of each sample
- Field measurement results
  - Inspect, notate, and photograph any anomalies.
  - Capture location (GPS coordinates) and take representative photographs.
  - Record water depths and times of deployment and retrieval.
  - Records species type, sex, length of carapace.
- Identification of quality control (QC) samples collected.
- Unusual circumstances that might affect interpretation of results.

8.8 Other activities

EAP field staff will follow laboratory guidelines for sample preparation, holding procedures, and Chain of Custody.

MEL is expecting the samples during the proposed sampling window. EAP will inform MEL and management staff (Page 1) of any changes to the plan.

9.0 Laboratory Procedures

9.1 Lab procedures table

Tables 11 and 12 present the measurement methods and requirements for sample collection and delivery for the Hylebos Waterway tissue study.

Table 11. Laboratory measurement methods.

Analyte	Sample Matrix	Expected Range of Results	Detection or Reporting Limit	Sample Prep Method	Analytical (Instrumental) Method
VOCs	Muscle Tissue	Varies	5.0-20 ug/Kg ww	5035A	EPA 8260C
VOCs	Hepatopancreas Tissue	Varies	5.0-20 ug/Kg ww	5035A	EPA 8260C
SVOCs	Muscle Tissue	Varies	25-100 ug/Kg ww	3541	SW8270E
SVOCs	Hepatopancreas Tissue	Varies	25-100 ug/Kg ww	3541	SW8270E

Table 12. Required containers, preservation techniques, and holding times.

Analyte	Sample Matrix	Container Type	Preservation	Maximum Holding Time (Lab)
VOCs	Muscle Tissue	Glass Vial	Cool to 4 ± 2℃ for no more than 48 hours then frozen to ≤-7℃ upon lab receipt.	14 Days
VOCs	Hepatopancreas Tissue	Glass Vial	Cool to 4 ± 2℃ for no more than 48 hours then frozen to ≤-7℃ upon lab receipt.	14 Days
SVOCs	Muscle Tissue	Glass Vial	Cool, ≤6°C	14 Days
SVOCs	Hepatopancreas Tissue	Glass Vial	Cool, ≤6°C	14 Days

9.2 Sample preparation methods

Once crabs are brought onboard, staff will immediately determine sex and release female Dungeness and any soft-shelled crab. Those that do not meet legal size requirements will also be released to the waterway. Crab will be minimally handled and wrapped inside aluminum foil (dull side), placed on dry ice, and brought back to Ecology's sample processing lab.

The steps listed in SOP number 8, Crab and Clam Tissue Processing (Tierra Solutions Inc., 2014) will be used when removing tissue and hepatopancreas for sample aliquots. Staff will work on sterile surfaces, first weighing, then euthanizing, the crab, and will use sharp tools to remove the carapace. Care will be taken to not introduce water droplets into the hepatopancreas tissue. Staff will scoop the tissue into a sterilized glass vial and put it on ice. For the muscle tissues, staff will work quickly to remove adequate tissue for each lab and process specifically for the target analyte. For VOCs, whole pieces of tissue will be placed into glass vials,

eliminating headspace as much as possible to prevent VOC escapement. Samples will be placed on ice and shipped (or driven) overnight to ALS Kelo. ALS lab staff will blend and homogenize the tissues prior to extraction. For the SVOCs, staff will quickly remove tissues as described above, homogenize the muscle tissue, and ship the samples to MEL overnight.

9.3 Special method requirements

The minimal holding time may be difficult to work around; therefore, a contingency plan would include the project manager driving the samples directly to MEL and ALS Kelso within 24 hours of tissue removal.

9.4 Laboratories accredited for methods

MEL in Port Orchard will process SVOCs in house. MEL has identified ALS in Kelso to contract out VOCs. Both labs have been accredited for the sampling methods listed in Table 11.

10.0 Quality Control Procedures

EAP's project manager has consulted with regional experts from the Puyallup Tribe, WDFW, the state Department of Health, and Ecology to identify any data gaps and assumptions. The project manager will recruit other staff to help dissect crab. It will be important to limit time between sample collection, processing, and lab analysis.

10.1 Table of field and laboratory quality control

Quality control (QC) samples that will be analyzed with each parameter suite are presented in Table 13.

Table 13. Quality control samples, types, and frequency.

Parameter	Field Blanks	Field Replicates	Laboratory Control Sample	Laboratory Method Blanks	Analytical Duplicates	Laboratory Matrix Spikes	Matrix Spike Duplicates
VOCs	N/A	1*	1/Batch	1/Batch	1/Batch	1/batch	1/Batch
SVOCs	N/A	1*	1/Batch	1/Batch	1/Batch	1/Batch	1/Batch

*If excess tissue is available

10.2 Corrective action processes

If crabbing efforts are not successful, the project manager will work with the TBiOS program at WDFW[11] to deploy mussel cages during the 2023/2024 winter. This QAPP will then be addended to include:

- Collection methods for caged mussels.
- Reanalyzing lab samples that do not meet QC criteria; analytical methods often state what to do when QC criteria are not met.

[11] https://wdfw.wa.gov/species-habitats/science/marine-toxics/tbios#staff

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

All field data and observations will be recorded on waterproof paper kept in field notebooks. After they return from the field, staff will transfer information contained in field notebooks to Excel spreadsheets. Data entries will be independently verified for accuracy by another member of the project team.

Field measurements (crab species type, carapace lengths, weights) and laboratory data for this project will be entered into Ecology's EIM database. Laboratory data will be uploaded into EIM, using the EIM XML results template. The EIM Study ID for this project is "OCCCRAB23" (Hylebos Waterway Crab Tissue, 2023).

11.2 Laboratory data package requirements

The contract lab, ALS Kelso, will be required to submit a Level 4 data package to MEL. After reviewing data packages from the contract lab, MEL will provide case narratives to EAP's project manager with the final qualified results and a description of the quality of the contract lab data. MEL will also provide case narratives for analyses performed in-house. Case narratives should include any problems encountered with the analyses, corrective actions taken, changes to the referenced method, and an explanation of data qualifiers. Narratives will also address the condition of samples on receipt, sample preparation, methods of analysis, instrument calibration, and results of QC tests.

The following data qualifiers will be used:

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

The qualifiers will be used in accordance with the method reporting limits such that:

- For non-detect values, the estimated detection limit (EDL) or method reporting limit (MRL) is recorded in the "Result Reported Value" column, and a "UJ" is recorded in the "Result Data Qualifier" column.
- Detected values that are below the quantitation limits are reported and qualified as estimates ("J").

11.3 Electronic transfer requirements

The contract lab will be required to submit data packages to MEL electronically, as specified in the scope of work for the analysis. Typically, the scope of work will specify an electronic file sharing location for the data package to be stored.

MEL will deliver case narratives to the project manager in PDF format, and electronic data deliverables of contract lab data will be emailed to the project manager via an Excel spreadsheet

format. Data generated by MEL (analyses done in-house) will be delivered to the project manager via MEL's LIMS database.

11.4 EIM data upload procedures

All lab data will be uploaded to Ecology's EIM database following Environmental Assessment Program (EAP) protocols and business rules. Following internal EAP protocols, an independent reviewer will conduct a QC review of this data upload.

Ecology staff will follow all guidelines for entering data in Ecology's EIM Data Entry Review Procedure (Ecology 2022), and complete the EIM Data Entry Review Checklist.

11.5 Model information management

N/A

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

There is no defined audit for the field work in this project.

Ecology's Environmental Laboratory Accreditation Program (LAU) evaluates a lab's quality system, staff, facilities and equipment, test methods, records, and reports. LAU also establishes that the lab can provide accurate, defensible data. All assessments, including MEL's internal performance and audits, are available from Ecology upon request.

12.2 Responsible personnel

No audits will be conducted during this project.

12.3 Frequency and distribution of reports

A technical memo/final report will be completed after receipt of sample results. See Table 5 for the final report schedule. The final summary report will include, at a minimum, the following:

- An introduction and background of the project.
- A map showing sampling locations.
- A description of field and laboratory methods.
- A discussion of data quality.
- Summary tables of contaminant concentrations.
- A discussion of the results.
- Conclusions and recommendations based on the sampling results.

At the end of the project, the project manager will summarize the results in a technical memo for Ecology's HWTR.

12.4 Responsibility for reports

EAP's project manager will be responsible for the final report.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

Field data will be verified at the time of collection by assistant field staff. Data will be compared to lab data to ensure that there is no evidence of contamination from staff, the bait used, or any other contaminants that may encounter the tissues.

13.2 Laboratory data verification

MEL staff will verify lab data before entering results into their LIMS database. Verification will include examining the data for errors, omissions, and compliance with QC acceptance criteria and the method. MEL will include a case narrative that discusses 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. MEL's case narrative will also define qualifiers and the reason for their use. Lab staff may be consulted to review QC data that are normally retained by MEL.

Lab background contamination will be evaluated by MEL and the data validator. For example, common lab contaminants (e.g., acetone) will have a 10x censor and a 5x for others. False positives from the lab or environment are almost always present for phthalates (Method 8270) and VOCs (Method 8260) acetone, methylene, chloride, and 2-butanone.

The project manager is responsible for 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

13.3 Validation requirements, if necessary

MEL will be responsible for validation of the contract laboratory data. The contract lab data will undergo an EPA Stage 4 data validation as defined in EPA (2009). If MEL is unable to perform the data validation with current staff, a contract vendor with the appropriate qualification will be selected to complete it. MEL or the contract vendor will provide (1) a case narrative summarizing the findings of the data validation, and (2) an electronic data deliverable (EDD) with the final results and final result qualifiers, as provided by the data validator.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining if project objectives were met

Following data verification and validation, the project manager will determine if the data are of sufficient quality to meet project goals and objectives. The project manager will review case narratives and results of QC tests to determine whether laboratory analyses met MQOs. Laboratory and quality assurance (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, procedures in the analytical methods, EPA National Functional Guidelines, and best professional judgment will be used in the final determination of whether to accept, reject, or accept the results with qualification.

The project manager and MEL will determine if the water chemistry data are useable by assessing whether the data have met the MQOs outlined in Tables 7 and 8. Based on this assessment, the data will either be accepted, accepted with appropriate qualifications, or rejected and re-analysis considered.

14.2 Treatment of non-detects

Not applicable, see section 6.2.2.2.

14.3 Data analysis and presentation methods

Not applicable.

14.4 Sampling design evaluation

Sampling designs for evaluations of tissue collection methods will be based on the needs of the project, species of interest, and waterbody. See section 7.2 for more details.

14.5 Documentation of assessment

Not applicable.

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16.0 Appendices

Appendix A: America's Fish Study

MEMORANDUM

September 12, 2005

To: Occidental Corrective Action Project Files

Cc: K Seiler, Ecology, Stan Leja, Ecology, Marcia Bailey, EPA Region 10, Jonathan Williams, EPA Region 10

From: Leon Wilhelm, Ecology Project Manager for Occidental Site

Subject: Sampling and Analysis of Fish Caught in Mouth of Hylebos Waterway

The following memo summarizes the procedures and results of a focused investigation to determine concentrations of volatile organic constituents of concern in fish and shellfish likely to be consumed by humans in the mouth of the Hylebos Waterway. It has been prepared based primarily on email correspondence with Marcia Bailey, EPA Region 10 Office of Environmental Assessment (OEA) toxicologist, who coordinated the overall investigation, and, to a limited extent, with Stan Leja, who coordinated with the Washington Department of Fish and Wildlife (DFW) staff on the capture and preservation of the specimens caught. The reason for this investigation was to evaluate the current Human Exposure RCRA Environmental Indicator (EI) at the Pioneer Americas (former Occidental) site.

Objectives

The exposure pathway of concern is human consumption of fish and shellfish contaminated with volatile organic compounds (VOCs) resulting from historic releases from the former Occidental) site. Accordingly, the objective of this focused investigation was to determine whether or not concentrations of VOCs of significant concern are present in fish and shellfish in the Hylebos Waterway, and, if they are, whether the concentrations in these fish and shellfish exceed levels that pose an unacceptable risk to the humans who potentially may consume them.

Assumptions and Limitations

The investigation was not an attempt to evaluate all of the potential constituents of concern at the site but focused on the most significant constituents of concern (COCs) previously identified. These consisted of vinyl chloride, trichloroethene (TCE), tetrachloroethene (PCE) and hexachlorobutadiene. Acceptable concentrations of these COCs in fish and shellfish were calculated based on an acceptable cancer risk level to humans from each of these carcinogens of 10 -6. The following assumptions based on default values in equation 730-2 in the Model Toxics Control Act (MTCA) regulations were used in these calculations:

Body weight = 70 kilograms (154 pounds)

Exposure frequency = 365 days per year (daily)

Exposure duration = 30 years

Although there is some data from other sites indicating that tribal, Asian and Pacific Islander fish consumption rates exceed the MTCA default value of 27 grams per day (54 grams/day x 0.5 diet fraction), this value was used in the absence of any available site-specific data in the Hylebos Waterway for this parameter. This was considered reasonable considering the conservative nature of the remaining default values used in the calculations. The resulting

concentrations in fish and shellfish for each of the VOCs analyzed for a cancer risk level of 10-6 are shown in the following table.

Tetrachloroethene ug/kg wet weight	Trichloroethene ug/kg wet weight	Vinyl Chloride ug/kg wet weight	Hexachlorobutadiene ug/kg wet weight
12	16	4	83

Collection of Fish and Shellfish from Hylebos Waterway

Dr. Sandie O'Neill of DFW agreed to obtain fish from the Hylebos Waterway adjacent to the former Occidental site at the conclusion of DFW's collection of fish from the Thea Foss Waterway. On May 6, 2005 the following fish and shellfish were caught by DFW staff from the bottom of the Hylebos Waterway adjacent to the former Occidental site using a trawler; 5 sole, 5 starry flounder, 2 white spotted greenling, 3 rock sole, 2 red rock crab, 1 sand sole and 5 Dungeness crab. The trawl was conducted using a 10 meter wide 400-mesh net and started just north (plant north) of the U.S. Navy property south of the Pioneer (former Occidental) site and ended north of Dock 1.

The fish and shellfish specimens were removed from the net, wrapped in foil and placed individually into Ziploc bags which were then placed in coolers and transported to Olympia where they remained overnight in a DFW freezer in Olympia. The next morning the fish and shellfish specimens were transported in a frozen condition to EPA's Manchester Laboratory where they remained frozen at -20 degrees C until they could be prepared for subsequent analysis.

Preparation of Fish and Shellfish for Analysis

It was determined that the fish and shellfish would be analyzed by Mike Hiatt, Research Chemist at the EPA National Exposure Research Laboratory (NERL) in Las Vegas Nevada. However NERL was not equipped to conduct the processing of the whole specimens caught for subsequent analysis. Therefore, the fish and shellfish were partially thawed, prepared for sampling at EPA's Manchester Laboratory, then refrozen and shipped in a frozen state to the Las Vegas laboratory. The fish were prepared based on procedures described in Quality Assurance Project Plan (QAPP) for Sampling and Analysis of Fish Harvested in the Hylebos Waterway, dated July 13, 2005, a copy of which is located in Ecology's files for Occidental Corrective Action. The QAPP was developed by Marcia Bailey based in part on the recommendations of Mike Hiatt. Fish preparation for subsequent sampling was overseen by Dave Terpening, Aquatic Biologist with EPA Region10's OEA. At least one "skin-on" fillet and liver were obtained from each fish specimen as individual samples. The hepatopancreas and "leg and claw" were obtained as individual samples from each crab. A detailed description of the procedures used, including measures taken to minimize the loss of VOCs, is described in the QAPP.

Analysis of Fish and Shellfish

The prepared and frozen fish and shellfish samples were received at the NERL laboratory in good condition on July 27, 2005 where they were subsequently analyzed by Mike Hiatt. The analytical method used to determine the concentrations of the target VOCs in the fish and crab samples was SW-846 Method 8261, Volatile Organic Compounds by Vacuum Distillation in Combination with Gas Chromatography/Mass Spectrometry (VD/GC/MS), a copy of which is in the project files. This method was developed primarily by Mike Hiatt.

Prior to conducting the analysis, the samples were further reduced in size to about 5 grams to sample from inside the prepared specimen where the VOCs would be least disturbed. The attached spreadsheet shows the analytical results. A detailed discussion of some of the laboratory issues pertaining to the analysis is contained in project files.

Results and Conclusions

Results from one sample, 79.8 ug/kg of PCE in a crab hepatopancreas, exceeded the corresponding 10-6 risk based concentration, 12 ug/kg, for this constituent. Results from the duplicate sample showed a similar value of 68.9 ug/kg. However, no other samples exceeded the 10-6 concentrations shown in the above table although there were consistent detections of PCE, TCE, and hexachlorobutadiene in many of the samples analyzed. The next highest concentration determined was 10.7 ug/kg also in a crab hepatopancreas. PCE concentrations of 6.42 and 4.18, below the 10-6 concentration of 12 ug/kg, were determined from white spotted greenling and flounder respectively.

Since only the results from the crab hepatopancreas exceeded the 10-6 risk based concentrations shown in the above table, plus the fact that it is also considered highly unlikely that total fish and shellfish consumption would consist solely of crab hepatopancreas. Also, losses of some VOCs, especially vinyl chloride, occurred to some extent during preparation and subsequently analysis of the fish and shellfish specimens. However, these losses, especially vinyl chloride, will likely occur to a much greater extent when these fish are prepared for subsequent eating.

Therefore, based solely on the evaluation of the results obtained from this limited focused investigation, it can reasonably be concluded that human exposure to currently identified constituents of concern through consumption of fish obtained from the Hylebos Waterway adjacent to the Occidental site is not “significant” and, therefore, is currently under control.

It cannot be overemphasized that this evaluation consisted of only a limited investigation to obtain the information necessary to resolve the environmental indicator of current human exposure through the fish consumption pathway. The results of this investigation in no way address potential future human exposure through this pathway. This potential for future human exposure is being addressed by the ongoing field investigations and planned remedial activities at the Occidental site being conducted under joint Ecology and EPA oversight.

Appendix B: Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Legacy toxics: Discontinued or banned chemicals in the United States (US) that are often used or produced by industry and remain in the environment long after they were first introduced.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

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

Reach: A specific portion or segment of a stream.

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

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Acronyms and Abbreviations

CB/NT	Commencement Bay/Nearshore Tideflats
COCs	Contaminants of concern
DQO	Data quality objective
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
GPRA	Government Performance and Response Act
GPS	Global Positioning System
HWTR	Hazardous Waste and Toxics Reduction Program
i.e.	In other words
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
PPA	Environmental Performance Partnership Agreement
QA	Quality assurance
QC	Quality control
RCRA	Resource Conservation and Recovery Act

RPD	Relative percent difference
SOP	Standard operating procedures
TPCHD	Tacoma Pierce County Health Department
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area

Units of Measurement

Ft	feet
G	gram, a unit of mass
Kg	kilograms, a unit of mass equal to 1,000 grams
m	meter
mm	millimeter
mg	milligram
mg/kg	milligrams per kilogram (parts per million)
mL	milliliter
µg/g	micrograms per gram (parts per million)
µg/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 sample 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 quality control (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 are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are 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 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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