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ECOLOGY
State of Washington

Addendum to Quality Assurance Project Plan

Survey of PFAS in the Greater Lake Washington Watershed

May 2021

Publication 21-03-105

Publication Information

This Quality Assurance Project Plan Addendum is on the Department of Ecology's website at https://apps.ecology.wa.gov/publications/SummaryPages/2103105.html. This is an addition to an original Quality Assurance Project Plan (QAPP).

This QAPP addendum was approved to begin work in April 2021. It was finalized and approved for publication in May 2021.

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This plan was reviewed by a licensed hydrogeologist. A signed and stamped copy of the report is available upon request.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at EIM Database. Search Study ID: SWON0003.

The Activity Tracker code for this project is 21-020.

Original Quality Assurance Project Plan:
Wong, S. and C. Mathieu. 2020. Quality Assurance Project Plan: Survey of PFAS in the Greater Lake Washington Watershed. Publication 20-03-112. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2003112.html.

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Addendum to Quality Assurance Project Plan

`Survey of PFAS in the Greater Lake Washington Watershed

by Diane Escobedo

May 2021

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EAP: Environmental Assessment Program
HWTR: Hazardous Waste and Toxics Reduction Program

Table of Contents

The numbered headings in this document correspond to the headings used in the original QAPP. Only relevant sections are included; therefore, some numbered headings are missing.

3.0 Background

3.1 Introduction and problem statement

In fall 2020, the Washington State Department of Ecology’s (Ecology’s) Environmental Assessment Program began conducting a field study to assess concentrations of per- and poly-fluoroalkyl substances (PFAS) in Lake Washington and investigate major pathways by which PFAS enters the lake. The study design includes characterization of the lake and its direct tributaries, stormwater discharges, bridge runoff, and atmospheric deposition. This study focuses on perfluoroalkyl acids (PFAAs) and their precursors. This addendum adds an initial screening of PFAS concentrations in areas of identified nearshore groundwater discharge to Lake Washington.

Ecology and the Washington State Department of Health are working to develop a Chemical Action Plan (CAP) to address PFAS in Washington. This study is being conducted with funding received from the state legislature to implement CAP recommendations for conducting monitoring and source identification of PFAS contamination in the environment.

Groundwater is a potential pathway by which PFAS may be entering the lake. Due to high water solubility and resistance to degradation of certain types of PFAS, once they contaminate a groundwater system they have the potential to be transported long distances and remain in groundwater for decades after the initial release (Eschauzier et al. 2013, Hatton et al. 2018, Xiao et al. 2015). The original Quality Assurance Project Plan (QAPP; Wong and Mathieu 2020) did not include assessment of the groundwater pathway due to lack of qualified staff. A hydrogeologist was hired to develop a groundwater sampling strategy. This addendum adds details for assessment of the groundwater pathway.

Groundwater assessment will include collecting samples in areas where groundwater discharges directly to Lake Washington. The goal is to provide an initial screening of PFAS concentrations in groundwater to help determine if this pathway warrants further investigation.

Sections not included in this addendum remain unchanged from the original QAPP (Wong and Mathieu, 2020).

3.2 Study area and surroundings

This study will take place in the Greater Lake Washington (Cedar-Sammamish) watershed, located in King and Snohomish counties, WA (Figure 1). The watershed encompasses 692 square miles and is comprised of two major sub-basins, the Cedar River and Sammamish River, which drain into Lake Washington.

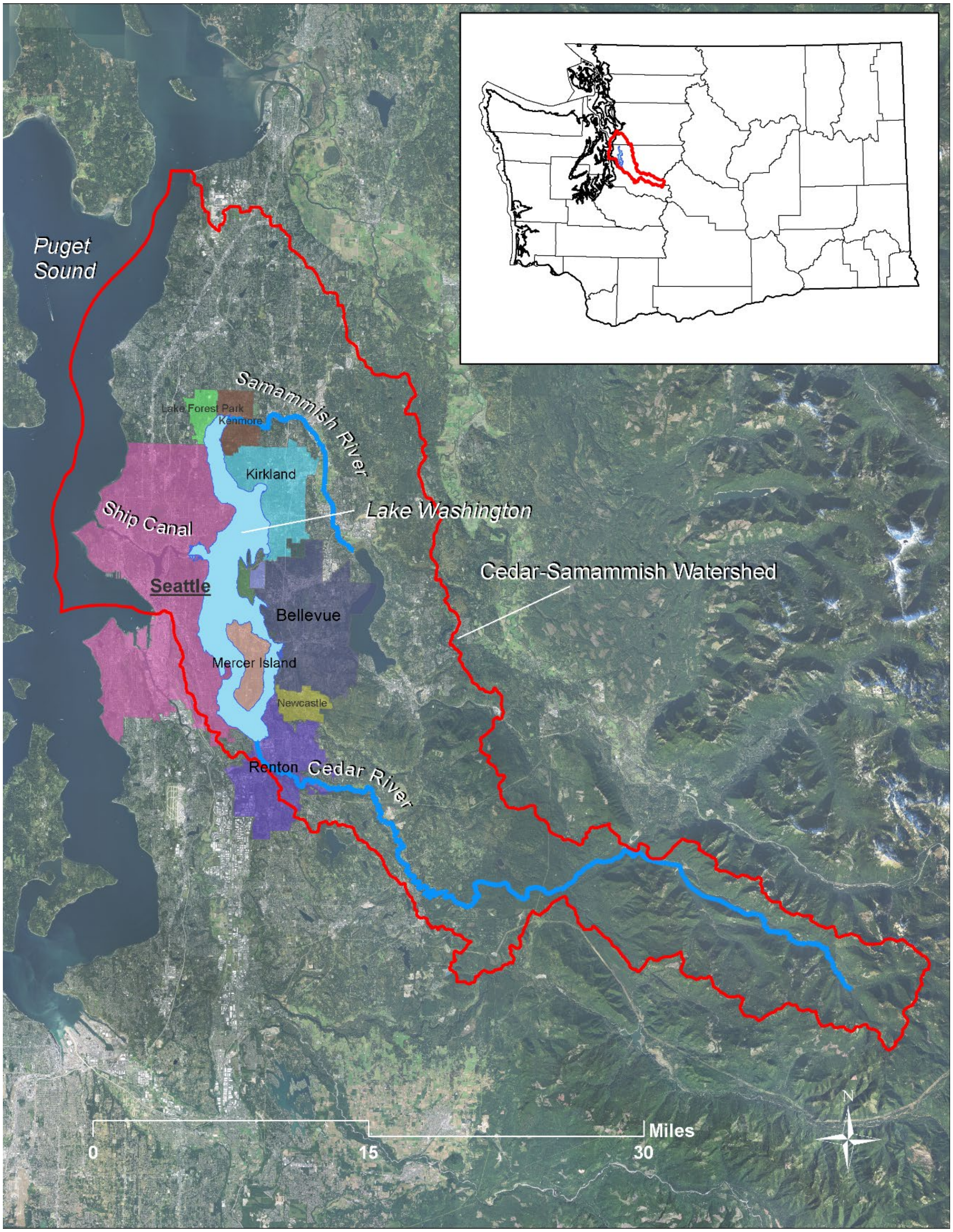

Figure 1. Overview map of study area.

Lake Washington is the second largest natural lake in Washington State. It is about 22 miles long, with an area of about 34 square miles, and maximum depth of 214 feet (King County 2015). Surface water leaves Lake Washington and empties into Puget Sound via the Washington Ship Canal.

The Hiram M. Chittenden Locks regulate the water level of the Ship Canal and Lake Washington. Water levels are maintained between an elevation of 20 and 22 feet, referenced to a United States Army Corps of Engineers (USACE) project specific datum, which is equivalent to 16.75 and 18.75 feet NAVD 88 (USACE 2021). In addition to maintaining water levels the locks also control saltwater intrusion from Puget Sound and provide a navigational passage for recreational and commercial vessels. Annual drawdown begins in about October and continues until the minimum elevation of 20 feet is reached, typically by December. Beginning in mid-February, less water is released to reach the eventual goal of 22 feet by May 1st. That level is maintained through the summer months to help meet increased summer water use (USACE 1994).

Groundwater in the study area originates primarily from precipitation infiltrating into the ground and surface water from lakes and streams discharging to groundwater in upland areas. Infiltration varies based on surficial geology, soils, land use, and vegetation. Shallow groundwater is frequently hydraulically connected to surface water. When the hydraulic head in groundwater is higher than surface water, groundwater will discharge to streams and lakes.

The Puget Sound aquifer system underlies this study area. The aquifer system is composed of alternating fine and coarse grained sediment deposited during glacial periods, and warmer interglacial periods of the last approximately 2.6 million years. The coarse grained and alluvial deposits generally form the water bearing units, or aquifers. Finer grained deposits create a semi-confining or confining unit when present. These finer grained units provide some protection to the aquifer from contaminants introduced at the land surface. In the lowland areas, groundwater movement in this aquifer system is generally from topographic highs to topographic lows, such as river valleys and lakes (Vaccaro et al. 1998).

The majority of the water districts abutting Lake Washington obtain their drinking water through Seattle Public Utilities, which sources water from surface water of the Cedar River and Tolt River watersheds (70% and 30% respectively, City of Seattle 2021). Water districts serving the cities of Renton, Lake Forest Park, Beaux Arts and the community of Skyway obtain all or part of their supply from groundwater wells. (City of Renton 2020, Lake Forest Park Water District 2021, Beaux Arts 2021, Skyway Water and Sewer District 2020).

4.0 Project Description

4.1 Project goals

The project goal is to identify, characterize, and prioritize the major pathways and sources of PFAS to Lake Washington. This addendum adds an assessment of the groundwater pathway. The specific goal for this portion of the project is to conduct an initial screening of PFAS concentrations in areas of identified nearshore groundwater discharge to Lake Washington.

4.2 Project objectives

The project will be implemented in two phases:

The objective of Phase 1 is to characterize PFAS concentrations in the lake and potential pathways to the lake. This addendum adds assessment of the groundwater pathway to determine the potential importance of urban groundwater as a source of PFAS to Lake Washington. Groundwater discharge to the lake has been documented during site characterizations conducted at various contaminated sites (Aspect 2013, Aspect 2018, Weston 2001). However, for the majority of the lake perimeter, discharge zones have not been identified and an estimate of the total volume of groundwater discharge to the lake has not been studied. There is no existing PFAS data from groundwater discharging directly into Lake Washington.

Of the cities bordering Lake Washington, the City of Renton is the only water utility that tested for PFAS in 2014 and 2015 under the Environmental Protection Agency's (EPA) third unregulated contaminant monitoring rule (UCMR3). UCMR3 included six PFAS. PFAS were not detected in any of the drinking water samples (City of Renton 2020). The proposed fifth UCMR, published March 11, 2021, would require sample collection between 2023 and 2025 (EPA 2021). UCMR5 includes a broader list of 29 PFAS, including the same six PFAS monitored during UCMR3 but with significantly lower minimum reporting levels.

Phase 1 groundwater sampling is intended to be a preliminary assessment of PFAS concentrations in groundwater discharging into the lake. Phase 1 of this study will not attempt to develop estimates of the groundwater discharge volume.

The objective of Phase 2 is to further identify potential sources to the lake through more concentrated sampling efforts. As with pathways discussed in the original QAPP, the Phase 2 sampling strategy for groundwater will be based on an assessment of Phase 1 results. Thus, the remainder of this QAPP focuses on describing Phase 1 of this study. An addendum to this QAPP may be prepared for Phase 2.

4.4 Tasks required

The main tasks for groundwater sampling Phase 1 field work are:

- Secure any necessary permissions for site access and sampling.
- Conduct a field temperature survey to identify groundwater discharge zones.
- Finalize locations for groundwater sampling based on permissions, accessibility and identification of discharge zones.
- Document any changes to sampling locations.

- Coordinate with laboratories prior to sampling.
- Conduct a utility locate to ensure buried utilities will not be impacted by sampling activities.
- Coordinate with Lake Forest Park Water District to schedule drinking water well sample.
- Prepare and decontaminate field equipment for PFAS sampling.
- Conduct sampling according to this QAPP:
    - Measure groundwater potentiometric hydraulic head and compare to surface water stage to establish the vertical hydraulic gradient between groundwater and surface water.
    - Measure and record surface water field parameters from the lake at each sample location prior to PushPoint sampler purging.
    - Manually install the PushPoint sampler. The sampler will be installed at each location for one time sampling and decontaminated between locations.
    - Measure groundwater field parameters from the PushPoint sampler including temperature, dissolved oxygen (DO), conductivity, pH, oxidation reduction potential (ORP), and turbidity. These measurements will be recorded as the groundwater is being purged.
    - Collect groundwater samples at identified discharge zones along the Lake shoreline. Sample analysis will include PFAS analytes and total oxidizable precursor (TOP) assay; sampling for Phase 1 will be done in spring 2021. See Table 2 of original QAPP for complete list of target analytes.
    - Collect groundwater sample from the Lake Forest Park Water District McKinnon Creek wellfield shallow well cistern.

Tasks for data management and analysis include:

- Complete data verification and validation.
- Review and assess laboratory data quality.
- Enter data into Ecology's Environmental Information Management (EIM) database.
- Compare concentrations among sampling locations, matrices, and events.
- Design sampling strategy for Phase 2 based on assessment of Phase 1 results.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1 shows the responsibilities of those who will be involved in this project.

Table 1. Organization of project staff and responsibilities.

Staff[1]	Title	Responsibilities
Cheryl Niemi HWTR Program Lacey Headquarters Phone: (360) 407-6850	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Samuel Iwenofu HWTR Program Lacey Headquarters Phone: (360)407-6346	HWTR Program Chemist & Quality Assurance Coordinator	Provides technical review of QAPP for project client and approves the final QAPP.
Siana Wong Toxics Studies Unit, SCS Phone: (360) 407-6432	Principal Investigator	Authors the original 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.
Callie Mathieu Toxics Studies Unit, SCS Phone: (360) 407-6965	PBT Monitoring Coordinator	Co-authors original QAPP. Assists with project development and field sampling.
Diane Escobedo Groundwater/Forests & Fish Unit, SCS Phone: (360) 407-6479	Hydrogeologist	Helps with sampling design. Assists with field sampling. Authors QAPP addendum for sampling groundwater. Oversees groundwater sampling field work and transportation of samples to laboratory. Authors groundwater section of final report.
Pam Marti Groundwater/Forests & Fish Unit, SCS Phone: (360) 407-6768	Licensed Hydrogeologist	Oversees hydrogeologic portion of the project and approves the QAPP addendum for sampling groundwater.
James Medlen Toxics Studies Unit, SCS Phone: (360) 407-6194	Unit Supervisor for the Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Jessica Archer SCS Phone: (360) 407-6698	Section Manager for the Project Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Stacy Polkowske Western Regional Operations Phone: (360) 407-6730	Section Manager for the Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Alan Rue Manchester Environmental Laboratory Phone: (360) 871-8801	Manchester Laboratory Director	Reviews and approves the final QAPP.
Contract Laboratory	Lab Project Manager	Reviews draft QAPP, coordinates with MEL QA Coordinator
Arati Kaza Phone: (360) 407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP. Authorizes Approval to Begin Work

[1]All staff except the client are from EAP
EAP: Environmental Assessment Program
EIM: Environmental Information Management database
HWTR: Hazardous Waste and Toxics Reduction Program
QAPP: Quality Assurance Project Plan
SCS: Statewide Coordination Section

5.2 Special training and certifications

It is required that a licensed hydrogeologist oversee or conduct hydrogeologic studies (Chapter 18.220, Chapter 308-15 WAC, and Chapter 18.235 RCW). The project manager is a licensed geologist. Pam Marti, a licensed hydrogeologist, is overseeing this study.

All field staff should have a detailed working knowledge of the QAPP and the applicable Standard Operating Procedures (SOPs) listed in section 8.2 to ensure credible and useable data are collected. This includes being familiar with the sampling equipment and instruments being used.

5.4 Proposed project schedule

Tables 2–4 lists key activities, due dates, and lead staff for this project. The project schedule assumes all field work and contracts are not affected by COVID-19 delays due to state and agency phased re-opening approaches.

Table 2. Schedule for completing field and laboratory work.

Task	Due date	Lead staff
Phase 1: Field work	April 30, 2021	Diane Escobedo
Phase 1: Laboratory analytical results	June 30, 2021	Contract Lab
Phase 1: Contract lab data validation	August 31, 2021	MEL QA Coordinator/ Contract vendor
Phase 2: Field work	April 30, 2022	Diane Escobedo
Phase 2: Laboratory analyses	June 30, 2022	Contract Lab
Phase 2: Contract lab data validation	August 31, 2022	MEL QA Coordinator/ Contract vendor

Table 3. Schedule for data entry.

Task	Due date	Lead staff
EIM data loaded*	September 30, 2022	Diane Escobedo
EIM QA	October 31, 2022	To be determined
EIM complete	November 30, 2022	Diane Escobedo

*EIM Project ID: SWON0003

EIM: Environmental Information Management database

Table 4. Schedule for final report*

Task	Due date	Lead staff	Support staff
Draft to supervisor	October 31, 2022	Siana Wong	Diane Escobedo
Draft to client/ peer reviewer	November 30, 2022	Siana Wong	
Draft to external reviewers	December 31 2022	Siana Wong	
Final draft to publications team	January 31, 2023	Siana Wong	
Final report due on web	March 31, 2023	Siana Wong	

*Phase 1 and 2 results will be combined into a single final report.

5.5 Budget and funding

Table 5. Estimated laboratory costs for Phase 1 groundwater sampling of this study.

Contract Lab Samples Total:	$29,000
Contract Lab Fee Total (30%):	$8,700
Equipment:	$300
GRAND TOTAL:	**$37,700**

Table 6. Estimated laboratory costs broken down by parameter and sample matrix for Phase 1 of this study.

Parameter	Sample Matrix	Number of Samples	Number of Field QC Samples[1]	Number of Lab QC Samples[2]	Cost Per Sample	Sub-total	Laboratory
PFAS-Analytes	Groundwater	25	3	2	500	$15,000	Contract Lab
PFAS-TOP Assay	Groundwater	25	3	NA	500	$14,000	Contract Lab

[1] Field quality control (QC) samples for PFAS Analytes and Top Assay in groundwater refer to field duplicate and field blank.
[2] Lab QC samples refer to Matrix Spike/Matrix Spike Duplicate (MS/MSD).

6.0 Quality Objectives

6.2 Measurement quality objectives

Project-specific measurement quality objectives (MQOs) for laboratory analyses are summarized in Table 9 and described in section 6.2 of the original QAPP (Wong and Mathieu 2020). The MQOs for field parameters are summarized in Table 7. Purging will continue until field parameters are stable, defined as 3 consecutive readings falling within the criteria summarized in Table 7.

Table 7. MQOs for field measurements for water purged from PushPoint sampler prior to sampling.

Parameter	Acceptable Range Between Readings	Instrument Sensitivity	Unit of Measure
Dissolved Oxygen	±0.05 for values <1 ±0.2 mg/L for values >1	0.1	mg/L
pH	±0.1 standard unit	0.1	standard unit
Specific Conductivity	±10.0 for values < 1000 ± 20.0 for values > 1000	10	µmhos/cm
Water Temperature	±0.1	0.1	°C
ORP	±10	0.1	mV
Turbidity	±10% for values >5 or 3 consecutive readings <5	0.1	NTU

ORP = Oxidation reduction potential

7.0 Study Design

7.1 Study boundaries

This project will take place in the Greater Lake Washington watershed (WRIA 8). A map of the tentative groundwater sampling locations are shown in Figure 2.

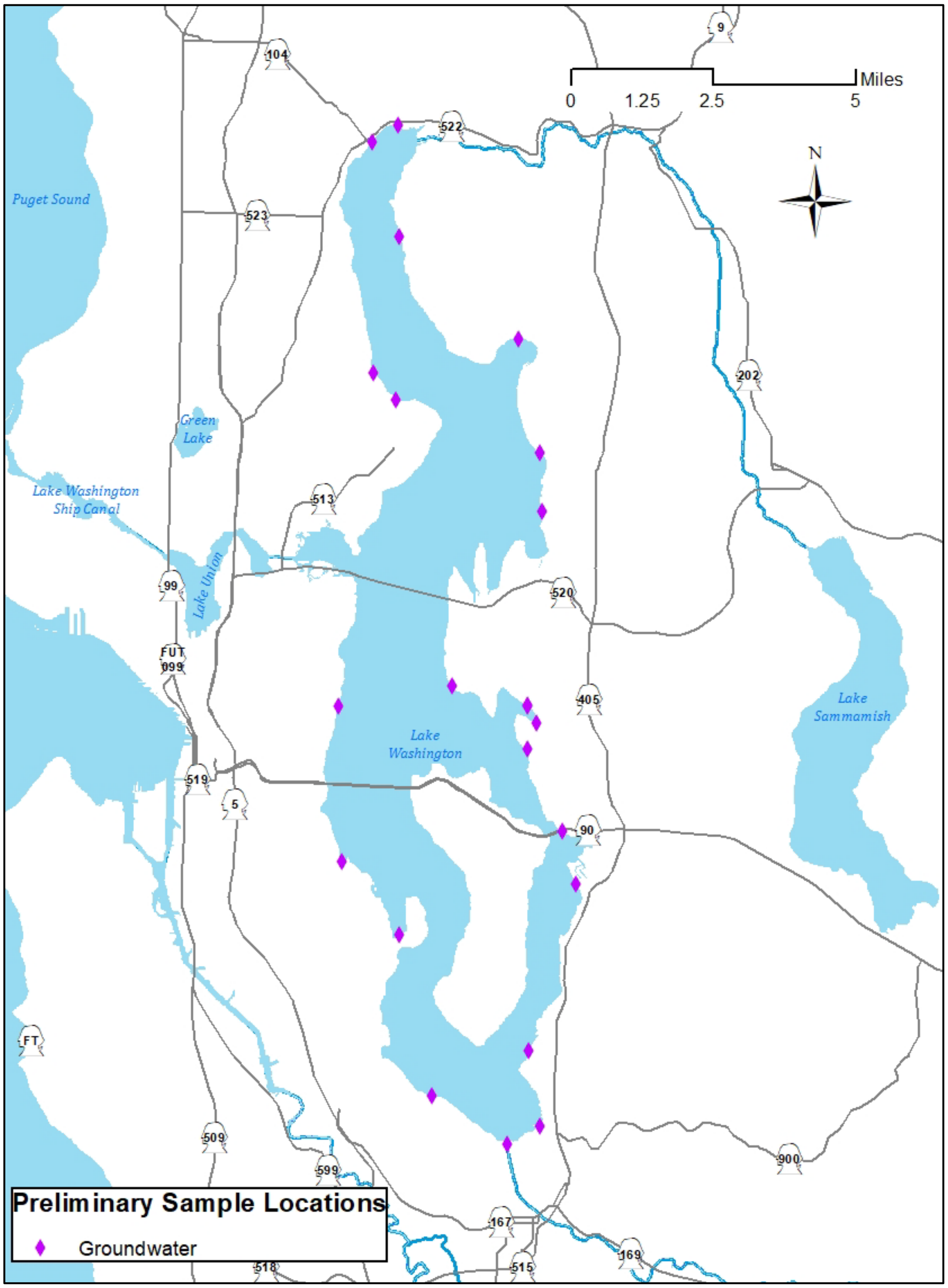

Figure 2. Map of preliminary groundwater sampling locations in Lake Washington.
Final sampling locations will depend on areas of confirmed groundwater discharge.

7.2 Field data collection

7.2.1 Sampling locations and frequency

The purpose of sampling groundwater is to assess PFAS concentrations in areas of identified groundwater discharge to Lake Washington. The temperature of nearshore lake water and sediment porewater will be used to identify areas along the shoreline where groundwater discharge is likely occurring. Heat is a natural tracer that can be used to track water that moves between groundwater and surface water. Surface water temperatures vary in direct response to air temperatures. However, groundwater maintains a fairly constant temperature year-round. In the wintertime, surface water temperatures are typically lower than groundwater temperatures. This difference in temperatures can be used to indicate groundwater and surface water interactions. Losing surface water reaches (surface water discharging to groundwater) are marked by sediment porewater temperatures which are close to surface water temperatures. Gaining surface water reaches (groundwater discharging to surface water) are marked by sediment porewater temperatures which are warmer than surface water temperatures.

Groundwater discharge to Lake Washington can occur as direct (through the lake bed) or indirect (discharge into tributary waters) discharge. Direct discharge to lakes is typically greatest in the nearshore area, decreasing exponentially with distance from shore (Lee 1977, Harvey et al. 2000). Groundwater inflow variability can occur due to heterogeneity in sediments at the sediment-water interface and topographic variation of the adjacent onshore water table (Cherkauer and Nader 1989; Harvey et al. 2000; Schneider et al. 2005). Seasonal variation of groundwater flow related to recharge, aquifer geometry and lithology can also occur and may influence where discharge areas are located. Seasonal variation is greatest in the shallow aquifers of the Puget Sound aquifer system (Vaccaro et al. 1998).

All available geologic and hydrogeologic data will be examined in order to identify areas along the Lake Washington shoreline where groundwater discharge is most probable. Sources for hydrogeologic and geologic information include studies conducted in association with public works projects and municipal permitting requirements, groundwater protection studies for drinking water supply wells and contaminated site investigations, Washington Department of Natural Resources' Geologic Information Portal, Ecology's well log database and peer reviewed journal articles. A field temperature survey will be conducted to further identify areas of groundwater discharge by comparing temperatures of sediment porewater and Lake Washington.

Twenty to 25 locations will be sampled depending on access considerations, groundwater flow patterns, and discharge zone variability. The sampling locations will be distributed along the lake shoreline in identified areas of groundwater discharge as access allows. An attempt will be made to select sampling locations representative of the full range of land use.

One sample will be collected from Lake Forest Park Water District's McKinnon Creek wellfield. Eight shallow wells in this wellfield are completed in the Vashon Advance aquifer (Qva), an important regional aquifer (AESI 2016, Leisch et al. 1963). Groundwater from the eight shallow artesian wells is collected in a cistern. The McKinnon Creek wellfield is located approximately 3,000 feet northwest of Lake Washington. Groundwater flow in the Qva Aquifer is generally from north to south, eventually discharging to Lake Washington (AESI 2016).

7.2.2 Field parameters and laboratory analytes to be measured

PFAAs, PFAA precursors, and their replacement chemicals are the target PFAS analytes for this project (Table 2 of original QAPP). Using a calibrated YSI or Hydrolab multi-parameter sonde, we will also measure water temperature, DO, pH, ORP, and specific conductance of porewater and lake water at each sampling location. A Hach 2100Q turbidimeter will be used to measure turbidity.

7.4 Assumptions underlying design

One assumption underlying the study design is that shallow aquifers, which are most likely to be impacted by surface releases, are discharging in the littoral zone of Lake Washington. Although discharge may be occurring in deeper water, no attempt will be made to identify areas of discharge beyond the littoral zone.

Another assumption is that the temperature contrast between sediment pore water and surface water, and hydraulic head measurements will verify groundwater discharge.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

A large portion of Lake Washington is private property. Access to sampling locations via land in areas abutting private property will be assessed by boat during the reconnaissance temperature survey. Access to private property will be arranged prior to conducting field work when necessary.

Sampling locations will be selected during late February, when the gradual process to increase the lake level by two feet begins. Groundwater sites will be sampled in spring 2021 and therefore considerations will need to be taken regarding access as the lake level continues to rise during the spring.

The temperature contrast between groundwater and surface water is expected to be greatest during the mid to late winter and mid to late summer months. The reconnaissance temperature survey will be conducted during mid to late winter and groundwater sampling will occur in the spring. Areas of groundwater discharge around the lake may vary seasonally. A temperature probe will also be used during the spring sampling event prior to advancing the PushPoint sampler to confirm previously identified areas of discharge.

7.5.2 Practical constraints

A detailed picture of the groundwater flow regime is limited to areas where hydrogeologic studies have occurred. All available geologic and hydrogeologic data will be examined in order to identify those areas of the lake where groundwater discharge is most probable.

8.0 Field Procedures

8.2 Measurement and sampling procedures

This section describes the field sampling procedures specific to groundwater sampling that will be used, which are adapted from the following Ecology SOPs:

- EAP033 – Hydrolab® DataSonde®, MiniSonde®, and HL4 Multiprobes (Anderson 2020)
- EAP061 – Installing, Monitoring, and Decommissioning Hand Driven In-Water Piezometers (Sinclair 2018)
- EAP077 – Collecting Groundwater Samples for Volatiles and other Organic Compounds from Water Supply Wells (Marti, In publication)
- EAP078 – Purging and Sampling Monitoring Wells plus Guidance on Collecting Samples for Volatiles and other Organic Compounds (Marti 2016)

Groundwater sampling sites will be accessed by boat or foot depending on access considerations. The sampling method will be inserting a PushPoint sampler device (Figure 3) 20 to 100 centimeters below the sediment/water interface in the lake's littoral zone. The PushPoint sampler is a 122-centimeter-long, 6.35 millimeter diameter stainless steel tube with a machined point and 4-centimeter-long slotted screen at the tip with approximately 20% open area. MHE Screen-Soks will be used in fine sediments if clogging issues occur. An internal guard rod will be used to add structural support during insertion. Once inserted to the desired depth the guard rod will be removed and high-density-polyethylene and silicone tubing will be attached to the sampling port (Henry 2003).

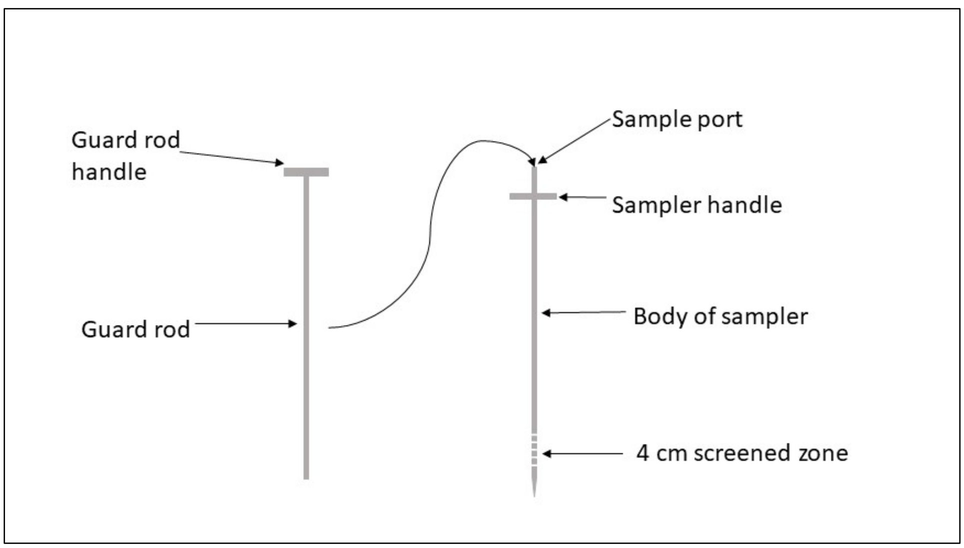

Figure 3. **Diagram of PushPoint sampler and guard rod.**

Prior to sampling, a measurement of the hydraulic head in the PushPoint sampler will be collected and compared to the lake surface level to determine the direction and magnitude of the vertical hydraulic gradient. Hydraulic head will be measured directly from the tubing if the water level is higher than the lake level (Figure 4). Samples will not be collected for chemical analysis if the head measurements indicated that there is a measurable downward vertical gradient between the lake and underlying pore water. Alternative sampling locations may be chosen in the field if the head relationship indicates the sample location in a groundwater recharge area or if lake-bed sediment type prohibits installation to the desired depth. Sample locations will be located for mapping purposes using a Global Positioning System (GPS).

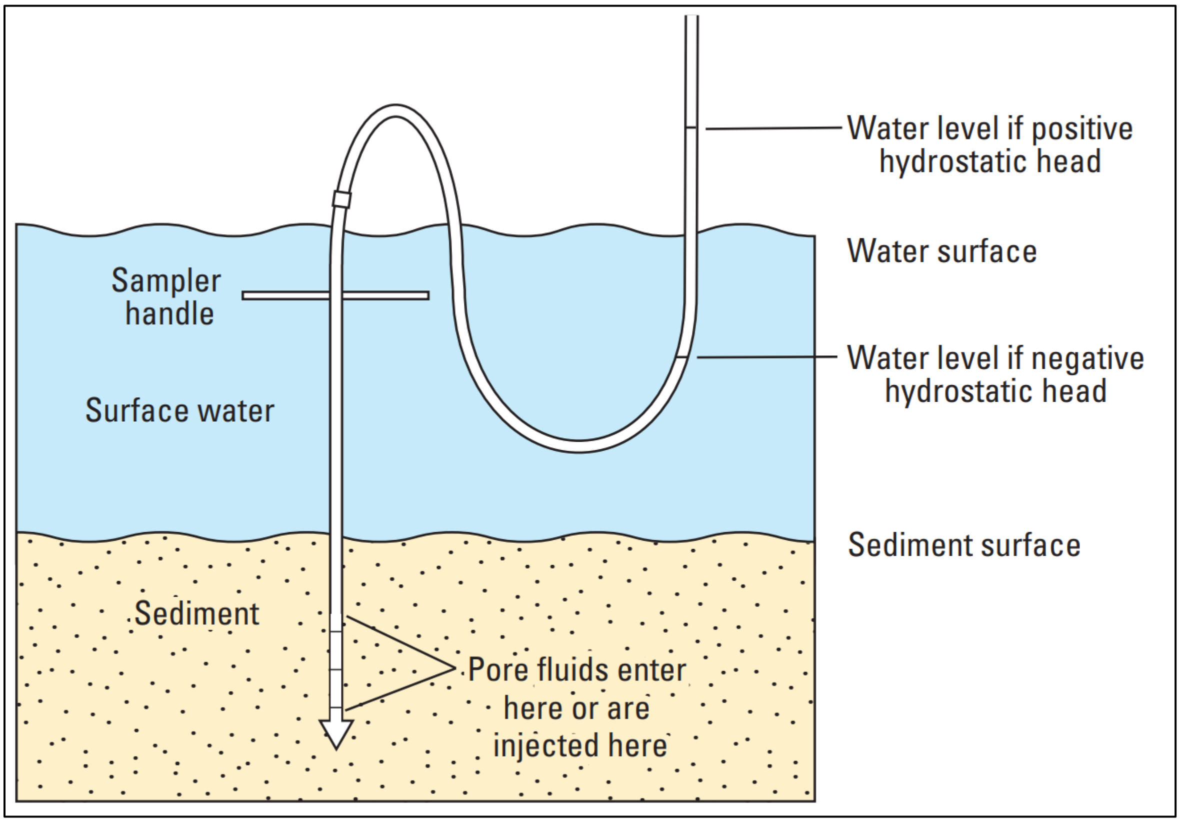

Figure 4. Diagram of PushPoint sampler and clear tubing can be used to indicate positive or negative hydrostatic head (Rosenberry and LaBaugh 2008).

A peristaltic pump will be attached to the tubing for purging through a flow cell. Temperature, specific conductance, pH, ORP, and DO concentration will be measured every three to five minutes until field parameters stabilize (Table 6). A Hach 2100Q turbidimeter will be used to measure turbidity. Once parameters have stabilized, the flow cell will be disconnected and groundwater samples will be collected (Figure 5). Low-flow sampling methods will be used. Pumping rates less than 500 milliliters/minute will be used for purging and sampling All samples will be collected in PFAS-free sample bottles provided by the contract lab. Separate groundwater samples will be collected for PFAS analytes and TOP assay. PFAS sample bottles will be capped as soon as possible after retrieving the water sample.

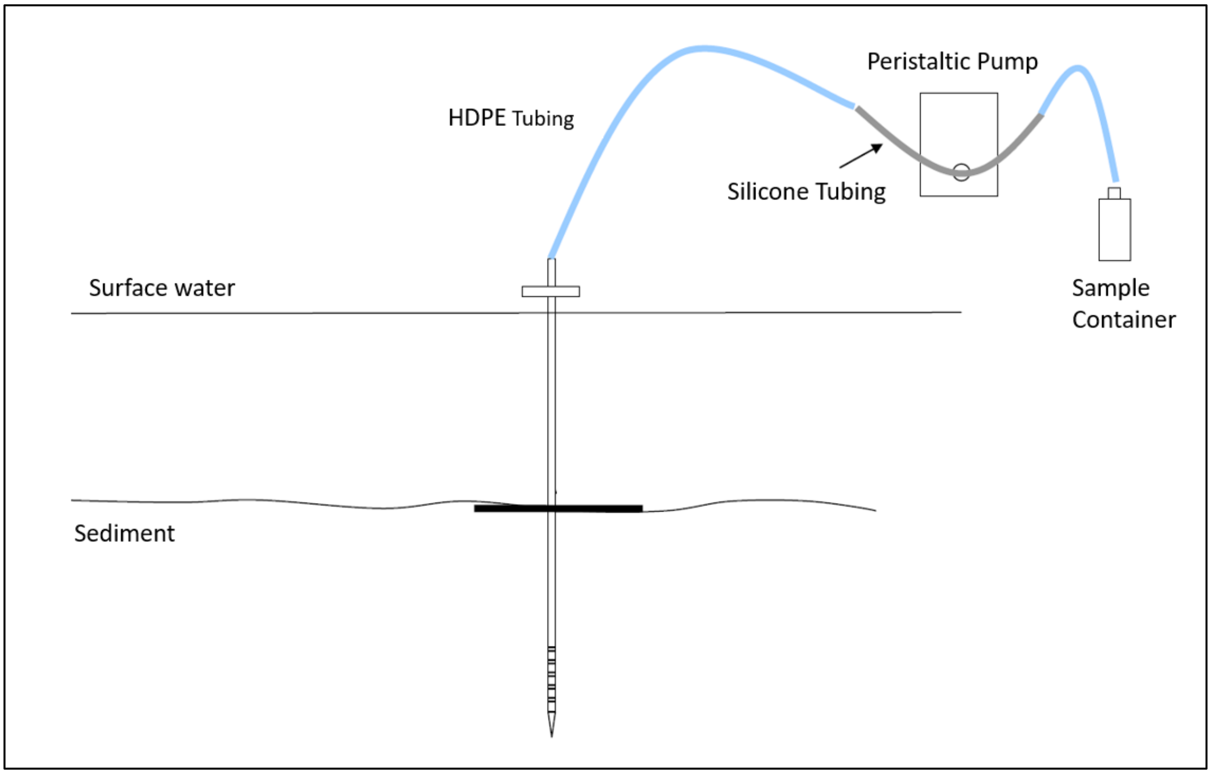

Figure 5. Diagram of PushPoint sampler inserted into the sediment and attached to a peristaltic pump for sampling (Modified from EPA 2013).

Immediately after collection, all samples will be placed in individual plastic bags with zip locks and then stored in a cooler filled with regular ice. Samples will be shipped to the contract laboratory for analysis.

Leakage of lake water around the annular space as porewater is withdrawn is a concern for shallow in-water sampling devices such as the PushPoint sampler. Previous studies by Pitz (2008) and Zimmerman et al. (2005) have demonstrated the PushPoint sampler is able to successfully draw porewater without surface water intrusion when inserted to shallow depths (5 and 10 centimeters, respectively) below the sediment surface. To minimize the potential for annular leakage low flow sampling methods will be used, sample collection will occur at a minimum depth of 20 cm below the sediment surface and only locations that exhibit an upward vertical hydraulic potential will be sampled.

To evaluate the likelihood of surface water leakage into the PushPoint sampler field measurements of temperature, pH, specific conductance, ORP, and DO levels will be measured from surface water immediately adjacent to the entry point of the sampler. These values will be compared to the values collected during purging. The hydraulic potential at the end of sampling will be rechecked and recorded to determine if drawdown of the piezometer potential occurred during pumping.

One sample will be collected from shallow wells in the Lake Forest Park Water District's McKinnon Creek wellfield. The wellfield consists of eight shallow (17 to 25 feet below ground surface) supply wells. Groundwater flows from the wells under artesian conditions and is collected in a cistern at a rate of 80 gallons per minute. The groundwater sample will be collected from the cistern before any pretreatment.

8.4 Equipment decontamination

Field equipment used to collect PFAS samples that require decontamination include the PushPoint sampler and guard rod. New tubing will be used for purging and sampling at each sample location.

The following procedure will be used to decontaminate the PushPoint sampler and guard rod prior to sampling and between sample points:

1. Rinse with tap water
2. Wash exterior with brush and Liquinox soap
3. Wash interior with garden sprayer and MHE decontamination adapter
4. Gently push guard rod into the bore of PushPoint to dislodge any material
5. Re-rinse with soap
6. Rinse with tap water
7. Final rinse with 100% methanol

Bending of the device may occur during insertion into the subsurface. The device should be straightened and cleaned after each use prior to reinsertion of the guard rod into PushPoint. Caution should be used when straightening the screened zone, as it is more prone to breakage (Henry 2003). Sealed clean trash bags or large plastic bags with zip locks can be used to store and transport decontaminated field equipment.

14.0 Data Quality (Usability) Assessment

14.4 Sampling design evaluation

The sampling design for this project is expected to be sufficient to meet the Phase 1 study objectives. Seasonal variability will not be assessed during Phase 1 groundwater sampling. Spatial variability will be assessed through collection of samples at multiple sites in the littoral zone of the lake.

15.0 References

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