Spokane River Watershed, West Plains Area: Addendum 2 to Programmatic Quality Assurance Project Plan:

Statewide Preliminary PFAS Assessments

December 2024

Publication 24-03-105

Publication Information

This Quality Assurance Project Plan Addendum is on the Department of Ecology's website at https://apps.ecology.wa.gov/publications/SummaryPages/2403105.html. This is an addition to an original Quality Assurance Project Plan (QAPP). It is not a correction (errata) to the original plan.

This QAPP addendum was approved to begin work in April 2024. It was finalized and approved for publication in December 2024.

Suggested citation for this addendum:
Carnes, J. 2024. Spokane River Watershed, West Plains Area: Addendum 2 to Programmatic Quality Assurance Project Plan: Statewide PFAS Preliminary Assessments. Publication 24-03-105. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2403105.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at EIM Database.[1] Search Study ID StatewidePFAS02

Activity Tracker code:
Ecology's Activity Tracker code for this addendum is 24-007.

Original Quality Assurance Project Plan:

Carnes, J., D. Escobedo, S. Wong. 2024. Programmatic Quality Assurance Project Plan: Statewide PFAS Preliminary Assessments. Publication 24-03-101. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2403101.html.

Contact Information

Publications Coordinator
Environmental Assessment Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 564-669-3028

Washington State Department of Ecology — ecology.wa.gov

Headquarters, Olympia	360-407-6000
Northwest Regional Office, Shoreline	206-594-0000
Southwest Regional Office, Olympia	360-407-6300
Central Regional Office, Union Gap	509-575-2490
Eastern Regional Office, Spokane	509-329-3400

This report was prepared under the supervision of a licensed hydrogeologist. A signed and stamped copy of the report is available upon request.

[1] https://www.ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database

Spokane River Watershed, West Plains Area: Addendum 2 to Programmatic Quality Assurance Project Plan

Statewide Preliminary PFAS Assessments

By Jacob Carnes, LG

December 2024

Approved by:

Signature: Date:

Rebecca Bohannan, Client, HWTR Program

Signature: Date:

Richelle Perez, Client's Section Manager, HWTR Program

Signature: Date:

Jacob Carnes, Author / Project Manager, EAP

Signature: Date:

Pam Marti, LHG, Author's Unit Supervisor, EAP

Signature: Date:

Jessica Archer, Author's Section Manager, EAP

Signature: Date:

Rob Waldrop, Director, Manchester Environmental Laboratory

Signature: Date:

Christina Frans, Interim Ecology Quality Assurance Officer

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

1.0 Table of Contents

Note: The numbered headings in this document correspond to the headings in the original QAPP. Only relevant sections are included here; therefore, some numbered headings may be missing.

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3.0 Background

3.1 Introduction and problem statement

Historical use of aqueous film forming foam (AFFF) for firefighting and training at Fairchild Air Force Base and potentially at Spokane International Airport has resulted in extensive groundwater contamination in the West Plains area, west of Spokane, WA. In 2017, the Air Force acknowledged that per- and polyfluoroalkyl substances (PFAS) in groundwater had migrated off-base and impacted municipal and private domestic drinking water wells (Air Force 2017). Groundwater sampling conducted for Spokane International Airport in 2017 and 2019 confirmed the presence of PFAS in groundwater below the airport (AECOM 2017; SES 2019); these sampling results were made public in 2023 (Ecology 2024a).

The Air Force began sampling drinking water wells in the West Plains area in October 2021. By December 2023, the Air Force had identified two municipal drinking water wells and 107 off-base domestic drinking water wells where concentrations of perfluorooctanoic acid + perfluorooctanesulfonic acid (PFOA + PFOS) were above the 70 parts per trillion (ppt) screening level used by the Department of Defense (Air Force 2023).

Ecology has established Preliminary Cleanup Levels (PCLs) for PFAS compounds under the Model Toxics Control Act (MTCA) method B for potable groundwater (Ecology 2024b). Ecology's PCLs are more stringent than screening levels used by the Air Force. More than 24% of samples exceeded one or more of the PCLs (Table 1). PFOA concentrations exceeded the 10 ng/L PCL in 295 of the 1,207 total samples. PFOS concentrations exceeded the 15 ng/L PCL in 291 of the samples. Perfluorohexanesulfonic acid concentrations were above the 65 ng/L PCL in 122 samples. Perfluorononanoic acid concentrations exceeded the 9 ng/L PCL in one sample (DoD 2024). Well location and depth information is not available for these sample results.

The general groundwater flow direction in the West Plains area is to the northeast and east, towards the Spokane River. Previous surface water sampling in the area on the Spokane River has been sparse. In the spring of 2016, a sample collected by Ecology near Nine Mile Dam had a 4:2 fluorotelomer sulfonic acid concentration of 11.3 ng/L, and a sample collected at the same location in the fall of 2016 had a total perfluoroalkyl acid (T-PFAA; sum of 12 PFAA compounds) concentration of 9.37 ng/L (Mathieu and McCall 2017). Four samples collected on the Spokane River by Eastern Washington University in March of 2024 had no detections for PFAS (Hampson et al. 2024); however, flows on the Spokane River are generally high during the spring due to upstream release from the Post Falls dam, which will dilute contaminant concentrations. Determining whether contamination is reaching surface water will lead to a better understanding of the potential extent of impacts.

Table 1. Summary of PFAS detections in drinking water wells, Oct. 2021 – March 2023.

Parameter	PCL (ng/L)	Range of Concentrations (ng/L)	Number of samples with positive detections	Number of Samples with detections > PCL	Percent of Samples with detections > PCL
Perfluorooctanoic acid (PFOA)	10	0.085–337	629	295	24.4%
Perfluorooctanesulfonic acid (PFOS)	15	0.083–1770	633	291	24.1%
Perfluorobutanesulfonic acid (PFBS)	345	0.057–230	587	0	0.0%
Perfluorohexanoic acid (PFHxA)	8000	0.56–888	718	0	0.0%
Perfluorohexanesulfonic acid (PFHxS)	65	0.065–1490	665	122	10.1%
Perfluorononanoic acid (PFNA)	9	0.064–21.3	78	1	0.1%
Hexafluoropropylene oxide dimer acid (HFPO-DA/GenX)	24	NAF	NAF	NAF	NAF
Perfluorobutanoic acid (PFBA)	8000	NAF	NAF	NAF	NAF

NAF: Not analyzed for
PCL: Preliminary Cleanup Level under MTCA method B for potable groundwater (Ecology 2024b)

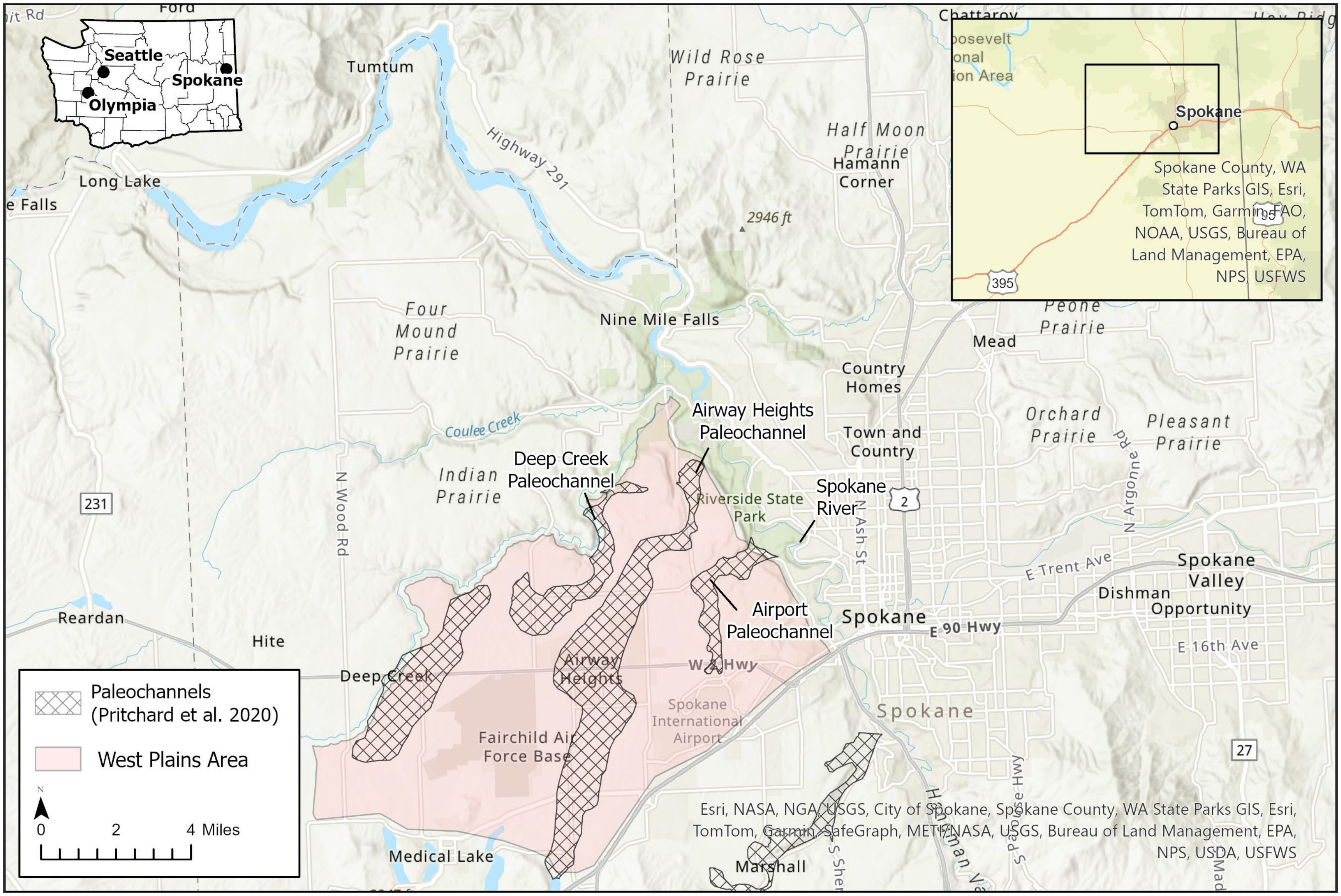

Figure 1. Map of the West Plains area and Spokane River.

3.2 Study area and surroundings

The Spokane River flows from Lake Coeur d'Alene in Idaho through eastern Washington and into the Columbia River. The total length of the river is 112 miles, and the watershed covers about 6,600 square miles. The river has complex interactions with groundwater. Upstream of Spokane, the river is predominately a losing stream. Near Spokane, the river intersects local groundwater levels and becomes a gaining stream (Hortness and Covert 2005). In the area of interest, tributaries to the Spokane River include Latah (Hangman) Creek, the Little Spokane River, and Deep and Coulee Creeks. The Spokane River and Deep Creek bound the West Plains area to the east and north.

Commercial, industrial, and residential land use is present within city limits. In more rural areas of the watershed, agriculture, rangeland, and forest are the primary land use categories (GeoEngineers et al. 2011). The Spokane River is widely used for recreational activities, including fishing and swimming.

3.2.1 Geology and hydrogeology

The West Plains area is underlain by Columbia River Basalt (CRB), which spans more than 81,000 square miles of the Columbia Plateau. The CRB and associated minor sedimentary interbeds are the primary aquifer in the region. In the West Plains area, the CRB includes the older Grand Ronde Basalt and the younger Wanapum Basalt (Derkey 2007; Derkey et al. 2004). Sedimentary interbeds within the basalts are part of the Latah Formation and are composed of loosely consolidated sand with interbedded silt and clay (Griggs 1976).

Between 17,500 and 14,500 years ago, megafloods from Glacial Lake Missoula scoured deep channels into the CRB. Five of these paleochannels are present in the West Plains area. The paleochannels are filled with sand and gravel deposited by the megafloods (Pritchard et al. 2020).

In the basalts, groundwater occurs in fracture zones at the top and bottom of individual basalt flows. Groundwater also occurs in the sedimentary interbeds of the Latah Formation. The interior zones of individual flow act as aquitards (Griggs 1976; Pritchard and Cebula 2016). Unconfined groundwater is found in the Wanapum Basalt and parts of the Latah Formation. Unconfined groundwater is also found in Quaternary megaflood sediments deposited in the paleochannels incised into the basalts by the Missoula floods.

Groundwater flow directions in the Wanapum and Grande Ronde basalts are generally west to east. Canyons and the paleochannels locally deflect flow directions and compartmentalize the basalt aquifers. Hydraulic connectivity between the Wanapum Basalt and Quaternary sediments within the paleochannels is complex. Some portions of the paleochannels recharge adjacent basalt aquifers, and others receive groundwater from the basalts. However, groundwater in the paleochannels generally discharges relatively quickly to the Spokane River valley (GSI Water Solutions and others 2015). The Airport and Airway Heights paleochannels span the distance between potential PFAS source areas of Fairchild Air Force Base and Spokane International Airport and the Spokane River. They are a potential conduit to deliver contamination to the river (Figure 1).

4.0 Project Description

4.1 Project goals

The overall goal of this assessment is to determine whether the PFAS-contaminated groundwater in the West Plains aquifer is migrating to nearby surface waters.

Determining whether PFAS-contaminated groundwater affects surface water will help prioritize areas for further investigation based on the magnitude of effects and the proximity of nearby receptors. Further investigations may include new studies by Ecology's Environmental Assessment Program under a new Quality Assurance Project Plan (QAPP) or work done by other Ecology programs informed by this study's results.

4.2 Project objectives

The objective of this assessment is to identify and characterize PFAS concentrations in surface water of the Spokane River and its tributaries and in shallow groundwater in areas identified as discharging to those surface waters (see section 7.2.1). Samples will be collected twice, once in August 2024 and once in March or April 2025.

4.4 Tasks required

The primary tasks for this preliminary assessment include:

- Coordinate any permissions needed for site access and sampling.
- Scout field sites before sampling to determine the feasibility of access and sampling.
- Coordinate with laboratories before sampling.
- Prepare and decontaminate field equipment.
- Conduct sampling according to section 7 of this QAPP addendum and section 8 of the programmatic QAPP (Carnes et al. 2024).
- Ship samples to laboratories for analysis of PFAS and general chemistry.
- Review and assess analytical data quality.
- Conduct data analysis and write a summary report.

5.0 Organization and Schedule

5.4 Proposed project schedule

Table 2. Sample schedule for completing field and laboratory work.

Task	Due date	Lead staff
Fieldwork	August 2024 and May 2025	Jacob Carnes
Laboratory analyses	December 2024 and September 2025	Manchester Environmental Laboratory (MEL)/Contract Lab
Draft Validated EDD	March 2025 and December 2025	MEL Data Validator
Contract lab data validation	February 2025	MEL Data Validator

Table 3. Schedule for data entry.

Task	Due date	Lead staff
EIM data loaded[a]	January 2026	Jacob Carnes
EIM QA	February 2026	Siana Wong
EIM complete	March 2026	Jacob Carnes

EIM: Environmental Information Management system
QA: quality assurance
[a] EIM Project ID: StatewidePFAS02

Table 4. Schedule for final report.

Task	Due date	Lead staff/support staff
Draft to supervisor	March 2026	Jacob Carnes/Siana Wong
Draft to client/ peer reviewer	April 2026	Jacob Carnes/Siana Wong
Draft to external reviewers	N/A	Jacob Carnes/Siana Wong
Final draft to publications team	May 2026	Jacob Carnes/Siana Wong
Final report due on the web	July 2026	Jacob Carnes/Siana Wong

QA: quality assurance
N/A: not applicable

5.5 Budget and funding

Table 5 summarizes the costs for laboratory analysis of samples. Ecology's Manchester Environmental Laboratory (MEL) will analyze samples for dissolved organic carbon, total organic carbon, and total suspended solids. An accredited contract laboratory will be used for PFAS analyses until MEL is accredited for method 1633 (EPA 2024).

Table 5. Outline of laboratory costs broken down by parameter and sample matrix.

Parameter	Sample Matrix	Laboratory	Cost Per Sample ($)	Number of samples	Total ($)
PFAS Analytes[a]	Water	Contract	385	72	$27,720
TOC	Water	MEL	38	41	$1,588
DOC	Water	MEL	49	60	$2,940
TSS	Water	MEL	20	37	$740
MEL Surcharge[b]					$8,316
Total					**$41,304**

DOC: Dissolved organic carbon
MEL: Manchester Environmental Laboratory
PFAS: Per- and polyfluoroalkyl substances
TOC: Total organic carbon
TSS: Total suspended solids
[a] If MEL is accredited for Method 1633 by the Spring 2025 sampling, the cost for PFAS analytes will be $510/sample, and there will be no surcharge. The total analytical costs will be $41,988.
[b] Analyses performed by contract labs are subject to a 30% surcharge for contracting and data review by MEL.

6.0 Quality Objectives

6.2 Measurement quality objectives

The Environmental Protection Agency (EPA) published the final Method 1633 for analysis of 40 PFAS compounds in January 2024 and issued errata in March 2024 (EPA 2024). The laboratory must be capable of meeting the requirements for precision, accuracy, and limits of quantitation applicable to this method.

Table 6 and Appendix B summarize the measurement quality objectives (MQOs) for the aqueous samples analyzed by method 1633. These MQOs apply to this and future environmental assessments completed under the Programmatic QAPP (Carnes et al. 2024). Laboratories must meet the precision, accuracy, and limits of quantitation defined in method 1633 (EPA 2024).

Table 6. Measurement quality objectives for aqueous samples analyzed for PFAS compounds by method 1633.

Lab and Field Duplicate Samples (RPD)[a]	Matrix Spike/Matrix Spike Duplicate (% Recovery)	Matrix Spike/Matrix Spike (RPD)	Method Blank	Ongoing Precision and Recovery and Low-level OPR (% Recovery)	Surrogate Standards (% Recovery)	Method Detection Limit
≤40	50–150	≤30	No analytes detected >½ LOQ or ML	See Appendix Table B1	See Appendix Table B2	0.1–4.0 ng/L

LOQ: Limit of Quantitation
ML: Minimum Level
OPR: On-going precision and recovery
PFAS: Per- and polyfluoroalkyl substances
RPD: Relative Percent Difference
[a] This criteria applies to results >5x the ML; for duplicate results <5x the ML, the acceptance criteria will be the absolute difference of the sample results <2x the ML.

7.0 Study Design

7.1 Study boundaries

This study will occur on the Spokane River between the Washington-Idaho state line and the downstream end of Long Lake, as well as tributaries to the river along that length (Figure 2).

7.2 Field data collection

7.2.1 Sampling locations and frequency

Sampling will occur in summer 2024 and spring 2025. Locations on the Spokane River, Little Spokane River, and Latah Creek will be sampled in August 2024. Several tributaries to the Spokane River, including Coulee Creek, Deep Creek, Garden Springs Creek, and Indian Canyon Creek, are typically dry by August. Locations on those tributaries will be sampled in March or April 2025. Three locations along the Spokane River will be sampled in the Summer of 2024 and Spring of 2025. Table 7 summarizes the planned spring and fall sampling events and lists the total number of samples to be collected, including quality assurance samples. Table 8 lists the number of quality assurance samples to be collected in the field.

Table 7. Summary of samples to be collected.

Lab	Parameter	Matrix	Number of Samples	Sample Arrival to Lab Date	Expected Range of Results
Contract	PFAS	Water	36	August 2024	<0.2–1,800 ng/L
MEL	TOC	Water	21	August 2024	1–10 mg/L
MEL	DOC	Water	30	August 2024	<1–10 mg/L
MEL	TSS	Water	19	August 2024	<1–50 mg/L
Contract	PFAS	Water	36	April/May 2025	<0.2–1,800 ng/L
MEL	TOC	Water	20	April/May 2025	1–10 mg/L
MEL	DOC	Water	30	April/May 2025	<1–10 mg/L
MEL	TSS	Water	18	April/May 2025	<1–50 mg/L

DOC: Dissolved organic carbon
PFAS: Per- and polyfluoroalkyl substances
TOC: Total organic carbon
TSS: Total suspended solids.

Table 8. Summary of quality assurance samples to be collected.

Analyte	Date	Primary Samples	Field Duplicates	Field Blanks	Equipment Blanks	Lab Duplicates	MS	MSD	Total
PFAS	Summer 2024	23	3	3	1	2	2	2	36
TOC	Summer 2024	17	2	—	—	—	1	1	21
DOC	Summer 2024	23	3	—	—	—	2	2	30
TSS	Summer 2024	17	2	—	—	—	—	—	19
PFAS	Spring 2025	23	3	3	1	2	2	2	36
TOC	Spring 2025	16	2	—	—	—	1	1	20
DOC	Spring 2025	23	3	—	—	—	2	2	30
TSS	Spring 2025	16	2	—	—	—	—	—	18

DOC: Dissolved organic carbon
MS: Matrix Spike
MSD: Matrix Spike Duplicate
PFAS: Per- and polyfluoroalkyl substances
TOC: Total organic carbon
TSS: Total suspended solids

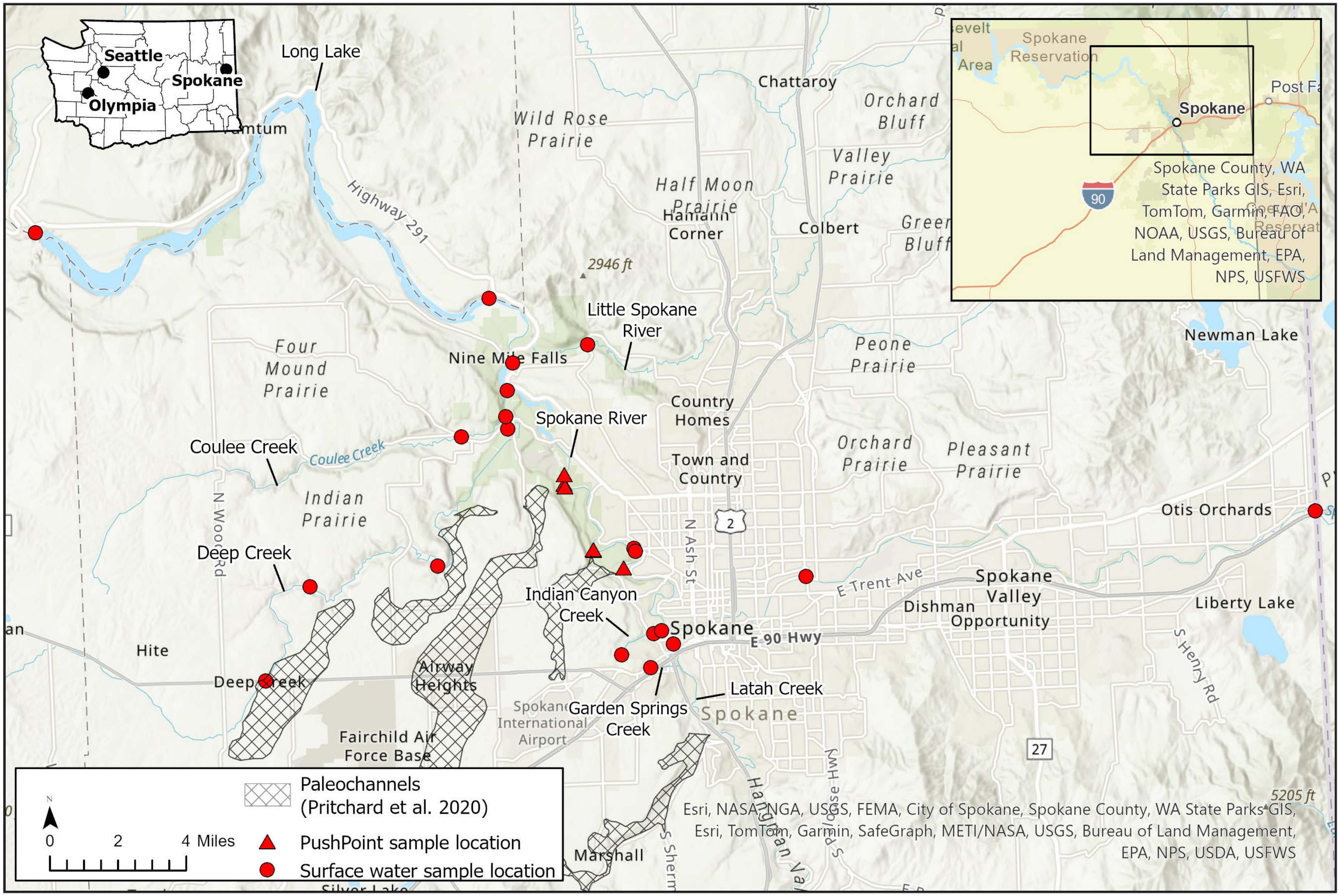

Figure 2. Map of prospective sample locations.

Table 9 lists prospective sample locations. Surface water samples will be collected along the Spokane River from the state line to the downstream end of Long Lake, including samples upstream and downstream of areas suspected of receiving contaminated groundwater discharge. Shallow (~1 ft below stream bed) groundwater samples will be collected with a PushPoint sampler in areas inferred to receive groundwater discharge from paleochannels. If site conditions prohibit the use of the PushPoint sampler, piezometers will be installed, if possible, to collect shallow groundwater samples.

Table 9. Sample locations.

Date	Location Description	Coordinates	Surface Water	Push Point
Summer 2024	Spokane River, State Line	47.697918, -117.042685	X	
Summer 2024	Spokane River, Upstream end of Deep Creek Bay	47.762775, -117.547905	X	
Summer 2024	Latah Creek, at stream gauge	47.6526688, -117.449658	X	
Summer 2024	Spokane River, upstream of Latah Creek	47.658438, -117.456574	X	
Summer 2024	City of Spokane WWTP effluent	47.693810, -117.471989	X	
Summer 2024	Spokane River, upstream of WWTP effluent	47.692581, -117.471175	X	
Summer 2024	Spokane River, below Nine Mile dam	47.774481, -117.544026	X	
Summer 2024	Little Spokane River, at Rutter Way gage	47.78100099, -117.4963338	X	
Summer 2024	Spokane River, upstream end of Long Lake	47.802281, -117.557367	X	
Summer 2024	Spokane River, Downstream of Long Lake Dam	47.836820, -117.841565	X	
Summer 2024	Spokane River, at Green Street	47.67905905, -117.3646571	X	
Summer 2024	Spokane River, Little Cove beach	47.686119, -117.478999	X	X
Summer 2024	Spokane River, unnamed beach	47.694119, -117.497406	X	X
Summer 2024	Spokane River, unnamed beach	47.722600, -117.514414	X	X
Summer 2024	Spokane River, unnamed beach	47.721482, -117.513904	X	X
Summer 2024	Spokane River, unnamed beach	47.726682, -117.514065	X	X
Summer 2024	Unnamed creek, at confluence with the Spokane River	47.694364, -117.497597	X	X

Date	Location Description	Coordinates	Surface Water	Push Point
Spring 2025	Indian Canyon Creek, confluence with Latah Creek	47.657320, -117.461616	X	
Spring 2025	Indian Canyon Creek, upstream of mystic falls	47.648844, -117.482284	X	
Spring 2025	Garden Springs Creek, Finch Arboretum	47.642875, -117.464474	X	
Spring 2025	Tributary to Deep Creek, confluence with Deep Creek	47.746611, -117.548491	X	
Spring 2025	Coulee Creek, confluence with Deep Creek	47.751821, -117.549614	X	
Spring 2025	Coulee Creek, 7 Mile Rd	47.743920, -117.577872	X	
Spring 2025	Deep Creek, at Christensen Rd	47.689411, -117.595640	X	
Spring 2025	Deep Creek, at Euclid Road	47.682579, -117.676551	X	
Spring 2025	Deep Creek, at US Highway 2	47.643340, -117.706352	X	
Spring 2025	Deep Creek	To Be Determined[a]	X	X
Spring 2025	Coulee Creek	To Be Determined[a]	X	X
Spring 2025	Indian Canyon Creek	To Be Determined[a]	X	X
Spring 2025	Garden Spring Creek	To Be Determined[a]	X	X
Spring 2025	Spokane River, Little Cove beach	47.686119, -117.478999	X	X
Spring 2025	Spokane River, unnamed beach	47.722600, -117.514414	X	X
Spring 2025	Unnamed creek, at confluence with the Spokane River	47.694364, -117.497597	X	X

[a] Because flows on Deep Creek, Coulee Creek, Indian Canyon Creek, and Garden Spring Creek are typically low, exact sample locations will be chosen based on the presence of flow and proximity to groundwater discharge areas identified by conductivity and temperature surveys described in this section.

We will attempt to collect an effluent sample from where the Spokane wastewater treatment plant discharges to the Spokane River to assess whether the river is receiving pass-through contamination.

We may also collect limited "opportunistic" samples if one or more of the planned sample locations are inaccessible. Opportunistic sample locations will be selected to replace the inaccessible sample location or supplement the information provided by the above sample locations.

Samples will be collected following section 8.2 of the original programmatic QAPP (Carnes et al. 2024) and PFAS-specific surface water sampling guidance developed by the state of Michigan (MDEQ 2022).

For surface water sampling at locations with a depth greater than one foot, samples will be collected approximately six inches below the water surface. If any sample locations have less than one foot of depth, samples will be collected from the approximate mid-point of the water column (MDEQ 2022).

To select groundwater sample locations for the shallow groundwater samples, the relative temperatures of river water and sediment porewater will be measured to identify areas along the riverbank where groundwater discharge is likely occurring. Surface water temperatures vary with ambient air temperatures, while groundwater maintains a relatively stable temperature year-round.

During hot summer weather, groundwater will be cooler than surface water. During cold winter weather, groundwater will be warmer than surface water. The difference in temperature between surface water and sediment pore water can indicate whether groundwater is discharging to surface water. Losing surface water reaches (surface water discharging to groundwater) are marked by sediment porewater temperatures that are close to surface water temperatures. Gaining surface water reaches (groundwater discharging to surface water) are marked by sediment porewater temperatures that are cooler than surface water temperatures in the summer and warmer than surface water temperatures in the winter.

Conductivity values in river water will also be used to identify locations where groundwater discharges to the river. Groundwater conductivity values near the Spokane River range from 270 uS/cm to 600 uS/cm, while surface water conductivity values in the Spokane River area range from 75 uS/cm to 250 uS/cm (Sinclair and Gallagher 2019). Localized areas of elevated conductivity in river water may indicate groundwater discharge to the river.

Before sampling, the hydraulic head in the PushPoint sampler or piezometer will be compared to the stream's water level to confirm gaining stream conditions at the sampling point. Then, the PushPoint sampler or piezometer will be purged until the field parameters (pH, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity) are stabilized, as described in the programmatic QAPP (Carnes et al. 2024).

Further investigations may be warranted to fully describe the PFAS distribution in the water column, pore water, and sediment. Additional sampling with methodology not included in this QAPP addendum (e.g., sediments samples, depth-integrated surface-water samples) would be described in a new QAPP Addendum or new QAPP.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

Access to sampling locations may be difficult for some sampling locations. We will visit the study area before sampling to assess the best access points. If access to specific sampling locations is not possible, a nearby and comparable accessible location will be chosen to collect the sample.

Samples will be frozen in the Ecology Headquarters walk-in freezer within 48 hours of collection. To meet the 48-hour criteria, we will use two sampling teams in the field. If a delay occurs in the field, one team will transport samples collected over the first two days of sampling to Lacey, while the other team will collect the remaining samples.

7.5.3 Schedule limitations

The summer 2024 samples need to be collected before Labor Day. After Labor Day, water is released from the Post Falls dam in Idaho, greatly increasing flows on the river. This sampling is tentatively scheduled for the week of August 19th. If needed, sampling can also be conducted the following week.

11.0 Data Management Procedures

11.3 Electronic transfer requirements

The contract laboratory will email the project manager an electronic data deliverable (EDD) in Microsoft Excel spreadsheet format following the Ecology EIM results template. The contract lab EDD may not include fields added in a recent EIM update. The newly added fields relate to data censoring for low-level polychlorinated biphenyl analyses and are not used for PFAS data.

13.0 Data Verification

13.3 Validation requirements, if necessary

Stage 4 data validation for all PFAS analyses is required for studies completed under this QAPP. The validation will be performed by MEL or a contracted firm. The stage 4 data validation will be completed using the technical specifications of the following:

- The programmatic QAPP (Carnes et al. 2024) and this QAPP addendum.
- EPA Method 1633 Final, Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS, January 2024.
- SGS-AXYS Method MLA-110 Analytical Procedure for the Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous Samples, Solids, Tissues, AFFF products, Blood/Serums and Solvent Extracts by LC-MS/MS Revision 02, Version 13, September 2023.
- National Functional Guidelines for Organic Superfund Methods Data Review (EPA 2020).
- MEL PFAS Analysis by EPA Method 1633, SOP 730137, Version 1.0 (Romine 2023)
- MEL Data Validation of EPA Method 1633 PFAS Analytical Data, SOP 770046, April 2024 (Frans 2024).

The above document versions are current as of the publication of this QAPP addendum. Validators should use the latest version available for each document.

14.0 Data Quality (Usability) Assessment

14.2 Treatment of non-detects

Contract laboratory sample results that are non-detects are reported to the contract-required detection limit or sample-specific detection limit, whichever is higher.

15.0 References

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16.0 Appendices

Appendix B. Method 1633 Acceptance Criteria

Table B1. IPR/OPR/LLOPR acceptance limits for target analytes in aqueous matrices.

Target Analyte	IPR Mean Recovery (%)[a]	IPR RSD (%)	ORP/LLORP Recovery (%)[a]
PFBA	70–135	21	70–140
PFPeA	70–135	23	65–135
PFHxA	70–135	24	70–145
PFHpA	70–135	28	70–150
PFOA	65–155	27	70–150
PFNA	70–140	28	70–150
PFDA	65–140	26	70–140
PFUnA	70–135	29	70–145
PFDoA	70–130	21	70–140
PFTrDA	60–145	29	65–140
PFTeDA	70–145	27	60–140
PFBS	70–140	23	60–145
PFPeS	70–135	25	65–140
PFHxS	70–135	27	65–145
PFHpS	70–140	30	70–150
PFOS	70–140	29	55–150
PFNS	70–135	29	65–145
PFDS	70–135	30	60–145
PFDoS	45–135	35	50–145
4:2FTS	70–135	27	70–145

Target Analyte	IPR Mean Recovery (%)[a]	IPR RSD (%)	ORP/LLORP Recovery (%)[a]
6:2FTS	70–135	32	65–155
8:2FTS	70–140	33	60–150
PFOSA	70–135	22	70–145
NMeFOSA	70–135	30	60–150
NEtFOSA	70–130	26	65–145
NMeFOSAA	65–140	32	50–140
NEtFOSAA	70–135	28	70–145
NMeFOSE	70–135	29	70–145
NEtFOSE	70–130	21	70–135
HFPO-DA	70–135	23	70–140
ADONA	70–135	23	65–145
PFMPA	60–140	23	55–140
PFMBA	65–145	27	60–150
NFDHA	65–140	37	50–150
9Cl-PF3ONS	70–145	30	70–155
11Cl-PF3OUdS	50–150	35	55–160
PFEESA	70–135	25	70–140
3:3FTCA	70–130	23	65–130
5:3FTCA	70–130	24	70–135
7:3FTCA	55–130	34	50–145

IPR: Initial precision and recovery
LLOPR: Low-level ongoing precision and recovery
OPR: On-going precision and recovery
RSD: Relative standard deviation
[a] The recovery limits apply to the target analyte results for IPR, OPR, and LLOPR samples for aqueous matrices. Data for this matrix type are derived from the multi-laboratory validation study and are, therefore, the limits required for this method.

Table B2. Acceptance limits for EIS compounds in all aqueous matrices and QC samples.

EIS Compound	Recovery (%)[a]
$^{13}C_4$-PFBA	5[b]–130
$^{13}C_5$-PFPeA	40–130
$^{13}C_5$-PFHxA	40–130
$^{13}C_4$-PFHpA	40–130
$^{13}C_8$-PFOA	40–130
$^{13}C_9$-PFNA	40–130
$^{13}C_6$-PFDA	40–130
$^{13}C_7$-PFUnA	30–130
$^{13}C_2$-PFDoA	10–130
$^{13}C_2$-PFTeDA	10–130
$^{13}C_3$-PFBS	40–135
$^{13}C_3$-PFHxS	40–130
$^{13}C_8$-PFOS	40–130
$^{13}C_2$-4:2FTS	40–200
$^{13}C_2$-6:2FTS	40–200
$^{13}C_2$-8:2FTS	40–300
$^{13}C_8$-PFOSA	40–130
D_3-NMeFOSA	10–130
D_5-NEtFOSA	10–130
D_3-NMeFOSAA	40–170

EIS Compound	Recovery (%)[a]
D_5-NEtFOSAA	25–135
D_7-NMeFOSE	10–130
D_9-NEtFOSE	10–130
$^{13}C_3$-HFPO-DA	40–130

EIS: Extracted Internal Standards
[a] The recovery limits for the EIS compounds were derived by the EPA from the aqueous sample data from a multi-laboratory validation study. To simplify laboratory operations, the EPA has applied the same EIS recovery limits used for field sample analyses to the EIS recoveries in the IPR, OPR, and LLOPR samples. There are no IPR mean or RSD criteria for the EIS compounds.
[b] Recovery of $^{13}C_4$-PFBA can be problematic in some field samples. Although the lower limit for recovery for this EIS is set below 10%, laboratories should routinely track recovery of this EIS and take reasonable steps to ensure that recovery is at least 10% in most samples.