Quality Assurance Project Plan
PFAS in Freshwaters Across Washington: Screening Level Survey

By
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For the
Environmental Assessment Program

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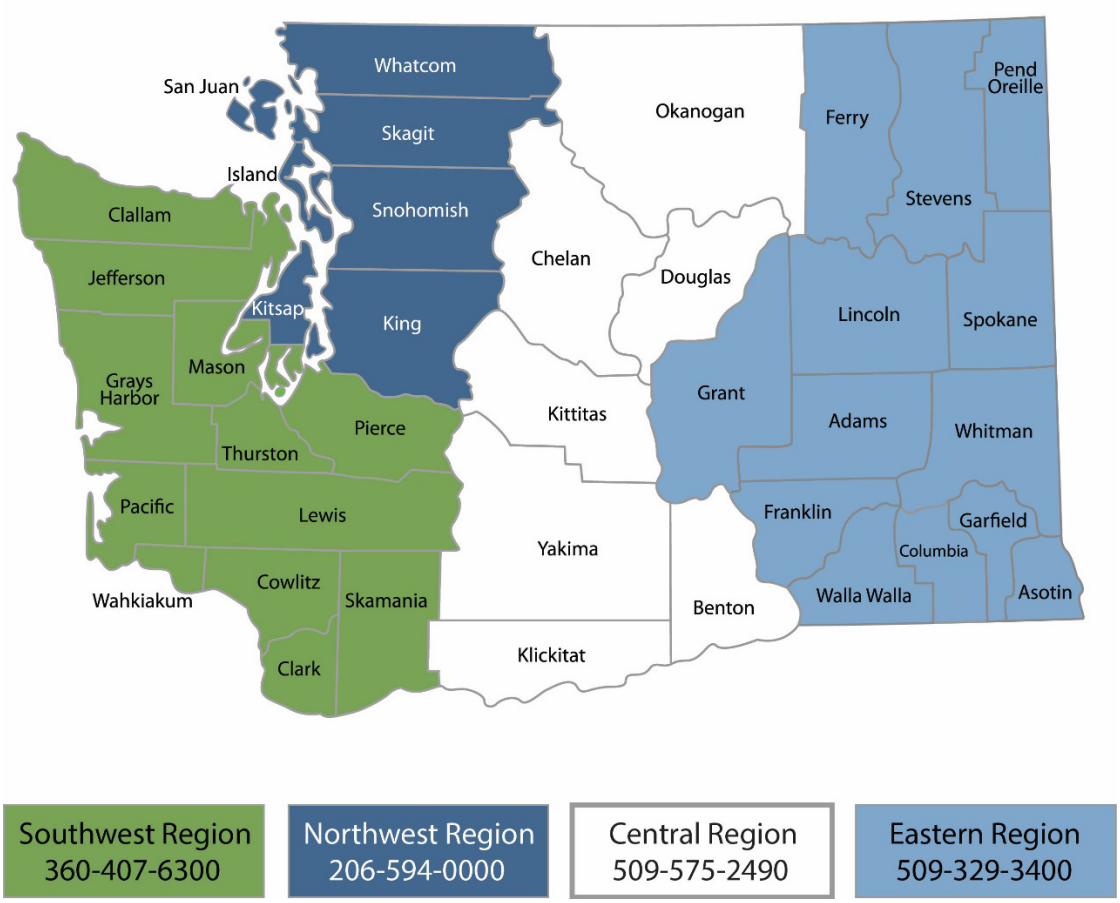
[1] https://www.ecology.wa.gov/Research-Data/Data-resources/Environmental-Information-Management-database

Department of Ecology's Regional Offices

Map of Counties Served



Region	Counties Served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
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Quality Assurance Project Plan

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By Siana Wong
October 2025

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2.0 Abstract

Per- and polyfluoroalkyl substances (PFAS) are a group of human-made fluorinated chemicals. There are thousands of PFAS compounds, many of which are known to be persistent, bioaccumulative, and toxic, and many more with unknown properties and health effects. Because of their widespread use in common consumer products and commercial and industrial applications, PFAS are found almost everywhere globally.

In Washington, two statewide studies conducted in 2008 and 2016 found detections of PFAS in all 18 waterbodies sampled. The highest levels of PFAS were found in urban and wastewater treatment plant-influenced waterbodies. Given the widespread occurrence of PFAS and the large network of surface waters across the state, there are likely waterbodies with PFAS contamination that remain unidentified, potentially posing a risk to human health and the environment.

In this study, the Washington State Department of Ecology (Ecology) will conduct a survey to screen for PFAS in selected freshwater bodies across the state. The main goal of this study is to document and characterize PFAS concentrations in surface waters across Washington, focusing in areas that have little or no PFAS data, and that have *potential* for PFAS contamination from surrounding land uses.

This study proposes collecting surface water samples from 35 freshwater bodies in watersheds characterized by different land uses across Washington during one summer low flow and one spring high flow event. Results from the study will add to our knowledge about PFAS occurrence in Washington and may indicate areas with contamination that might otherwise remain unidentified and unaddressed.

3.0 Background

3.1 Introduction and problem statement

Per- and polyfluoroalkyl substances (PFAS) are a group of thousands of human-made fluorinated chemical compounds that are persistent, bioaccumulative, and toxic. PFAS have physical and chemical properties (e.g., water and oil repellency, heat and stain resistance, friction reduction, and chemical durability) that have made them useful in a wide array of commercial products and industrial applications since the 1940s. They have been used in consumer products such as nonstick cookware, surface treatments for carpets and clothing, and some cosmetic and personal care products. They have been used in industrial applications such as aqueous film-forming foams (AFFF), processing aids used in plastic and rubber manufacturing, sealants and coatings used in building and construction, electrical, fuel, and mechanical components used in aerospace and automotive manufacturing, and water and grease-proof coatings used in paper and packaging (ITRC 2023).

In the early 2000s, manufacturers in the U.S. began phasing out certain PFAS, including legacy PFAS such as perfluorooctane sulfonic acid (PFOS) and perfluorooctanoic acid (PFOA), as concerns about their impacts to human health and the environment grew. A growing body of scientific research has provided evidence linking certain PFAS with effects to the liver, immune, and endocrine systems, reproductive and developmental issues, increased risk of some cancers, and other health effects (ASTDR 2021). The same properties that have made PFAS so useful have also made them harmful to the environment. Certain PFAS do not easily break down once released from their sources into landfills, wastewaters, and ultimately the environment (ITRC 2023). Many PFAS can accumulate in organisms and biomagnify through food webs, even at low environmental concentrations (Garcia-Garin et al. 2023; Miranda et al. 2023).

Less is known about the thousands of newer PFAS chemicals that have replaced legacy PFAS (Fenton et al. 2021; Ng et al. 2021). As newer PFAS continue to be developed and used to replace the older chemistries, concerns about their potential toxicity and environmental impacts have risen, thus repeating the cycle of potentially “regrettable substitutions.” For example: Little data exists on the toxicity of newer PFAS; some newer PFAS transform into legacy PFAS in the environment; some newer short-chain PFAS are more highly mobile and may be more difficult to remediate in the environment; and many newer PFAS go undetected in the environment because current analytical methods cannot effectively detect them.

Because of their persistence and widespread use, PFAS are ubiquitous in the environment — they have been detected globally in air, groundwater, surface water, drinking water, rainwater, and animals (e.g., Brase et al. 2021; Xu et al. 2021; Cousins et al. 2022; Waterkeeper Alliance 2022; Andrews et al. 2023; Faust 2023; Smalling et al. 2023). Some areas are known to be more highly contaminated with PFAS, including areas of AFFF release, industrial facilities that produce or use PFAS, and waste management sites (Salvatore et al. 2022).

In Washington state, it has been estimated that there are over 1,000 facilities where PFAS might be used as part of their manufacturing and industrial processes (Ecology and Health 2022). This estimate does not include AFFF release or waste management sites. In addition,

there are over 70,000 miles of rivers and streams[1] and over 8,000 lakes in Washington (Dion 1978), making water quality monitoring challenging with limited resources. Given the sheer number of sites with PFAS contamination potential across Washington, and the vast number of freshwaters in the state, it is likely that there are contaminated areas that have not been well-studied or monitored and remain unidentified.

In this study, the Washington State Department of Ecology's (Ecology's) Chemical Action Plan Implementation Monitoring (CAPIM) program will conduct statewide sampling to screen for PFAS in areas where there is potential for PFAS contamination, and where little or no data exists. We will document levels in different geographies and land use types across the state. We will also incorporate multiple PFAS analytical methods into our sampling to test for the presence of newer PFAS and ultrashort-chain PFAS, of which limited data currently exists for the state. Results from the study may indicate areas with contamination that might otherwise remain unidentified and therefore unaddressed, potentially posing a risk of human health and the environment. In these cases, further assessments may be recommended, for example, through the CAPIM program's programmatic QAPP (Carnes et al. 2024a) or through other programs.

3.2 Study area and surroundings

Sampling for this study will focus on surface waters across Washington that have greater potential for PFAS contamination based on surrounding land uses. This includes urban, rural, and montane settings in western, central, and eastern regions of the state. A map of proposed sampling locations is given in Figure 1. Sampling areas will be characterized by one or more of the following:

- ***High number of PFAS industrial sector facilities.*** Areas where there are relatively high numbers of industrial activities that may be associated with PFAS.
- ***High pesticide exposure areas.*** Areas with greater pesticide exposures.
- ***Downstream from wastewater treatment plants (WWTPs).*** Surface waters downstream from WWTP discharges.
- ***Biosolids application areas.*** Waterbodies in known biosolids application areas.
- ***Downgradient from recreational ski areas.*** Waterbodies downgradient from recreational ski areas.
- ***Proximity to airports.*** Waterbodies proximate to commercial airports.
- ***Reference locations.*** Waterbodies in non-urban watersheds with no known major non-atmospheric sources of PFAS.

[1] https://www.rivers.gov/washington

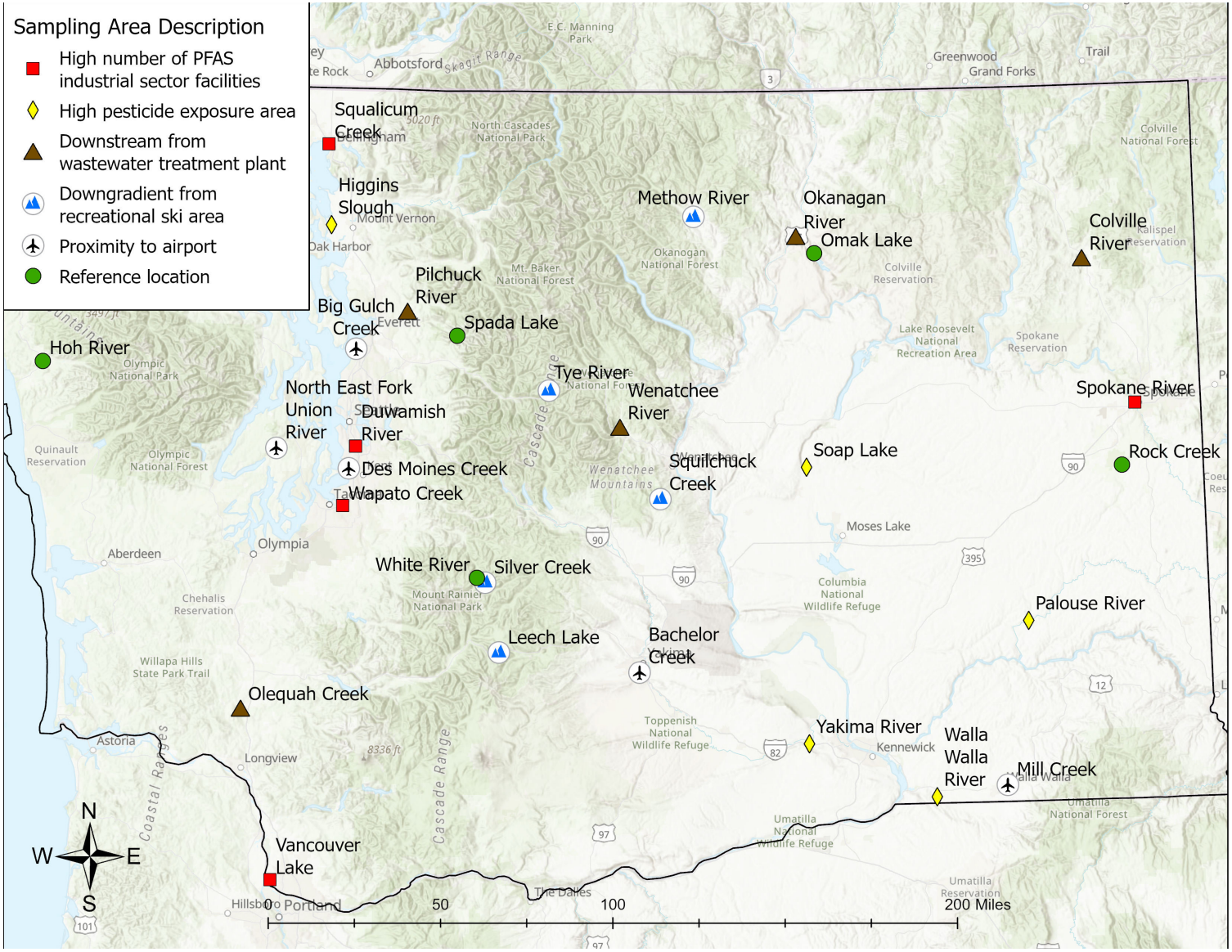

Figure 1. Map showing proposed sampling locations across Washington.

Sampling locations in biosolids application areas are to be determined and not shown.

3.2.1 History of study area

We used the site selection criteria described above to prioritize study locations among the extensive network of freshwaters across the state. Further rationales for including these areas in our statewide PFAS sampling are provided below. It is possible that study locations have multiple PFAS sources. For this project, we will select locations that have potential for PFAS contamination based on land uses defined by one or more of the site selection criteria. If high levels of PFAS are found at a study location, further study to delineate sources would likely be necessary.

High Number of PFAS Industrial Sector Facilities

Although PFAS manufacturing does not currently and did not historically occur in Washington (Ecology and Health 2022), PFAS are still used and found in many consumer products and commercial and industrial applications in the state. As a result, PFAS ends up in Washington's waste streams and ultimately the environment (Furl and Meredith 2010; Mathieu and McCall 2017; Bothfield and Mathieu 2022; Wong 2024; Mathieu and Foster 2025). Urban developed areas tend to have the highest PFAS contamination because of the concentrated presence of multiple potential sources like AFFF releases, industrial facilities that use PFAS, waste management sites, and consumer products that contain PFAS (Jarvis et al. 2021; Smalling et al. 2023; Paige et al. 2024).

In Washington, industrial activities that are commonly or presumed to be associated with PFAS ("PFAS industrial sectors") tend to be concentrated in major metropolitan areas (See Section 4.3). In this study, sampling sites will include waterbodies within the major metropolitan areas of the Puget Sound region, Spokane, Vancouver, as well as the smaller metropolitan area of Bellingham.

High Pesticide Exposure Areas

Pesticides are used in agriculture, home gardens and lawns, commercial areas, and public spaces such as parks and golf courses to kill undesirable insects, weeds, rodents, and fungi. Some conventional pesticides are known to contain PFAS.

Donley et al. (2024) found that the biggest contributors to PFAS in U.S.-based conventional pesticides were active ingredients and their metabolites, as well as leaching from fluorinated pesticide containers. It should be noted that Donley et al. (2024) used the Organization for Economic Co-operation and Development (OECD) definition for PFAS, which includes any compound with at least one fully fluorinated methyl or methylene carbon atom without any H/Cl/Br/I atom attached to it. In regulatory context, this definition is more encompassing than the EPA's definition, which includes chemicals that meet the structural definition outlined in 40 CFR 705[1]. In our screening level study, we more broadly use the term PFAS.

[1] https://www.ecfr.gov/current/title-40/chapter-I/subchapter-R/part-705

Based on the OECD definition, 59 of the 66 currently registered conventional PFAS active ingredients identified in Donley et al. (2024) are in 1,358 pesticide labels currently registered in Washington state (Washington State University Pesticide Resources and Education Program, n.d.). These and other common organofluorine pesticide compounds may not be included in the target analyte list for this project (Table A1), however could eventually break down into trifluoroacetic acid (TFA), a type of ultrashort-chain PFAS (Donley et al. 2024; Joerss et al. 2024), or be measurable as extractable organic fluorine (EOF).

Leaching from fluorinated storage containers is a mechanism by which PFAS can enter into pesticide products. For example, Whitehead and Peaslee (2023) found considerable levels of perfluoroalkyl carboxylic acids (PFCAs) in fluorinated storage containers, as well as the food products contained within them. In that study, short-chain PFCAs were the most frequently detected compounds in both the fluorinated containers and food matrices, with decreasing analyte concentration as carbon chain length increased.

There is potential for higher detections of PFAS in areas where PFAS-containing pesticides are used. However, little is known about the effects of these pesticides on the environment. In this study, sampling sites will include areas of Washington that are estimated to have greater exposures to pesticides (See Section 4.3), which are also areas of the state that tend to have more PFAS data gaps. The highest exposures are estimated to be in central and eastern Washington, and smaller areas of northwestern Washington. An assumption is made that areas with greater pesticide exposures are also areas with greater exposures to pesticides containing PFAS. However, this may not always be the case.

Downstream from Wastewater Treatment Plants

The presence of PFAS in WWTP effluent is well-documented and reviewed (e.g., Lenka et al. 2021; Kurwadkar et al. 2022; Thompson et al. 2022). Their presence results from the many different uses and releases of PFAS that eventually wind up in residential, commercial, and industrial wastewaters. PFAS can be resistant to degradation in conventional WWTP processes, and studies have shown them to be largely retained or transformed in treated effluent and sewage sludge (Coggan et al. 2019; Kim et al. 2022; Moneta 2023). The levels and composition of PFAS in WWTP influents and effluents may be unique to the treatment plant (Bothfield and Mathieu 2022).

In Washington, higher levels of PFAS have been documented in waterbodies that receive effluents from WWTPs (Furl and Meredith 2010; Wong 2024). In this study, sampling sites will include waterbodies across central, eastern, and western Washington that receive effluent from WWTPs, and that have little or no PFAS data. River sampling locations will be located downstream of mixing zones.

Biosolids Application Areas

Biosolids are treated sewage sludge produced from the treatment of wastewater meeting specific EPA standards for land application or disposal. The practice of using treated wastes for soil amendment has been around for a century and regulated in the U.S. since the 1990s.

Because they are rich in organic matter and essential plant nutrients, they have been used globally as fertilizers for agriculture, public parks, and reforestation efforts.

The occurrence of PFAS in biosolids is well documented and reviewed (e.g., Venkatesan and Halden 2013; ITRC 2023; Saliu and Sauvé 2024). The use of biosolids as a soil amendment can potentially introduce PFAS to the aquatic environment through runoff into the receiving surface waters or infiltration to the groundwater (ITRC 2023; Oviedo-Vargas et al. 2025). The soils to which biosolids are applied may also serve as a long-term reservoir for PFAS in the environment (Johnson 2022). Effects to receiving waters may vary from location to location and depend on the levels and composition of PFAS present in the biosolids, surrounding environmental factors, and land management practices.

In Washington, PFAS have been detected in sewage sludge and biosolids collected from WWTP facilities that receive non-industrial wastewaters (Bothfield and Mathieu 2022). However, little information exists on whether applications of biosolids in the state have any measurable effects on PFAS levels in surrounding waters. In this study, sampling sites will include waterbodies in areas where biosolids have been applied to document PFAS concentrations and composition in those areas and help fill this data gap.

Downgradient from Recreational Ski Areas

Ski waxes are used to improve glide between the ski and snow surface and enhance performance in cross-country and downhill skiing. Fluorinated ski waxes offer a competitive advantage over non-fluorinated ski waxes because they typically provide superior glide. Previous studies have documented a variety of PFAS in different ski waxes available on the market (Plassmann and Berger 2010; Fang et al. 2020; Wang et al. 2020; Müller et al. 2023). Studies have also documented increased levels of PFAS in the blood of wax technicians, ski coaches, and experienced skiers compared to the general populations (Nilsson et al. 2010; Henn et al. 2024), which has led to concerns for human health. Additionally, abrasion of the ski wax onto the snow surface can cause the chemicals to shed onto the snow and lead to higher PFAS levels in snowmelt, receiving waters, and surrounding soils (Grønnestad et al. 2019; Carlson and Tupper 2020; Wang et al. 2020; Müller et al. 2023; Vogel et al. 2024).

Concern over impacts to human health and the environment led the U.S. Ski & Snowboard and the Canadian Ski Association to ban fluorinated ski waxes in North American competition beginning in 2020, following suit of similar earlier action by the International Ski Federation and the International Biathlon Union. In Washington, Ecology made the regulatory determination under the Safer Products for Washington program that a reporting requirement be added for ski waxes (Ecology 2024a). Manufacturers would be required to provide notice of the use of PFAS in ski waxes under RCW 70A.430.060.

Shifts in regulations and markets may lead to less frequent use of fluorinated ski waxes in recreational and competitive settings, and decisions by local ski shops to discontinue selling or using fluorinated waxes. However, fluorinated ski waxes may still be commercially available and used.

PFAS may also be present in other recreational outdoor gear such as waterproof clothing and gear treated with durable water repellent (DWR) finishes. Aging and weathering of fabrics treated with PFAS-containing DWR has been shown to result in volatilization, leaching, and transformation of PFAS from the fabrics (Van der Veen et al. 2020; Schellenberger et al. 2022). The concentrated occurrence of water-repellent gear presents another potential source of PFAS to the environment from recreational ski areas (Miner et al. 2020).

In Washington, no studies were found that documented PFAS levels in recreational ski areas and their surrounding environment. In this study, sampling sites will include locations downgradient of popular recreational ski areas to help fill this data gap.

Proximity to Airports

The greatest concern of PFAS contamination at airports is caused by AFFF release from fire training exercises and emergency responses (National Academies of Sciences, Engineering, and Medicine 2023). Other common sources of PFAS contamination at airports include hydraulic fluid releases from maintenance facilities and releases from industrial processes that use PFAS (National Academies of Sciences, Engineering, and Medicine 2023). Impacts of PFAS contamination at airports to the surrounding environment have been documented in previous studies, most commonly from AFFF-related releases (De Solla et al. 2012; Ahrens et al. 2015; Liu et al. 2022).

For several decades, the Federal Aviation Administration has required that 14 CFR Part 139 commercial airports maintain AFFF onsite, with a 2006 mandate that AFFF formulations contain PFAS in order to meet military specification performance standards (MIL-F-24385, “Mil-Spec”). Beginning in 2023, a new federal law allows Part 139 airports to transition to fluorine-free foam (F3) that meets new military specifications. In Washington, there are eleven Part 139 airports that currently store AFFF. Beginning in 2025, Washington State law will require Part 139 airports in the state to transition to F3 under RCW 70A.400.

With regulatory shifts away from AFFF, impacts from AFFF releases at airports can be expected to decline. Still, PFAS contamination from decades of AFFF use or from other sources at airports can linger in the surrounding environment. In this study, sampling sites will include locations near commercial airports in waterbodies that have had no known or limited PFAS sampling to document levels and composition in those areas.

Reference Locations

PFAS have been detected in remote locations across the world, from the Arctic to the Amazon to the Antarctic (Joerss et al. 2020; Hartz et al. 2023; Kourtchev et al. 2024; Pala et al. 2024). They enter even the most remote environments with no direct human inputs through global cycling and transport process such as atmospheric deposition and ocean circulation. In ice core samples collected from a remote region of the Arctic, Hartz et al. (2023) furthermore found atmospheric deposition of ultrashort-chain PFAS to be increasing over time.

In this study, we will sample non-urban locations across Washington that have no known major non-atmospheric sources of PFAS to the environment. We will focus in areas that have limited or no data in order to document PFAS levels and composition in those areas. Results from reference locations can be compared to results from non-reference sampling locations in this study to characterize differences in levels and composition between the two.

3.2.2 Summary of previous studies and existing data

In a 2008 statewide survey of 14 surface waterbodies across Washington, Furl and Meredith (2010) observed widespread occurrences of total perfluoroalkyl acid (sum of 13 perfluoroalkyl acid compounds) concentrations near or less than 10 ng/L in surface waters. That study found the highest total concentrations (greater than 10 ng/L) in waterbodies that receive treated effluent from WWTPs and in urban waterbodies.

In a follow-up statewide survey of 15 surface waterbodies across Washington, Mathieu and McCall (2017) similarly found the highest total perfluoroalkyl acid concentrations in WWTP-influenced and urban waterbodies. The study also found generally lower detection frequencies and total concentrations in surface waters in 2016 compared to 2008 at revisited sites.

In 2023, Ecology collected surface water and fish tissue samples for PFAS analysis in 10 lakes in western Washington (Mathieu and Foster 2025). Through Ecology's CAPIM programmatic QAPP studies, preliminary PFAS assessments have been carried out in the Yakima River (Carnes 2024a) and Spokane River watersheds (Carnes 2024b). Localized studies have also been completed in the Greater Lake Washington (Wong and Mathieu 2020), and South Fork Palouse River (Wong 2024) watersheds.

This study will mostly include sampling locations not previously sampled in the statewide surveys or CAPIM studies.

3.2.3 Parameters of interest and potential sources

PFAS are the main parameters of interest for this study. Targeted analyses will be used to test for 80 PFAS compounds at each site (Appendix A). Previous CAPIM studies focused on 40 target PFAS analytes. In this study we will test for an additional 40 compounds to document their presence and levels in waterbodies across the state and add to the current body of knowledge about PFAS in Washington's environment. The additional list includes ultrashort-chain PFAS compounds, such as TFA, which has become of interest and concern due to its persistence, mobility, global distribution, and increasing accumulation in the environment over time (Freeling and Björnsdotter 2023; Arp et al. 2024).

Extractable organic fluorine (EOF) will also be analyzed at each site to screen for the presence of unidentifiable PFAS compounds. EOF measures the total amount of organic fluorine that can be extracted from a sample, and can include both PFAS identifiable through target analyses and unknown PFAS. Organic fluorine compounds that are not considered PFAS may also be present in EOF, including some refrigerants (Sicard and Baker 2020), pharmaceuticals (Inoue et al. 2020), and pesticides (Donley et al. 2024). While not all EOF is PFAS, EOF is still a useful tool to screen for the presence of PFAS, including those unidentifiable through target analyses.

Samples will also be analyzed using the total oxidizable precursor (TOP) assay to screen for unidentifiable ultrashort-chain PFAS compounds. This method estimates the amount of unknown precursors to ultrashort-chain PFAS by oxidizing them to their stable and detectable ultrashort-chain end products. Inclusion of the ultrashort-chain TOP analysis in this project will add to our limited knowledge about ultrashort-chain PFAS in Washington.

3.2.4 Regulatory criteria or standards

In July 2022, Ecology established preliminary groundwater and soil cleanup levels for six PFAS compounds (PFOS, PFOA, PFNA, PFHxA, PFBS, and HFPO-DA under the Model Toxics Control Act. Cleanup levels were based on State Action Levels for PFOA, PFOS, PFNA, PFHxS, and PFBS in drinking water, set by the Washington State Department of Health (DOH) in January 2022.

In December 2022, the DOH updated screening levels for PFOS in fish fillet tissue. The updated screening levels are 1.8 ng/g and 0.6 ng/g for the general population and high consumers, respectively.

In April 2024, the first federal drinking water standards for five PFAS compounds (PFOS, PFOA, PFNA, PFHxS, HFPO-DA) and PFAS mixture were finalized, establishing enforceable maximum contaminant levels for these compounds (89 FR 32532[1]). Enforceable levels were set at 4 ng/L for PFOS and PFOA and 10 ng/L for PFNA, PFHxS, and HFPO-DA in drinking water.

In August 2024, Washington State adopted EPA's then draft national recommended aquatic life criteria for PFOS and PFOA in freshwater and marine waters (173-201A WAC1[2]). The Washington State freshwater aquatic life criteria freshwater water column are 3,000,000 ng/L (acute) and 8,400 ng/L (chronic) for PFOS and 49,000,000 ng/L (acute) and 94,000 ng/L (chronic) for PFOA. EPA's recommendations were later revised and finalized in October 2024 with lower thresholds for freshwater water column: 71,000 ng/L (acute, PFOS), 250 ng/L (chronic, PFOS), 3,100,000 ng/L (acute, PFOA), and 100,000 ng/L (chronic, PFOA).

In December 2024, the EPA drafted national recommended human health criteria for PFOS, PFOA, and PFBS in surface waters (89 FR 1050411[3]). The draft criteria for water + organism and organism only, respectively, are: 0.0009 ng/L and 0.00036 ng/L for PFOA; 0.06 ng/L and 0.07 ng/L for PFOS; and 400 ng/L and 500 ng/L for PFBS. As of March 2025, these recommendations have not been finalized by the EPA and have not been promulgated into Washington State law.

[1] https://www.federalregister.gov/documents/2024/04/26/2024-07773/pfas-national-primary-drinking-water-regulation

[2] https://app.leg.wa.gov/wac/default.aspx?cite=173-201A

[3] https://www.federalregister.gov/documents/2024/12/26/2024-30637/draft-national-recommended-ambient-water-quality-criteria-for-the-protection-of-human-health-for

4.0 Project Description

4.1 Project goals

The main project goal is to document, characterize, and screen for PFAS concentrations in freshwaters across Washington state, with a focus on areas that have little or no PFAS data, and have the potential for PFAS contamination from surrounding land uses.

The second goal is to document results for PFAS by target and screening analytical methods that have not been or less frequently been tested for in Ecology's previous environmental PFAS studies.

4.2 Project objectives

Project objectives are to:

- Collect surface water samples from 35 sites representing freshwaters (rivers, creeks, and lakes) in watersheds characterized by different land uses across Washington during two sampling events (summer low flow and spring high flow).
- Analyze samples for:
    - 40 target PFAS analytes (EPA 1633A)
    - Additional 35 target PFAS analytes (SGS AXYS Method MLA-121)
    - 5 ultrashort-chain target PFAS analytes (SGS AXYS Method MLA-120)
    - EOF (SGS AXYS Method MLA-119)
    - TOP assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)
    - Total organic carbon (TOC)
    - Dissolved organic carbon (DOC)
    - Total suspended solids (TSS)
- Collect field measurements for water temperature, dissolved oxygen, pH, and specific conductance using a YSI sonde.
- Report and disseminate results.

4.3 Information needed and sources

Information was gathered from multiple sources to aid in site selection.

EPA's Enforcement and Compliance History Online (ECHO) PFAS Industry Sector dataset was obtained from EPA's PFAS Analytic Tools[1] (EPA, n.d.). This dataset includes a list of industrial facilities in Washington state that *potentially* handle PFAS based on their industrial profile. A list of the types and numbers of PFAS industrial sector facilities in Washington is shown in Table 1.

Table 1. Types, counts, and statuses of industrial facilities in Washington that potentially handle or release PFAS.

Note: A facility may count in more than one category. Data source: EPA's PFAS Analytic Tools (EPA, n.d.).

Industry	Count	Active
Airports	555	62
Waste Management	381	161
Metal Coating	196	65
Chemical Manufacturing	186	75
Electronics Industry	140	35
Metal Machinery Manufacturing	125	56
Petroleum	119	60
Plastics and Resins	116	47
National Defense	66	26
Printing	51	16
Paper Mills and Products	46	30
Paints and Coatings	43	10
Industrial Gas	23	15
Mining and Refining	23	11
Cleaning Product Manufacturing	20	5
Fire Training	20	1
Furniture and Carpet	18	3
Fire Protection	17	4
Textiles and Leather	15	7
Airports (Part 139)	11	11
Cement Manufacturing	8	6
Glass Products	8	5
Consumer Products	3	0
Oil and Gas	1	0

[1] https://awsedap.epa.gov/public/extensions/pfas_tools/pfas_tools.html

According to the EPA's disclaimer, the ECHO dataset "**does not indicate** that PFAS are actually being manufactured, processed, used, or released by the facility." For this project the dataset is treated as a list of potential sources based only on industrial profiles. The dataset was used in conjunction with Geographic Information Systems (GIS) to identify watersheds with highest facility counts (Figure 2). For this exercise, we did not differentiate between specific industry types.

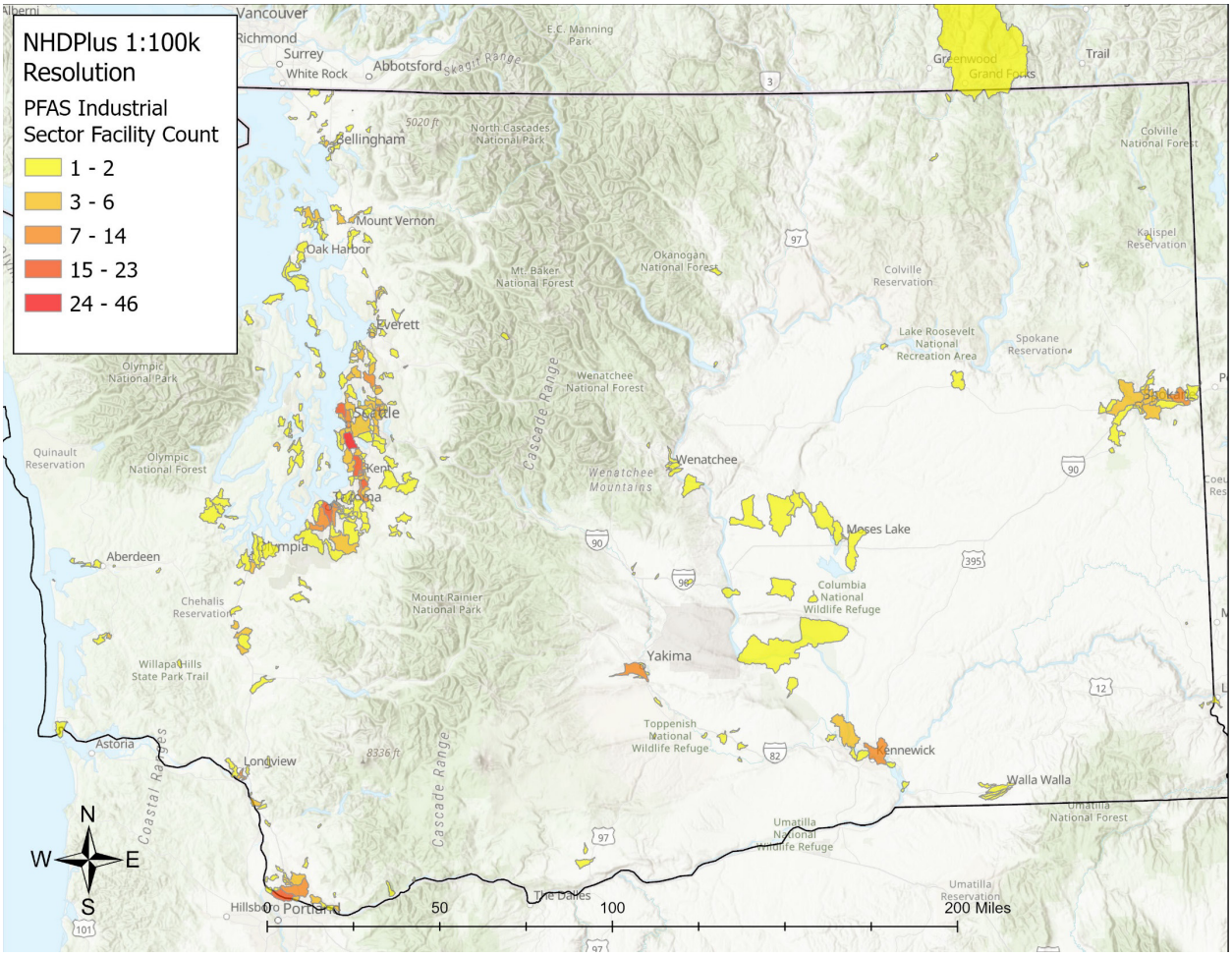

Figure 2. Map of Washington showing counts of PFAS industrial sector facilities by watershed.

Data source: EPA's PFAS Analytic Tools (EPA, n.d.).

We obtained environmental public health information from the DOH's Washington Tracking Network Data Portal[1] (DOH, n.d.). From the Data Portal, we used 2019 Pesticide Exposure data and 2019 – 2021 Pesticide Illness data to identify geographic areas in Washington with highest pesticides exposures (Figure 3). This information, in conjunction with GIS, was used to identify watersheds within high pesticide exposure areas.

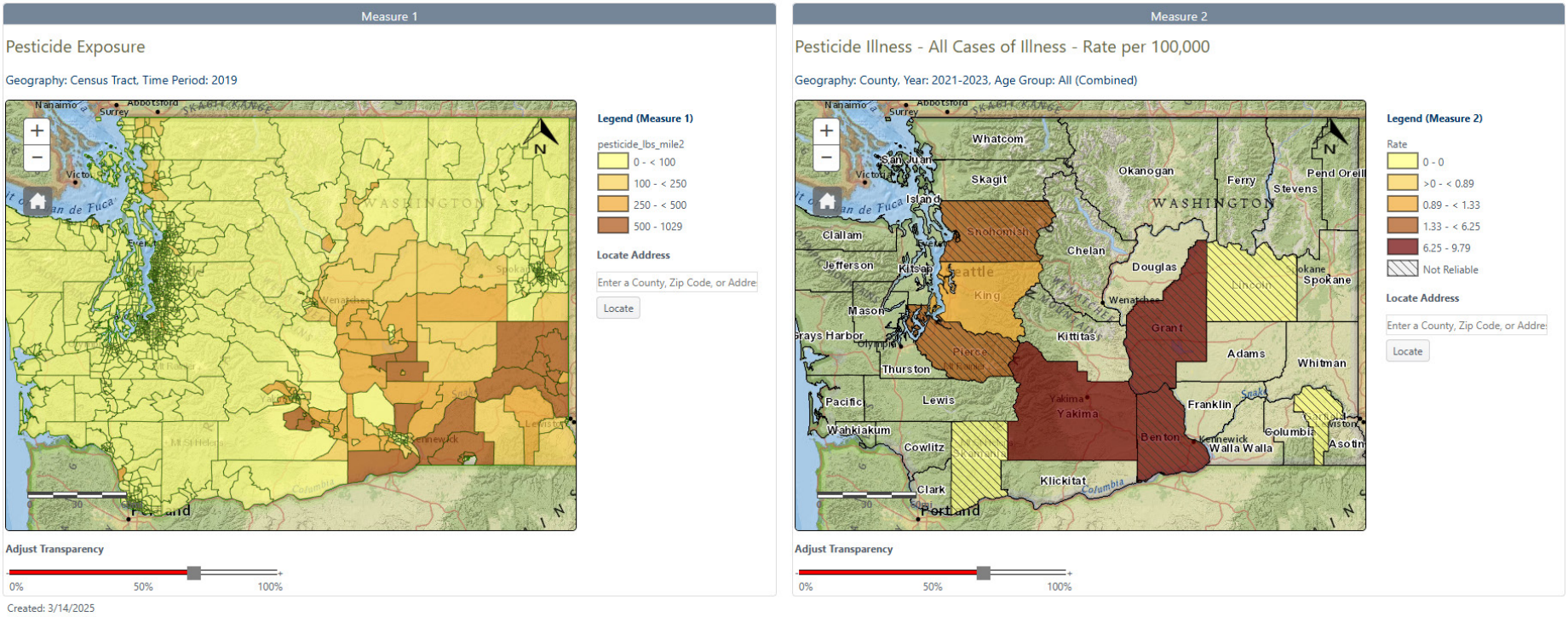

Figure 3. Maps showing pesticide exposure (left) and pesticide illness data (right) in Washington.

Data source: Washington State Department of Health's Washington Tracking Network Data Portal (DOH, n.d.). Exposure data are shown by census tract for the year 2019, and illness data are shown by county for the period 2021 – 2023.

[1] https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/data-portal

We are working with Ecology's Solid Waste Management Program to identify suitable sampling locations in areas where known biosolids land applications have occurred in Washington. Google Maps and National Pollutant Discharge Elimination System (NPDES) permit information was used to identify airport and WWTP facilities that discharge effluent to surface waters in the state.

Google Maps was used to identify surface waters downgradient from recreational ski areas, as well as reference locations. Ecology's Environmental Information Management (EIM) system database was used to identify locations where PFAS samples have already been collected. We mostly selected locations where PFAS data were lacking.

4.4 Tasks required

Tasks required to complete project objectives include:

- Conduct field reconnaissance for suitable sampling sites.
- Finalize site selection based on desktop research, guidance from local/subject matter specialists, accessibility, and feasibility for sampling.
- Coordinate with laboratories during project planning and sampling.
- Coordinate sampling schedule and logistics.
- Conduct field sampling.
- Review laboratory data and data validation report.
- Analyze data and draft final report.
- Enter data into EIM.

4.5 Systematic planning process

This QAPP serves as the systematic planning for this project.

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
Rebecca Bohannan HWTR Program Headquarters Phone: 509-379-4814	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Siana Wong Toxics Studies Unit Statewide Coordination Section Phone: 360-522-3054	Project Manager	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.
Jacob Carnes Groundwater Monitoring Unit Statewide Coordination Section Phone: 360-688-4413	Field Assistant	Helps collect samples and records field information.
Jim Medlen Toxics Studies Unit Statewide Coordination Section Phone: 360-480-6175	Unit Supervisor for Project Manager	Provides internal review of the QAPP, approves the budget, and approves the final QAPP.
Jessica Archer Statewide Coordination Section Phone: 360-890-2721	Section Manager for Project Manager and Study Area	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Rob Waldrop Manchester Environmental Laboratory Phone: 360-519-2083	Director	Reviews and approves the final QAPP.
Contract Laboratory	Project Manager	Reviews draft QAPP, coordinates with MEL QA Coordinator
Christina Frans Phone: 360-995-2473	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

[1]All staff except the client are from EAP.

EAP: Environmental Assessment Program.

EIM: Environmental Information Management database.

HWTR: Hazardous Waste and Toxics Reduction

MEL QA: Manchester Environmental Laboratory Quality Assurance

QAPP: Quality Assurance Project Plan.

5.2 Special training and certifications

Field staff will be trained in all aspects of conducting sampling for this project (see Section 8.2). This includes following procedures to conduct PFAS sampling and other water quality parameters in aquatic environments; avoid cross-contamination while conducting PFAS sampling; and store and transport samples to the laboratories.

5.3 Organization chart

Not Applicable – See Table 2.

5.4 Proposed project schedule

Tables 3 – 5 list 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	May 2026	Siana Wong
Laboratory analyses	August 2026	Contract Laboratory (PFAS) / Manchester Environmental Laboratory (General Chemistry)
Contract lab data validation	January 2027	Manchester Environmental Laboratory Data Validation Chemist

Table 4. Schedule for data entry

Task	Due Date	Lead Staff
EIM data loaded*	February 2027	Siana Wong
EIM review	March 2027	Jacob Carnes
EIM complete	April 2027	Siana Wong

* EIM Project ID: SWON0005
EIM: Environmental Information Management database.

Table 5. Schedule for final report.

Task	Due Date	Lead Staff
Draft to supervisor	April 2027	Siana Wong
Draft to client/ peer reviewer	May 2027	Siana Wong
Final draft to publications team	June 2027	Siana Wong
Final report due on web	August 2027	Siana Wong

5.5 Budget and funding

Table 6 shows the total estimated laboratory costs and Table 7 shows a detailed laboratory cost breakdown for this project.

Table 6. Total estimated costs for project.

Item	Cost
Contract Lab Samples Total	$192,838
Contract and Data Validation Fee Total (30%)	$57,851
MEL Samples Total	$8,151
GRAND TOTAL:	**$258,840**

MEL: Manchester Environmental Laboratory

Table 7. Estimated costs for project, broken down by parameter and number of samples.

Parameter	Sample Matrix	Laboratory	Number of Sampling Events	Number of Samples Per Event	Number of Field Duplicates	Number of Field Blanks	Number of MS & MSD Samples	Total Number of Samples for Project	Cost Per Sample	Subtotal
40 target PFAS analytes (EPA 1633A)	Water	Contract	2	40	4	4	6	108	$420	$45,360
35 target PFAS analytes (SGS AXYS Method MLA-121)	Water	Contract	2	40	4	4	6	108	$486	$52,488
5 ultrashort-chain target PFAS analytes (SGS AXYS Method MLA-120)	Water	Contract	2	35	4	4	6	98	$355	$34,790
Extractable organic fluorine (PFAS screen; SGS AXYS Method MLA-119)	Water	Contract	2	35	4	4	0	86	$314	$27,004
Total oxidizable precursor assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)	Water	Contract	2	35	4	4	0	86	$386	$33,196
Total suspended solids	Water	MEL	2	35	4	0	0	78	$16.50	$1,287
Total organic carbon	Water	MEL	2	35	4	0	0	78	$38.50	$3,003
Dissolved organic carbon	Water	MEL	2	35	4	0	0	78	$49.50	$3,861

MS: Matrix Spike; MSD = Matrix Spike Duplicate

6.0 Quality Objectives

6.1 Data quality objectives

The main data quality objective for this project is to collect, screen, and analyze PFAS in surface water samples from at least 35 sampling sites representing different land use types across Washington. Project-specific measurement quality objectives (MQOs) will be used to assess overall data quality.

6.2 Measurement quality objectives

The MQOs for this project are described in this section and summarized in Table 8 for laboratory samples and Table 9 for field measurements.

Table 8. Project measurement quality objectives for water samples.

Parameter	Field and Lab Duplicate Samples (RPD)*	Matrix Spike/Matrix Spike Duplicate (% Recovery)	Matrix Spike/Matrix Spike Duplicate (RPD)*	Method Blank	Laboratory Control Sample (% Recovery)	Surrogate Standards (% Recovery)
40 target PFAS analytes (EPA 1633A)	≤40	50–150	≤40	No analytes detected >½ LOQ	See Table 5 of EPA 1633A (EPA 2024)	See Table 5 of EPA 1633A (EPA 2024)
35 target PFAS analytes (SGS AXYS Method MLA-121)	≤40	50–150	≤40	No analytes detected >½ LOQ	70–130*	50–150**
5 ultrashort-chain target PFAS analytes (SGS AXYS Method MLA-120)	≤40	50–150	≤40	No analytes detected >½ LOQ	50–150	20–150
Extractable organic fluorine (PFAS screen; SGS AXYS Method MLA-119)	≤40	NA	NA	No analytes detected >½ LOQ	70–130	NA
Total oxidizable precursor assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)	≤40	NA	NA	No analytes detected >½ LOQ	50–150	10–150
Total suspended solids	≤20	NA	NA	≤RL	80–120	NA

Parameter	Field and Lab Duplicate Samples (RPD)*	Matrix Spike/Matrix Spike Duplicate (% Recovery)	Matrix Spike/Matrix Spike Duplicate (RPD)*	Method Blank	Laboratory Control Sample (% Recovery)	Surrogate Standards (% Recovery)
Total organic carbon	≤20	75–125	≤20	≤RL	80–120	NA
Dissolved organic carbon	≤20	75–125	≤20	≤RL	80–120	NA

* Criteria applies to results >5x the reporting limit; for duplicate results <5x the reporting limit, the acceptance criteria will be the absolute difference of the sample results <2x the reporting limit.
** Percent recoveries are compound specific
LOQ: Limit of quantitation
NA: Not applicable
PFAS: Per- and polyfluoroalkyl substance
RPD: Relative percent difference

Table 9. Measurement quality objectives for field measurements.

Parameter	Accept	Qualify	Reject
Water temperature (ºC)	≤ ±0.2	≥ ±0.2 and ≤ 0.8	≥ ±0.8
Dissolved oxygen (mg/L)	≤ ±0.3	≥ ±0.3 and ≤ ±0.8	≥ ±0.8
Specific conductance (µS/cm)	≤ ±5%	≥ ±5% and ≤ ±15%	≥ ±15%
pH	≤ ±0.2	≥ ±0.2 and ≤ ±0.8	≥ ±0.8

6.2.1 Targets for precision, bias, and sensitivity

6.2.1.1 Precision

Precision is a measure of variability between results of replicate measurements due to random error. It is usually assessed using duplicate field measurements or laboratory analysis of duplicate samples.

At least one field duplicate for PFAS and general chemistry parameters will be collected for every 10 samples. Field duplicates will be collected by repeating the water sampling procedure (filling a separate container with site water). Laboratory duplicates and matrix spike duplicates will be analyzed for each batch of samples. MQOs for field, laboratory, and matrix spike duplicates are given in Table 8.

6.2.1.2 Bias

Bias is the difference between the sample mean and the true value. Bias will be measured as a percent recovery of laboratory control samples and surrogate standards. For PFAS samples, matrix spike/matrix spike duplicate (MS/MSD) samples will also be analyzed to assess interferences caused by the sample matrix that could bias the result. One MS/MSD pair will be

collected for every 20 samples and analyzed for each sample batch. MQOs for laboratory control sample, surrogate sample, and MS/MSD recoveries are given in Table 8.

6.2.1.3 Sensitivity

Sensitivity measures the capability of an analytical method to detect a substance above background level and is often described as a detection or reporting limit. The analytical laboratory should be able to meet the typical reporting limit for each analyte given in Table 12 of Section 9.1.

Field blanks will be collected and analyzed to assess contamination during the water sample collection process, including contamination of sample containers and handling of containers in the field. One field blank will be collected for every ten samples. Field blanks will be collected in the field by filling a PFAS-free sample container with PFAS-free laboratory-grade water. Method blanks will be prepared and analyzed by the laboratory for each batch of samples to assess contamination during the laboratory preparation and analysis procedure. MQOs for field and method blanks are given in Table 8.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

Standard operating procedures (SOPs) will be followed to ensure comparability between projects. Section 8.2 lists the relevant SOPs and describes the specific sampling procedures that will be used for this project.

6.2.2.2 Representativeness

The locations that will be sampled represent areas that have *potential* for PFAS contamination based on their proximity to industrial land uses that are presumed to be associated with PFAS.

The samples to be collected will represent PFAS concentrations in surface waters at the respective locations during the dry season (summer low flow) and wet season (winter/spring high flow). The sampling strategy used to achieve representativeness is described in Section 7.2.

6.2.2.3 Completeness

The project will be considered complete and sufficient for meeting study objectives if 95% of PFAS samples collected and analyzed meet MQOs.

6.3 Acceptance criteria for quality of existing data

Not Applicable. This project will not analyze existing data.

6.4 Model quality objectives

Not Applicable.

7.0 Study Design

7.1 Study boundaries

Ecology will collect PFAS samples from surface waters (rivers, creeks, lakes) throughout Washington. A map of proposed sampling locations in provided in Figure 1.

7.2 Field data collection

7.2.1 Sampling locations and frequency

Surface water samples from 35 waterbodies across Washington will be collected during one summer low flow and one spring high flow event in 2025 – 2026. Proposed sampling locations are given in Table 10. Final site selection will be based on access and sampling feasibility. If a planned site cannot be sampled, we will sample at an alternative site of the same sample area description.

At each of the biosolids application areas, two sites will be sampled to accommodate request by the Solid Waste Management Program: One upstream and one downstream from the land application area. The upstream samples will be analyzed for 75 target PFAS analytes (EPA 1633 and SGS AXYS Method MLA-121), and the downstream samples will be analyzed for the whole parameter suite for this study.

Table 10. List and general description of proposed sampling locations.

Location	Waterbody Description	Region	County	Approximate Location	Sampling Area Description
Duwamish River	River	Northwest	King	47.500506, -122.288142	High number of PFAS industrial sector facilities; Downstream from wastewater treatment plant; Proximity to airport
Spokane River	River	Eastern	Spokane	47.659335, -117.449103	High number of PFAS industrial sector facilities
Squalicum Creek	Creek	Northwest	Whatcom	48.766093, -122.500242	High number of PFAS industrial sector facilities
Vancouver Lake	Lake	Southwest	Clark	45.671184, -122.742328	High number of PFAS industrial sector facilities
Wapato Creek	Creek	Southwest	Pierce	47.250006, -122.359751	High number of PFAS industrial sector facilities; Proximity to airport
Higgins Slough	Creek	Northwest	Skagit	48.427491, -122.471216	High pesticide exposure area
Palouse River	River	Eastern	Whitman	46.75847, -118.14886	High pesticide exposure area
Soap Lake	Lake	Eastern	Grant	47.421293, -119.495048	High pesticide exposure area
Walla Walla River	River	Eastern	Walla Walla	46.027888, -118.731582	High pesticide exposure area
Yakima River	River	Central	Yakima	46.259780, -119.498639	High pesticide exposure area; Downstream from wastewater treatment plant; Proximity to airport
Pilchuck River	River	Northwest	Snohomish	48.076271, -121.982159	Downstream from wastewater treatment plant
Colville River	River	Eastern	Stevens	48.278344, -117.749297	Downstream from wastewater treatment plant
Okanagan River	River	Central	Okanogan	48.395719, -119.544952	Downstream from wastewater treatment plant
Olequah Creek	Creek	Southwest	Lewis	46.392702, -122.951264	Downstream from wastewater treatment plant
Wenatchee River	River	Central	Chelan	47.598260, -120.650615	Downstream from wastewater treatment plant
5 locations to be determined	—	—	—	—	Biosolids application area
Leech Lake	Lake	Central	Yakima	46.64349, -121.38554	Downgradient from recreational ski area
Methow River	Creek	Central	Okanogan	48.475478, -120.189378	Downgradient from recreational ski area
Silver Creek	Creek	Southwest	Pierce	46.936625, -121.474910	Downgradient from recreational ski area
Squilchuck Creek	Creek	Central	Chelan	47.29154, -120.39948	Downgradient from recreational ski area
Tye River	River	Northwest	King	47.745571, -121.092951	Downgradient from recreational ski area
Bachelor Creek	Creek	Central	Yakima	46.562972, -120.527605	Proximity to airport

Location	Waterbody Description	Region	County	Approximate Location	Sampling Area Description
Big Gulch Creek	Creek	Northwest	Snohomish	47.910013, -122.298199	Proximity to airport; High number of PFAS industrial sector facilities
Des Moines Creek	Creek	Northwest	King	47.406013, -122.327735	Proximity to airport; High number of PFAS industrial sector facilities
Mill Creek	Creek	Eastern	Walla Walla	46.070692, -118.304277	Proximity to airport
Northeast Fork Union River	River	Northwest	Kitsap	47.485227, -122.779419	Proximity to airport
Spada Lake	Lake	Northwest	Snohomish	47.972484, -121.667442	Reference location
White River	River	Southwest	Pierce	46.957000, -121.526736	Reference location
Omak Lake	Lake	Eastern	Okanogan	48.31917, -119.43019	Reference location
Rock Creek (Turnbull National Wildlife Refuge)	Creek	Eastern	Spokane	47.398444, -117.544810	Reference location
Hoh River	River	Southwest	Jefferson	47.812001, -124.249582	Reference location

7.2.2 Field parameters and laboratory analytes to be measured

At all sites, samples will be collected for analysis of:

- 40 target PFAS analytes (EPA 1633A)
- Additional 35 target PFAS analytes (SGS AXYS Method MLA-121)
- 5 ultrashort-chain PFAS (SGS AXYS Method MLA-120)
- EOF (PFAS screen; SGS AXYS Method MLA-119)
- TOP assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)

At each site, we will also collect samples for TOC, DOC, and TSS. Field measurements at each site will include water temperature, dissolved oxygen, specific conductance, and pH. We will also collect flow at wadable stream sites where flow can be measured using a flow meter. At some stream sites, flow information may be available from USGS gage stations.

7.3 Modeling and analysis design

Not Applicable.

7.4 Assumptions underlying design

The study assumes that sampling locations have higher potential for PFAS contamination compared to reference locations, and that the different sampling areas represent different contamination source potentials. Another assumption is that quantitation limits for each of the analytical methods will be low enough to characterize PFAS concentrations among the different sampling areas.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

One logistical challenge is the statewide distribution of sites. Diligent planning and scheduling will help maximize efficiency for sampling locations statewide. Site reconnaissance will help minimize challenges associated with access or sampling feasibility. Only publicly accessible locations will be sampled.

Timing the sampling at montane locations (primarily sites downgradient of recreational ski areas) present another logistical challenge. Sampling locations may still be snow-covered or difficult to access in the early season. Site reconnaissance and desktop research will be conducted to evaluate if planned locations can be sampled for the spring event.

Weather, road, wildfire, and air quality conditions may affect the field work schedule. Field work will be rescheduled if any of these create unsafe conditions for sampling.

Backup sampling locations will be used if planned locations cannot be sampled due to inaccessibility, infeasibility, or unsafe sampling conditions.

Holding times for PFAS and general chemistry parameters will be considered when scheduling field work. If necessary, PFAS samples will be shipped to the analytical laboratory overnight

from the field in an ice-filled cooler at 6ºC or less to meet sample holding times. Sampling will be avoided on Fridays, and PFAS samples will only be shipped to the laboratory Monday through Wednesday to ensure that samples are received by the laboratory.

7.5.2 Practical constraints

Multiple days and overnight travel will be needed to complete this statewide sampling project. This project may require securing approval for travel during the current State travel freeze. If necessary, we will plan our travel schedule and submit an exemption request at least one month in advance to allot enough time for the approval process.

Another potential constraint is the availability of field staff. Sampling schedules will be coordinated with field staff well ahead of time to avoid scheduling conflicts.

7.5.3 Schedule limitations

Factors that may cause delay to the project schedule include:

- Extension of the State budget and travel freeze beyond June 30, 2025
- Review and approval time of the QAPP
- Delays in receiving raw and validated data

8.0 Field Procedures

8.1 Invasive species evaluation

Field staff will follow Ecology's SOP for minimizing the spread of invasive species (Ecology 2024b). The project manager will determine if planned sampling locations lie within areas of concern for invasive species. If necessary, cleaning and decontamination procedures in the SOP will be followed to ensure that field gear is adequately cleaned or decontaminated before sampling in a new area.

8.2 Measurement and sampling procedures

Measurement and sampling procedures for this project will follow guidance from the following Ecology SOPs:

- EAP015 – Manually Obtaining Surface Water Samples (Ecology 2022).
- EAP024 – Measuring Streamflow for Water Quality Impairment Studies (Ecology 2019)
- EAP033 – Hydrolab® DataSonde®, MiniSonde®, and HL4 Multiprobes (Ecology 2020)

In addition, field staff will follow sampling guidance developed by the Michigan Department of Environment, Great Lakes, and Energy to avoid PFAS cross contamination during sampling (EGLE 2024). This includes avoiding materials containing fluorinated polymers or non-polymers (which may potentially contain PFAS) including certain types of waders, rain gear, and personal care products. Other precautions during sampling will be followed such as using new nitrile gloves for collecting PFAS samples and using "clean hands/dirty hands" practices for low-level contaminant sampling.

For stream locations, surface water samples will be collected at the approximate thalweg of the channel. For lake locations, surface water will be sampled at the approximate deepest location of the lake by means of a small raft or kayak. If sampling by raft or kayak is not practical, we will collect a composited sample for each parameter from three shoreline sites along the lake.

At each site, one surface water sample for each analyte will be collected at about 15 – 30 cm below the water surface, using a telescopic sampling pole. All sample bottles will be triple rinsed with site water (except for TOC bottles, which are pre-acidified with hydrochloric acid). Samples for the PFAS suite (EPA 1633A, additional target analytes, ultrashort-chain analytes, EOF, and ultrashort-chain TOP assay) will be collected first using the PFAS-free sample bottles provided by the laboratory to avoid cross contamination and the potential for sorption of PFAS to transfer equipment.

TOC samples will be collected using a clean, triple-rinsed polyethylene transfer bottle, then poured into the TOC sample bottle. DOC samples will be collected using a clean triple-rinsed polyethylene transfer bottle, then filtered into the DOC sample bottle using a 0.45-micron polypropylene filter and syringe. TSS samples to be collected using a clean triple-rinsed polyethylene bottle. Immediately after collection, all PFAS samples will be placed in individual plastic bags with zip locks and then stored in a cooler filled with wet ice maintained at 6ºC or less until further processing. All other samples will also be stored in a cooler filled with ice at 6ºC or less.

Field measurements of water temperature (°C), dissolved oxygen concentration (mg/L), pH, and specific conductance (µS/cm) will be collected at each site at about 15 – 30 cm below the water surface using a calibrated YSI EXO sonde.

If possible, flow will be measured at stream sites using a Marsh McBirney Flo-Mate flow meter during the summer low flow and winter/spring high flow sampling events. Measured flow and flow data from USGS continuous stream gages will be used to estimate the instantaneous PFAS loads (mass per unit time) at each site for each event.

8.3 Containers, preservation methods, holding times

Table 11 shows sample container type, preservation, and holding time information for each parameter.

Table 11. Sample containers, preservation, and holding times for water samples

Parameter	Quantity Required	Container	Field Preservation	Sample Holding Time
40 target PFAS analytes (EPA 1633A)	500 mL	Organics-free 500 mL HDPE bottle	Cool to ≤6°C; Dark	28 days if stored in dark at ≤6°C*; 90 days if stored frozen in dark at ≤-20°C
35 target PFAS analytes (SGS AXYS Method MLA-121)	500 mL (maximum 50 mg solids)	Organics-free 500 mL HDPE bottle	Cool to ≤6°C; Dark	28 days if stored in dark at ≤4°C; 90 days if stored frozen in dark at ≤-20°C
5 ultrashort-chain target PFAS analytes (SGS AXYS Method MLA-120)	20 mL (maximum 50 mg solids)	Organics-free 20 mL HDPE bottle	Cool to ≤6°C; Dark	28 days if stored in dark at ≤6°C**; 90 days if stored frozen in dark at ≤-20°C
Extractable organic fluorine (PFAS screen; SGS AXYS Method MLA-119)	1 L	Organics-free 1 L HDPE bottle	Cool to ≤4°C; Dark	28 days if stored in dark at ≤6°C**; 90 days if stored frozen in dark at ≤-20°C**
Total oxidizable precursor assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)	60 mL (maximum 50 mg solids)	Organics-free 60 mL HDPE bottle	Cool to ≤6°C; Dark	28 days if stored in dark at ≤6°C**; 90 days if stored frozen in dark at ≤-20°C
Total suspended solids	1 L	1 L wide-mouth polyethylene bottle	Cool to ≤4°C; Dark	7 days
Total organic carbon	125 mL	125 mL narrow-mouth polyethylene bottle, pre-acidified	1:1 HCl acid to pH<2; Cool to ≤6°C; Dark	28 days
Dissolved organic carbon	125 mL	125 mL narrow-mouth polyethylene bottle, pre-acidified; 0.45 µm pore size filters	Filter in field with 0.45 µm pore size filter; 1:1 HCl acid to pH<2; Cool to ≤6°C; Dark	28 days

*7 days for N-MeFOSE, N-EtFOSE, N-MeFOSAA, and N-EtFOSAA if stored in dark at ≤6°C.

** Project-specified holding time: There is no standard established hold time.

HCl: Hydrochloric

HDPE: High-density polyethylene

8.4 Equipment decontamination

Because PFAS samples will be collected from the surface waters using pre-cleaned sample bottles provided by the laboratory, we do not anticipate the need to decontaminate sampling equipment.

8.5 Sample ID

Sample IDs will consist of a work order number assigned by MEL, followed by a consecutive number assigned by the project manager.

8.6 Chain of custody

The chain of custody will be maintained to account for all samples from the time of sampling to delivery to the laboratory. We will use the laboratory's chain of custody forms to accompany samples shipped to the laboratory.

8.7 Field log requirements

A Rite in the Rain field notebook will be used to record data and notes at each site. The following will be recorded:

- Site name, date, time
- Site coordinates
- Field staff
- Weather conditions
- Site conditions
- Parameters collected
- Quality Control (QC) samples collected
- Sample IDs for each sample collected
- Field measurements (water temperature, dissolved oxygen concentration, pH, specific conductance)
- Flow measurement data and information
- Notes of any changes or deviations from the QAPP

Corrections to errors in the field notebook will be made with a single strike-through line, initialed, and dated.

8.8 Other activities

After field sampling, PFAS samples will be transported back to Ecology Headquarters and immediately stored frozen at -20°C or less. Frozen samples will be shipped overnight to the analytical laboratory as soon as practical between Monday and Wednesday.

General chemistry samples will be delivered to MEL the next day after returning to Ecology Headquarters from the field. Samples will be stored in Ecology's walk-in cooler at 6°C or less until picked up by MEL's courier.

9.0 Laboratory Procedures

9.1 Lab procedures table

Table 12 presents laboratory procedure information for project analytes.

Table 12. Measurement methods (laboratory) for water samples.

Analyte	Samples (Estimated Number / Projected Sampling Date)	Expected Range of Results	Typical Reporting Limit	Sample Preparation	Analytical Method
40 target PFAS analytes	54 / August 2025; 54 / April 2026	<0.8–60 ng/L per analyte	0.8–3.2 ng/L	EPA 1633A	EPA 1633A
35 target PFAS analytes	49 / August 2025; 49 / April 2026	<0.8–60 ng/L per analyte	0.1–5 ng/L	Weak anion exchange SPE	SGS AXYS Method MLA-121
5 ultrashort-chain target PFAS analytes	49 / August 2025; 49 / April 2026	Unknown	5–100 ng/L	Weak anion exchange SPE	SGS AXYS Method MLA-120
Extractable organic fluorine (PFAS screen)	43 / August 2025; 43 / April 2026	Unknown	1.5 µg/L	Weak anion exchange SPE	SGS AXYS Method MLA-119
Total oxidizable precursor assay for ultrashort-chain PFAS	43 / August 2025; 43 / April 2026	Unknown	20–408 ng/L	Oxidation by potassium persulfate; Weak anion exchange SPE	SGS AXYS Method MLA-122
Total suspended solids	39 / August 2025; 39 / April 2026	<1–300 mg/L	1.0 mg/L	Gravimetric, Dried 103°–105°C	SM2540D
Total organic carbon	39 / August 2025; 39 / April 2026	<0.5–10 mg/L	0.5 mg/L	NA	SM5310B
Dissolved organic carbon	39 / August 2025; 39 / April 2026	<0.5–10 mg/L	0.5 mg/L	NA	SM5310B

PFAS: Per- and polyfluoroalkyl substances
SPE: Solid Phase Extraction

9.2 Sample preparation method(s)

The analytical laboratory will follow the general sample preparation method listed in Table 12 for each analysis.

9.3 Special method requirements

Special method requirements are not anticipated.

9.4 Laboratories accredited for methods

Released in December 2024, EPA 1633A is the most recent revision to EPA 1633 and addresses minor editorial errors and provides technical clarifications to EPA 1633. Because there currently are no laboratories accredited for EPA 1633A, the analytical laboratory must be accredited for EPA 1633 for analysis of 40 target PFAS analytes. Laboratory waivers will be obtained for analyses of 35 additional target PFAS analytes (SGS AXYS Method MLA-121), 5 target ultrashort-chain PFAS analytes (SGS AXYS Method MLA-120), EOF (SGS AXYS Method MLA-119), and TOP assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122).

10.0 Quality Control Procedures

10.1 Table of field and laboratory quality control

Planned field and laboratory QC samples for each analysis are shown in Table 13.

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

Parameter	Field Duplicate	Field Blank	Lab-oratory Duplicate	Lab-oratory Control Sample	Matrix Spike / Matrix Spike Duplicate	Method Blank	Surrogates
40 target PFAS analytes (EPA 1633A)	10% of samples	10% of samples	1/batch	1/batch	1/batch	1/batch	All samples
35 target PFAS analytes (SGS AXYS Method MLA-121)	10% of samples	10% of samples	1/batch	1/batch	1/batch	1/batch	All samples
5 ultrashort-chain target PFAS analytes (SGS AXYS Method MLA-120)	10% of samples	10% of samples	1/batch	1/batch	1/batch	1/batch	All samples
Extractable organic fluorine (PFAS screen; SGS AXYS Method MLA-119)	10% of samples	10% of samples	1/batch	1/batch	NA	1/batch	NA
Total oxidizable precursor assay for ultrashort-chain PFAS (SGS AXYS Method MLA-122)	10% of samples	10% of samples	1/batch	1/batch	NA	1/batch	All samples
Total suspended solids	10% of samples	NA	1/batch	1/batch	NA	1/batch	NA
Total organic carbon	10% of samples	NA	1/batch	1/batch	1/batch	1/batch	NA
Dissolved organic carbon	10% of samples	NA	1/batch	1/batch	1/batch	1/batch	NA

NA: Not Applicable

10.2 Corrective action processes

The analytical laboratory is expected to follow the corrective actions described by the respective analytical method if laboratory QC criteria are not met. The best course of action to be taken for results that do not meet MQOs and laboratory acceptance criteria will be discussed with the project manager. Samples may be re-analyzed, or data may be rejected or qualified. The data validator will document and discuss corrective actions taken in the case narrative.

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

Field data recording requirements are described in Section 8.7. Requirements for entering, loading, reviewing, and correcting field and laboratory data in EIM are described in Sections 11.4 and 13.1.

11.2 Laboratory data package requirements

This project requires a Level 4 data package to be provided by the analytical laboratory for all PFAS data. The data package will include all raw data, including all project samples, batch QC, and instrument QC, along with a text narrative in PDF format. MEL will verify that all data packages are complete in accordance with the Statement of Work and QAPP.

The data package will also include a final dataset in Excel spreadsheet or Comma Separated Values (CSV) format (See Section 11.3). MEL will provide the project manager with the final validated dataset in Excel spreadsheet or CSV format, along with a case narrative in PDF format summarizing the data validation (Section 13.2 and 13.3).

11.3 Electronic transfer requirements

The contract laboratory will deliver an electronic data deliverable (EDD) in Microsoft Excel spreadsheet or CSV format to MEL. The EDD should meet the format defined by MEL and described in the Statement of Work.

Laboratory data provided by MEL will be downloaded from MEL's Laboratory Information Management System (LIMS) into Excel spreadsheets.

11.4 EIM/STORET data upload procedures

Data for this project will be entered and stored in Ecology's EIM database[1]. Field data and information recorded in the field notebook that are pertinent for EIM will be entered into Ecology's EIM locations and results templates. Validated laboratory data results will be entered into the EIM results template. When EIM locations and results templates are completed, the

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

project manager will enter them into the EIM database under the Study ID SWON0005. Another EAP staff member will review the data uploaded into EIM and document any errors. The final corrected data will be reviewed by the project manager and re-uploaded into EIM.

11.5 Model information management

Not Applicable.

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

No field audits are planned for this project. The analytical laboratories for this project must undergo performance and system audits of their routine procedures to receive and maintain accreditation.

12.2 Responsible personnel

Not Applicable.

12.3 Frequency and distribution of reports

One final report will be completed at the end of this project summarizing the project and results.

12.4 Responsibility for reports

The project manager will author the final report.

13.0 Data Verification

Field notebooks will be reviewed by the project manager to ensure field sheets are completed with no missing data or information. Errors in the field notebook will be corrected with a single strikethrough line, initialed, and dated. The project manager will initial the bottom of the field sheet after review has been completed, and the data and information have been entered into an Excel spreadsheet.

13.1 Field data verification, requirements, and responsibilities

Field notebooks will be reviewed by the project manager to ensure field sheets are completed with no missing data or information. Errors in the field notebook will be corrected with a single strikethrough line, initialed, and dated. The project manager will initial the bottom of the field sheet after review has been completed, and the data and information have been entered into an Excel spreadsheet.

13.2 Laboratory data verification

MEL or an independent contracted firm will conduct data verification and provide a summary of the verification to the project manager in the form of a case narrative (See Section 13.3). The project manager will be responsible for final acceptance of project data.

13.3 Validation requirements, if necessary

A Stage 4 data validation following technical guidance in EPA (2018) and EPA (2020) will be required for all PFAS target and screening analyses. The validation will be conducted by MEL or an independent contracted firm. Data will be validated against method-specific QC criteria and project-specific MQOs. A conversion of contract laboratory qualifiers to MEL-amended qualifiers will be required during the data validation process. A discussion of the data verification and validation will be provided in the case narrative, which will be provided to the project manager after completion of analyses from both sampling events. The case narrative will include:

- Whether a complete data package was provided by the analytical laboratory
- Whether project MQOs were met
- Whether proper procedures were followed according to the analytical method
- Whether instrument calibrations and QC checks were within limits
- Explanation of MEL-amended qualifiers and reason for their use
- Discussion of any problems during sample analysis and corrective actions taken

13.4 Model quality assessment

Not Applicable

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

The project manager will determine if the project data are usable by assessing whether the data have met project MQOs described in Section 6. Based on this assessment, data will be accepted, accepted with qualification, or rejected. If data are rejected, the project manager, with guidance from MEL, will decide the proper course of action.

14.2 Treatment of non-detects

Laboratory results that are reported as less than the Limit of Detection (LOD) will be treated as non-detect and qualified as “U” at the LOD. Sample identification failures will be qualified “NJ” (evidence that the analyte is present but does not meet identification criteria; result is an estimate), accepted as detected, and included in total PFAS calculations. Analyte concentrations in samples that are <5 times the detected analyte concentrations in the method blank will be qualified as non-detect due to method blank contamination. Total PFAS calculations will only include detected results, and will include results qualified as “J.”

14.3 Data analysis and presentation methods

Results for each analytical method will be summarized in a table. PFAS composition may be compared among the different locations sampled during this project, and to analyte patterns of known types of PFAS releases. For example, releases of AFFF, landfill leachate, and WWTP effluent often have characteristic analyte patterns (Thompson et al. 2022; Coffin et al. 2023; Yan et al. 2024). Simple bar charts, box plots, and spatial maps may be used to visualize data. Scatter plots and correlation coefficients will be used to determine if PFAS concentrations are correlated with ancillary parameters, such TOC, DOC, and TSS.

14.4 Sampling design evaluation

The sampling design will be evaluated following the first sampling event in summer. The effectiveness of the sample media, selected analytical methods, and sampling locations to produce meaningful results will be assessed and adaptations will be made if necessary. If results for a large number of samples are non-detect for a given non-standard (non-EPA) method, we may decide to drop the analytical method for the spring sampling event.

14.5 Documentation of assessment

An assessment of project results will be documented in the final report.

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16.0 Appendices

Appendix A. List of Target Analytes for this Study

Table A1. List of target analytes for this study.

Analyte Name	Analyte Short Name	Chemical Abstracts Service Registry Number	Analytical Method	Analyte Group
Perfluorobutanoic acid	PFBA	375-22-4	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluoropentanoic acid	PFPeA	2706-90-3	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorohexanoic acid	PFHxA	307-24-4	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluoroheptanoic acid	PFHpA	375-85-9	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorooctanoic acid	PFOA	335-67-1	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorononanoic acid	PFNA	375-95-1	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorodecanoic acid	PFDA	335-76-2	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluoroundecanoic acid	PFUnA	2058-94-8	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorododecanoic acid	PFDoA	307-55-1	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorotridecanoic acid	PFTrDA	72629-94-8	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorotetradecanoic acid	PFTeDA	376-06-7	EPA 1633A	Perfluoroalkyl carboxylic acid (PFCA)
Perfluorobutanesulfonic acid	PFBS	375-73-5	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluoropentanesulfonic acid	PFPeS	2706-91-4	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluorohexanesulfonic acid	PFHxS	355-46-4	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)

Analyte Name	Analyte Short Name	Chemical Abstracts Service Registry Number	Analytical Method	Analyte Group
Perfluoroheptanesulfonic acid	PFHpS	375-92-8	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluorooctanesulfonic acid	PFOS	1763-23-1	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluorononanesulfonic acid	PFNS	68259-12-1	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluorodecanesulfonic acid	PFDS	335-77-3	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
Perfluorododecanesulfonic acid	PFDoS	79780-39-5	EPA 1633A	Perfluoroalkane sulfonic acid (PFSA)
1H,1H, 2H, 2H-Perfluorohexane sulfonic acid	4:2 FTS	757124-72-4	EPA 1633A	Fluorotelomer sulfonic acid
1H,1H, 2H, 2H-Perfluorooctane sulfonic acid	6:2 FTS	27619-97-2	EPA 1633A	Fluorotelomer sulfonic acid
1H,1H, 2H, 2H-Perfluorodecane sulfonic acid	8:2 FTS	39108-34-4	EPA 1633A	Fluorotelomer sulfonic acid
3-Perfluoropropyl propanoic acid	3:3 FTCA	356-02-5	EPA 1633A	Fluorotelomer carboxylic acid
2H,2H,3H,3H-Perfluorooctanoic acid	5:3 FTCA	914637-49-3	EPA 1633A	Fluorotelomer carboxylic acid
3-Perfluoroheptyl propanoic acid	7:3 FTCA	812-70-4	EPA 1633A	Fluorotelomer carboxylic acid
Perfluorooctanesulfonamide	PFOSA	754-91-6	EPA 1633A	Perfluoroalkane sulfonamide
N-methylperfluorooctanesulfonamide	N-MeFOSA	31506-32-8	EPA 1633A	Perfluoroalkane sulfonamide
N-ethylperfluorooctanesulfonamide	N-EtFOSA	4151-50-2	EPA 1633A	Perfluoroalkane sulfonamide
N-methyl perfluorooctanesulfonamidoacetic acid	N-MeFOSAA	2355-31-9	EPA 1633A	Perfluoroalkane sulfonamido acetic acid
N-ethyl perfluorooctanesulfonamidoacetic acid	N-EtFOSAA	2991-50-6	EPA 1633A	Perfluoroalkane sulfonamido acetic acid
N-methylperfluorooctanesulfonamido ethanol	N-MeFOSE	24448-09-7	EPA 1633A	Perfluorooctane sulfonamide ethanol
N-ethylperfluorooctanesulfonamido ethanol	N-EtFOSE	1691-99-2	EPA 1633A	Perfluorooctane sulfonamide ethanol
Perfluoro-3-methoxypropanoic acid	PFMPA	377-73-1	EPA 1633A	Ether acid
Perfluoro-4-methoxybutanoic acid	PFMBA	863090-89-5	EPA 1633A	Ether acid
Nonafluoro-3,6-dioxaheptanoic acid	NFDHA	151772-58-6	EPA 1633A	Ether acid

Analyte Name	Analyte Short Name	Chemical Abstracts Service Registry Number	Analytical Method	Analyte Group
Hexafluoropropylene oxide dimer acid (GenX)	HFPO-DA	13252-13-6	EPA 1633A	Ether acid
4,8-Dioxa-3H-perfluorononanoic acid	ADONA	919005-14-4	EPA 1633A	Ether acid
Perfluoro(2-ethoxyethane)sulfonic acid	PFEESA	113507-82-7	EPA 1633A	Ether acid
9-Chlorohexadecafluoro-3-oxanonane1- sulfonic acid (F-53B Major)	9Cl-PF3ONS	756426-58-1	EPA 1633A	Ether acid
11-Chloroeicosafluoro-3-oxaundecane1- sulfonic acid (F-53B Minor)	11Cl-PF3OUdS	763051-92-9	EPA 1633A	Ether acid
bis(fluorosulfonyl)imide, lithium salt	TFSi	90076-65-6	SGS AXYS Method MLA-121	Perfluorosulfonyl imide
Perfluorobutylsulphonamide	PFBSA	30334-69-1	SGS AXYS Method MLA-121	Perfluoro sulfonamide
Perfluorohexanesulfonamide	PFHxSA	41997-13-1	SGS AXYS Method MLA-121	Perfluoro sulfonamide
Perfluoroheptanesulfonamide	PFHpSA	82765-77-3	SGS AXYS Method MLA-121	Perfluoro sulfonamide
Perfluorodecanesulfonamide	PFDSA	4262-70-8	SGS AXYS Method MLA-121	Perfluoro sulfonamide
N-Methylperfluorobutanesulfonamide	N-MeFBSA	68298-12-4	SGS AXYS Method MLA-121	Perfluoro sulfonamide
N-Methyl-n-perfluorobutanesulfonylglycine	N-MeFBSAA	159381-10-9	SGS AXYS Method MLA-121	Perfluoroalkylsulfonamidoacetic acid
N-Methyl-n-perfluorohexanesulfonylglycine	N-MeFHSAA	715646-50-7	SGS AXYS Method MLA-121	Perfluoroalkylsulfonamidoacetic acid
Perfluoro-1-octanesulfonamidoacetic acid	PFOSAA	2806-24-8	SGS AXYS Method MLA-121	Perfluoroalkylsulfonamidoacetic acid
6:2 Fluorotelomer carboxylic acid	6:2 FTCA	53826-12-3	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid
8:2 Fluorotelomer carboxylic acid	8:2 FTCA	27854-31-5	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid
10:2 Fluorotelomer carboxylic acid	10:2 FTCA	53826-13-4	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid

Analyte Name	Analyte Short Name	Chemical Abstracts Service Registry Number	Analytical Method	Analyte Group
6:2 Fluorotelomer unsaturated carboxylic acid	6:2 FTUCA	70887-88-6	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid
8:2 Fluorotelomer unsaturated carboxylic acid	8:2 FTUCA	70887-84-2	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid
Perfluoroethylcyclohexane sulfonate	PFECHS	133201-07-7	SGS AXYS Method MLA-121	Fluorotelomer carboxylic acid
7H-Perfluoro-4-methyl-3,6-dioxaoctanesulfonic acid *(Nafion By product 2, aka PFESA)*	Nafion BP2	749836-20-2	SGS AXYS Method MLA-121	Nafion byproduct
10:2 Fluorotelomer sulfonate	10:2 FTS	120226-60-0	SGS AXYS Method MLA-121	Fluorotelomer sulfonate
Perfluoro-2-methyoxyacetic acid	PFMOAA	674-13-5	SGS AXYS Method MLA-121	Perfluoroether carboxylate
Perfluoro-3,5,7-trioxaoctanoic acid	PFO3OA	39492-89-2	SGS AXYS Method MLA-121	Perfluoroether carboxylate
Perfluoro-3,5,7,9-butaoxadecanoic acid	PFO4DA	39492-90-5	SGS AXYS Method MLA-121	Perfluoroether carboxylate
Perfluoro-3,5,7,9,11-pentaoxadodecanoic acid	PFO5DoA	39492-91-6	SGS AXYS Method MLA-121	Perfluoroether carboxylate
Perfluoro-3,5,7,9,11,13-hexaoxatetradecanoic acid	PFO6TeA	NA	SGS AXYS Method MLA-121	Perfluoroether carboxylate
2,2,3,3-tetrafluoro-3-{[1,1,1,2,3,3-hexafluoro-3-(1,2,2,2-tetrafluoroethoxy)propan-2-yl]oxy}propanoic acid *(Hydro-Eve acid)*	Hydro-EVE	88457-10-7	SGS AXYS Method MLA-121	Perfluoroether carboxylate
Perfluorohexylphosphonate	PFHxPA	40143-76-8	SGS AXYS Method MLA-121	Perfluoroalkylphosphonic acid
Perfluorooctylphosphonate	PFOPA	40143-78-0	SGS AXYS Method MLA-121	Perfluoroalkylphosphonic acid
Perfluorodecylphosphonate	PFDPA	52299-26-0	SGS AXYS Method MLA-121	Perfluoroalkylphosphonic acid
1H,1H,2H,2H-perfluorooctylphosphate	6:2 PAP	NA	SGS AXYS Method MLA-121	Polyfluoroalkyl phophate mono ester

Analyte Name	Analyte Short Name	Chemical Abstracts Service Registry Number	Analytical Method	Analyte Group
1H,1H,2H,2H-perfluorodecylphosphate	8:2 PAP	NA	SGS AXYS Method MLA-121	Polyfluoroalkyl phophate mono ester
Bis(perfluorohexyl)phosphinate	6:6 PFPi	70609-44-8	SGS AXYS Method MLA-121	Perfluoroalkylphosphinate
Perfluorohexylperfluorooctylphosphinate	6:8 PFPi	610800-34-5	SGS AXYS Method MLA-121	Perfluoroalkylphosphinate
Bis(perfluorooctyl)phosphinate	8:8 PFPi	500776-69-2	SGS AXYS Method MLA-121	Perfluoroalkylphosphinate
Bis(1H,1H,2H,2H-perfluorooctyl)phosphate	6:2 diPAP	57677-95-9	SGS AXYS Method MLA-121	Polyfluoroalkyl phophate di-ester
Bis(1H,1H,2H,2H-perfluorodecyl)phosphate	8:2 diPAP	678-41-1	SGS AXYS Method MLA-121	Polyfluoroalkyl phophate di-ester
Perfluorohexadecanoic acid	PFHxDA	67905-19-5	SGS AXYS Method MLA-121	Perfluorocarboxylate
Perfluorooctadecanoic acid	PFODA	16517-11-6	SGS AXYS Method MLA-121	Perfluorocarboxylate
Trifluoroacetic acid	TFA	76-05-1	SGS AXYS Method MLA-120	Perfluoroalkyl carboxylate (Ultrashort-chain)
Pentafluoropropionic acid	PFPrA	422-64-0	SGS AXYS Method MLA-120	Perfluoroalkyl carboxylate (Ultrashort-chain)
Trifluoromethanesulfonic acid	PFMeS	1493-13-6	SGS AXYS Method MLA-120	Perfluoroalkyl sulfonate (Ultrashort-chain)
Pentafluoroethanesulfonic acid	PFEtS	354-88-1	SGS AXYS Method MLA-120	Perfluoroalkyl sulfonate (Ultrashort-chain)
Heptafluoropropanesulfonic acid	PFPrS	423-41-6	SGS AXYS Method MLA-120	Perfluoroalkyl sulfonate (Ultrashort-chain)

Appendix B. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Aqueous film-forming foam: A highly effective firefighting product intended for suppressing high-hazard flammable liquid fires.

Clean Water Act: A federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved organic carbon: Organic matter that is able to pass through a filter which removes material between 0.70 and 0.22 mm in size.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Durable water repellent: A coating added to fabrics to make them water-resistant.

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

Extractable organic fluorine: The total amount of organic fluorine that can be extracted from a sample using an organic solvent.

Fluorine-free foam: Foam that does not contain any fluorinated compounds and that is used to suppress flammable liquid fires.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

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.

Solid phase extraction: A method where a liquid or gaseous test sample interacts with a solid phase, allowing for the selective adsorption of analytes on the solid surface. This process involves partitioning compounds between solid and liquid phases, with a greater affinity for the solid phase than the sample matrix.

Streamflow: Discharge of water in a surface stream (river or creek).

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.

Thalweg: The deepest and fastest moving portion of a stream.

Total organic carbon: A measure of the total amount of organic carbon in a substance.

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

Ultrashort-chain PFAS: A subset of PFAS that have three or fewer carbon atoms in their carbon chain.

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

AFFF	Aqueous film-forming foam (See Glossary above)
CAPIM	Chemical Action Plan Implementation Monitoring
CFR	Code of Federal Regulations
CSV	Comma separated values
DO	Dissolved oxygen (see Glossary above)
DOC	Dissolved organic carbon (See Glossary above)
DOH	Washington State Department of Health
DQO	Data quality objectives
DWR	Durable water repellent (See Glossary above)
EAP	Environmental Assessment Program
e.g.	For example
ECHO	Enforcement and Compliance History Online
Ecology	Washington State Department of Ecology
EDD	Electronic data deliverable
EIM	Environmental Information Management database
EOF	Extractable organic fluorine (See Glossary above)
EPA	U.S. Environmental Protection Agency
et al.	And others
F3	Fluorine-free foam (See Glossary above)
FR	Federal Register
GIS	Geographic Information System software
HCl	Hydrochloric
HDPE	High-density polyethylene
HFPO-DA	Hexafluoropropylene oxide dimer acid
HWTR	Hazardous Waste and Toxics Reduction
ID	Identification
LIMS	Laboratory Information System
LOD	Limit of detection
LOQ	Limit of quantification
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
MS	Matrix spike
MSD	Matrix spike duplicate

NA	Not applicable
NPDES	National Pollutant Discharge Elimination System (See Glossary above)
OECD	Organization for Economic Co-operation and Development
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutane sulfonic acid
PFCA	Perfluoroalkyl carboxylic acid
PFHxA	Perfluorohexanoic acid
PFHxS	Perfluorohexane sulfonic acid
PFNA	Perfluorononanoic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
RCW	Revised Code of Washington
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
SPE	Solid phase extraction (See Glossary above)
TFA	Trifluoroacetic acid
TOC	Total organic carbon (See Glossary above)
TOP	Total oxidizable precursor (See Glossary above)
TSS	Total suspended solids (see Glossary above)
USGS	United States Geological Survey
WAC	Washington Administrative Code
WWTP	Wastewater treatment plant
YSI	Yellow Springs Instruments, Inc.

Units of Measurement

°C	degrees centigrade
Cm	centimeter
L	liter
mg	milligram
mg/L	milligrams per liter (parts per million)
mL	milliliter
ng/L	nanograms per liter (parts per trillion)
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter, a unit of conductivity

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 the 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).

Limit of detection: The lowest quantity or concentration of a component that can be reliably detected and distinguished from the limit of blank with a given analytical method.

Limit of quantification: The lowest analyte concentration that can be quantitatively detected with a stated accuracy and precision.

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 2025).

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).

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