



Quality Assurance Project Plan: Jefferson County Landfill Groundwater Background Arsenic Concentrations

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

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

Data for this project are available in Ecology's [EIM Database](#).¹ Search Study ID: LTEL0001.

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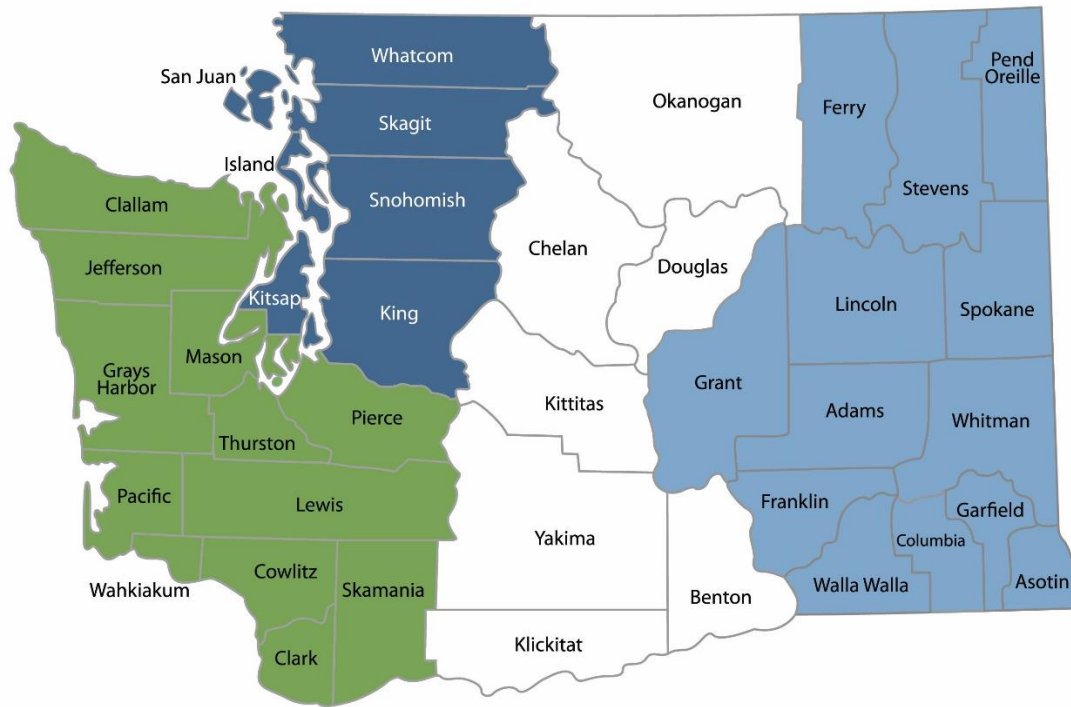
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Northwest Region
206-594-0000

Central Region
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Eastern Region
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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
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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
Headquarters	Across Washington	PO Box 47600 Olympia, WA 98504	360-407-6000

Quality Assurance Project Plan

Jefferson County Landfill

Groundwater Background Arsenic Concentrations

By Luke Telfer
October 2026

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2.0 Abstract

The Jefferson County Landfill, located near Port Townsend, Washington, served as the primary municipal solid waste disposal facility for Jefferson County until its closure in 1993.

Groundwater monitoring began in 1987 in response to the adoption of Washington Administrative Code (WAC) 173-304, which established comprehensive requirements for landfill operation, closure, and post-closure care. Post-closure groundwater monitoring has continued pursuant to WAC 173-304-407 to evaluate landfill stabilization and protect downgradient groundwater resources.

In December 2024, a memorandum prepared by Aspect Consulting documented that landfill gas generation, leachate generation, and settlement have substantially diminished, indicating that the landfill is approaching long-term stability. However, total arsenic concentrations in groundwater were found to have stabilized at levels exceeding the statewide groundwater quality criterion of 0.05 µg/L, including in the designated background monitoring well.

Using a statistical analysis of data collected from the designated upgradient monitoring well, Aspect Consulting estimated the background groundwater arsenic concentration and proposed a provisional site-specific enforcement limit of 12.6 µg/L. This site-specific enforcement limit must be approved by both Jefferson County Public Health and Ecology. Additional data is necessary to confirm background arsenic conditions and support a determination that post-closure monitoring may be discontinued under WAC 173-304-407(8).

The primary objective of this project is to supply data for the development of a more robust and representative estimate of background groundwater arsenic concentrations in the vicinity of the landfill. This objective will be achieved by sampling domestic wells near the landfill. Groundwater samples will be analyzed for total and dissolved arsenic to characterize concentration ranges and geochemical behavior. The resulting dataset will be used to evaluate whether observed arsenic concentrations are consistent with natural background conditions and to support regulatory decisions regarding the completion of post-closure activities.

3.0 Background

3.1 Introduction and problem statement

The Jefferson County Landfill is located southwest of Port Townsend on the Quimper Peninsula and historically served as the principal disposal facility for Jefferson County (Figure 1). New solid-waste regulations implemented under WAC 173-304 in 1985 established comprehensive design, operating, closure, and post-closure requirements for landfills in Washington State (WAC 173-304). Groundwater monitoring began in 1987 to comply with the new requirements (Sweet, Edwards & Associates 1987). The landfill closed in 1993, and post-closure monitoring and maintenance continued under the General Closure and Post-Closure Requirements in WAC 173-304-407, including groundwater, landfill gas, and settlement monitoring.

A memorandum prepared in 2024 documented that landfill gas generation, leachate production, and settlement had declined to minimal levels and that the waste mass appears stabilized (Aspect Consulting 2024). However, monitoring data showed that total arsenic concentrations had stabilized at levels exceeding the groundwater quality criterion of 0.05 µg/L established under WAC 173-200-040 for carcinogenic contaminants (WAC 173-200-040; WAC 173-200-900). Arsenic was observed in all monitoring wells at concentrations ranging from 10 to 30 µg/L. This includes the designated upgradient well, indicating that the background level is far above the groundwater criteria for arsenic.

Using data collected from the upgradient well, Aspect Consulting (2024) proposed a provisional site-specific enforcement limit of 12.6 µg/L, consistent with the regulatory allowance for establishing background concentrations under WAC 173-200-060(4). The memorandum concludes that a more robust background estimate is needed before cessation of post-closure activities can be authorized by the jurisdictional health department under WAC 173-304-407(8). This project is therefore designed to obtain additional groundwater arsenic data from nearby domestic supply wells to support development of a defensible site-specific background concentration.

3.2 Study area and surroundings

The Jefferson County Landfill lies about half a mile southwest of Port Townsend in the central portion of the Quimper Peninsula (Figure 1). The 275-acre site occupies generally flat uplands with elevations between 200 and 220 feet above mean sea level. Surrounding land uses include rural-residential parcels to the north, forested lands to the west and south, and the Jefferson County Transfer Station to the east.

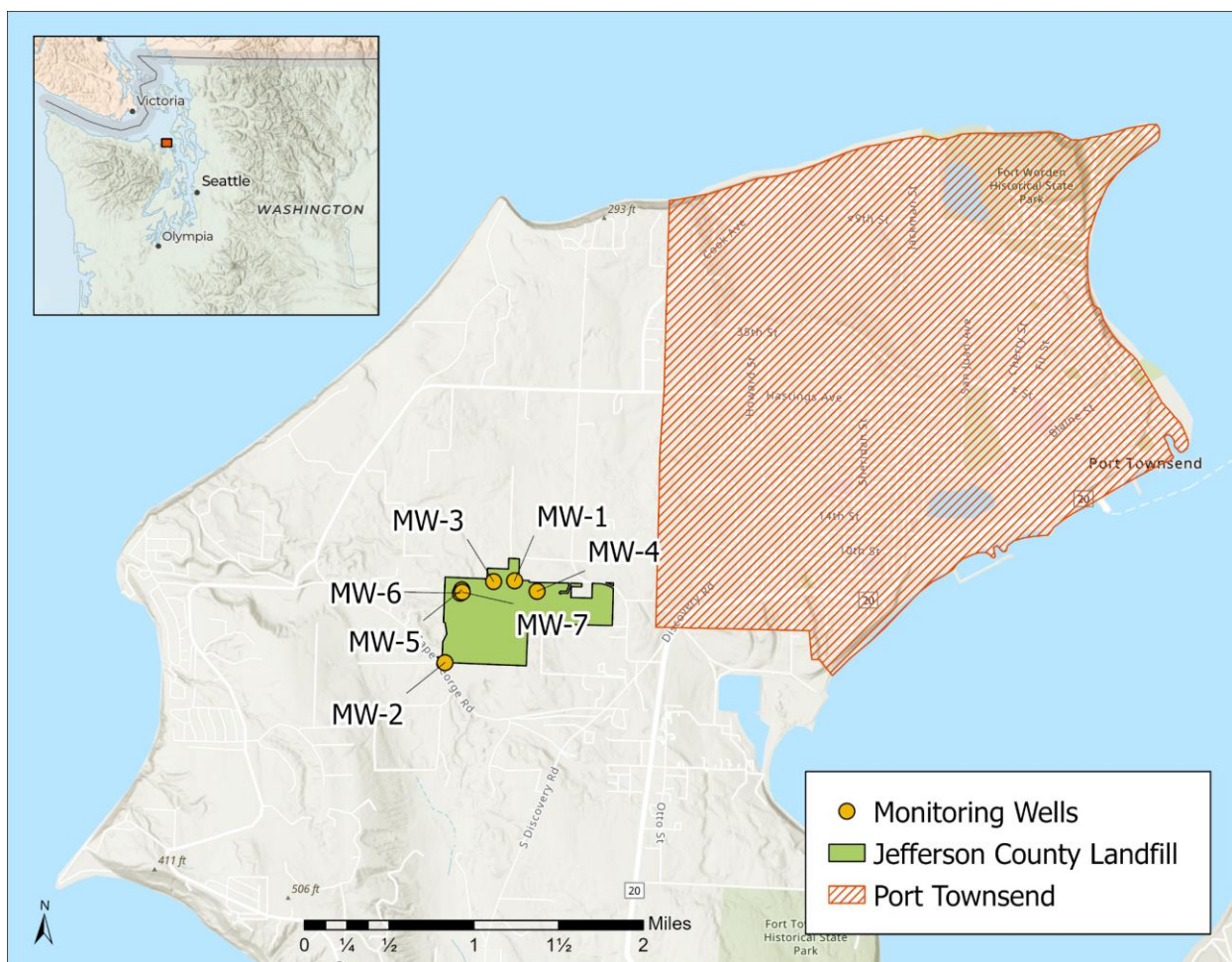


Figure 1. Map of the Jefferson County Landfill study area.

Annual precipitation averages approximately 20–25 inches due to the Olympic Mountain rain shadow, with the majority falling between October and April (NOAA 2021). The area is part of the Puget Lowland level III ecoregion, characterized by a mild maritime climate, Douglas-fir and Grand fir forests, oak woodlands, and associated understory vegetation (EPA 1998).

Surface water features are limited because precipitation readily infiltrates the sandy and gravelly glacial deposits. Drainage is confined to small, intermittent swales, roadside ditches, and isolated wetlands. No perennial streams are located near the landfill. The subsurface consists of layered Vashon glacial deposits overlying a Pre-Vashon outwash aquifer. In many areas, these units are separated by an interglacial confining layer that supports isolated zones of perched groundwater systems west of the landfill (Sweet, Edwards & Associates 1987; Aspect Consulting 2023). Groundwater in the regional outwash aquifer is typically encountered at depths of approximately 190 feet below ground surface and flows northeast across the peninsula.

3.2.1 History of study area

Landfilling began at the site in 1973 and continued for two decades under progressively more stringent regulatory frameworks. In 1985, adoption of WAC 173-304 required significant upgrades in design, operation, and environmental monitoring. Methane detection along the landfill's western boundary in 1987 prompted the installation of the first groundwater monitoring wells and evaluation of gas management needs (Sweet, Edwards & Associates 1987). A landfill gas collection system and flare were installed by 1989 to address ongoing methane production.

Following implementation of the new regulatory standards and development of the County's Solid Waste Management Plan, the landfill ceased accepting waste in 1993. Post-closure monitoring began immediately thereafter under WAC 173-304-407, including groundwater quality, landfill gas, settlement, and general facility maintenance. Monitoring continued for decades as the waste mass decomposed and stabilized.

By 2023–2024, long-term monitoring data showed minimal landfill gas production, negligible leachate generation, and no meaningful settlement. In accordance with WAC 173-304-407(8)(b), the County initiated post-closure termination proceedings. However, arsenic concentrations remained above the numeric groundwater criterion, requiring further evaluation of naturally occurring background conditions before post-closure activities can be discontinued (Aspect Consulting 2023; Aspect Consulting 2024).

3.2.2 Summary of previous studies and existing data

Groundwater monitoring at the landfill began in 1987 with a hydrogeologic investigation to characterize site geology, hydrostratigraphy, groundwater flow, and baseline water quality conditions. This study documented the layered glacial sediments underlying the site and provided the first dataset on groundwater quality, including metals, major ions, and indicator parameters (Sweet, Edwards & Associates 1987).

From 1987 through 2023, the County implemented routine groundwater monitoring consistent with WAC 173-304-407. These efforts included sampling of upgradient and downgradient wells for total and dissolved metals, indicator parameters, and occasional volatile organic compounds. Arsenic sampling began in 2020 and showed that concentrations were stable at each of the monitoring wells. However, these stable concentrations were well above the 0.05 µg/L groundwater criterion, ranging from 10 µg/L to 30 µg/L (Figure 2).

Annual monitoring reports over the post-closure period documented declining landfill gas generation and stable groundwater quality, with arsenic and manganese as the only constituents consistently exceeding regulatory criteria. The 2024 memorandum recommending an end to post-closure care proposed a provisional site-specific background concentration for arsenic of 12.6 µg/L, derived from the upgradient well (Aspect Consulting 2024). Under WAC 173-304-407(8)(c), this site-specific background concentration must be approved by both Ecology and Jefferson County Public Health in order for post-closure activities to be terminated.

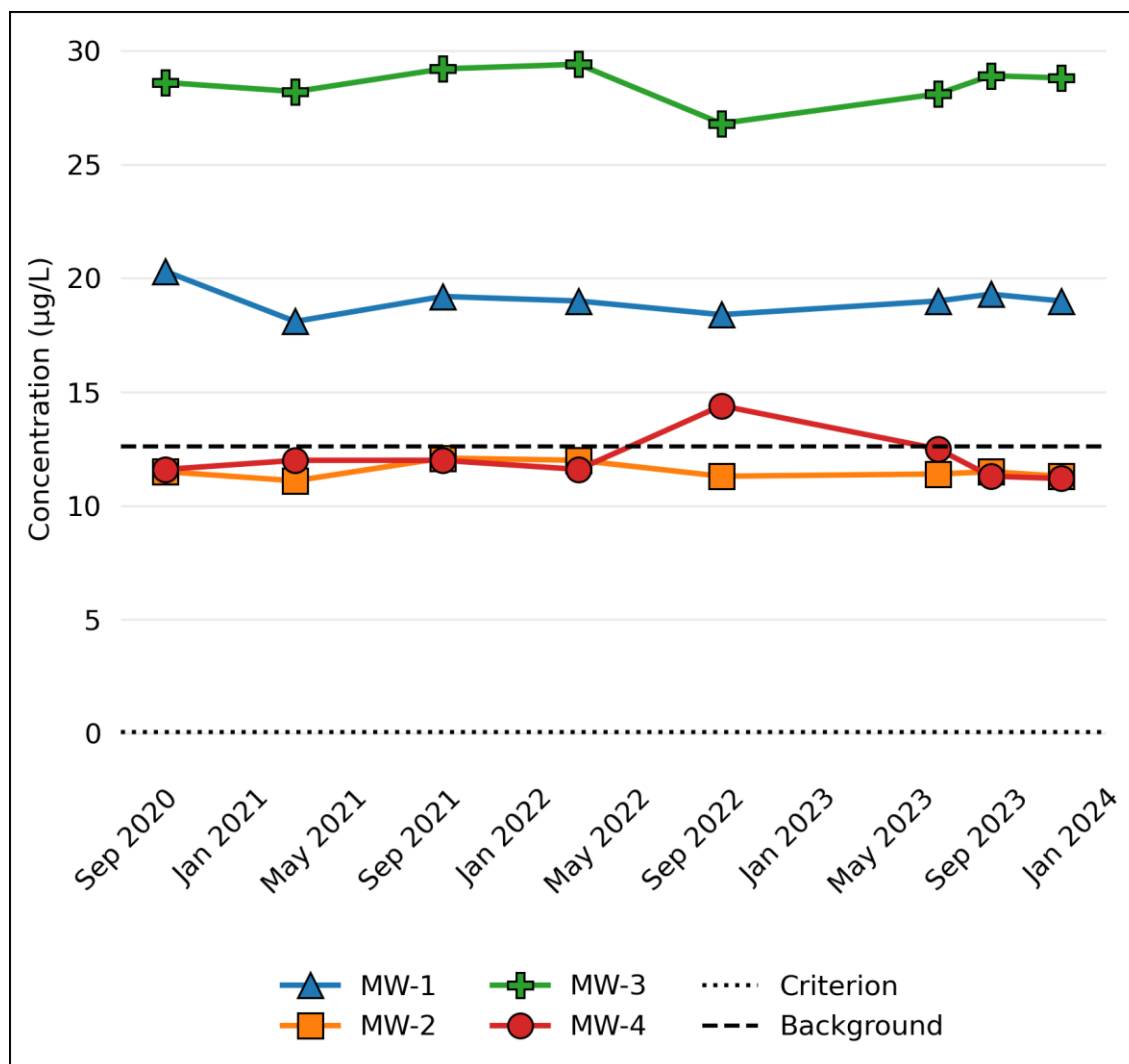


Figure 2. Total Arsenic concentrations collected by Aspect Consulting from October 2020 to December 2023 (Aspect Consulting 2024).

3.2.3 Parameters of interest and potential sources

Arsenic is the sole contaminant of concern for this study. Long-term monitoring shows that other parameters have stabilized within normal ranges and do not indicate leachate impacts. Arsenic consistently exceeds the 0.05 µg/L groundwater quality criterion in all landfill monitoring wells, including the upgradient well, demonstrating that naturally elevated background conditions are likely present (WAC 173-200-040; Aspect Consulting 2023, 2024).

Elevated groundwater arsenic in the region is commonly associated with reducing conditions in glacial deposits. The landfill's historical gas generation may have influenced redox chemistry and mobilized arsenic from aquifer sediments, contributing to elevated concentrations. As landfill gas production continues to decline, arsenic levels are expected to decrease toward natural background values (Aspect Consulting 2024).

Field parameters—including pH, temperature, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential—will be measured during sampling to determine stabilization and ensure sample quality, following standard groundwater sampling practice (Ecology 2025). These parameters are not contaminants of concern but are required to ensure reliable arsenic results.

3.2.4 Regulatory criteria or standards

Two primary regulations apply to this study: the Minimum Functional Standards for Solid Waste Handling (WAC 173-304) and the Water Quality Standards for Groundwaters of the State of Washington (WAC 173-200). WAC 173-304 governs landfill closure and post-closure care, including groundwater monitoring requirements and the conditions under which post-closure activities may be terminated. Under WAC 173-304-407(8), termination requires certification from a professional engineer and concurrence from the jurisdictional health department that the facility is stabilized.

WAC 173-200 establishes groundwater quality criteria and specifies that total arsenic shall not exceed 0.05 µg/L, as listed in Table 1 under carcinogenic contaminants (WAC 173-200-040). However, the rule also allows development of a site-specific background concentration that supersedes numeric criteria when natural conditions exceed the standard (WAC 173-200-060(4)). In such cases, compliance is based on whether facility operations have caused groundwater to exceed natural background rather than on the numeric criterion.

This project supports regulatory decision-making by improving the estimate of site-specific background arsenic concentration needed for evaluating compliance under WAC 173-200 and for determining whether post-closure activities may be discontinued under WAC 173-304-407.

4.0 Project Description

Groundwater monitoring at the former Jefferson County Landfill has shown that arsenic concentrations stabilized at levels higher than the statewide groundwater quality criterion. These concentrations were observed at both downgradient and upgradient locations, suggesting that elevated arsenic is likely related to naturally occurring background conditions rather than releases from landfill operations. However, the site-specific background arsenic concentration used to support this interpretation was derived from data collected at a single background monitoring well, which provides an insufficient basis for confidently characterizing natural variability in groundwater arsenic concentrations in the area.

This project will collect total and dissolved arsenic samples from ten nearby domestic wells completed in the regional Pre-Vashon outwash aquifer. These wells will provide a broader and more representative dataset for evaluating natural background arsenic levels in groundwater near the site. The resulting data will be used to develop a better estimate of background arsenic concentrations, which can be compared to concentrations previously observed at the landfill. This improved background characterization will support regulatory decision-making regarding whether arsenic concentrations reflect natural conditions and whether post-closure care and monitoring requirements at the former landfill can be formally concluded.

4.1 Project goals

The goal of this project is to collect high-quality groundwater data needed to better characterize natural background concentrations of arsenic in the vicinity of the Jefferson County Landfill. Previous estimates of site-specific background arsenic concentrations were based on limited data from a single background monitoring well and are therefore not sufficiently robust to support regulatory decision-making. By expanding the dataset using groundwater samples from nearby domestic wells, this project seeks to provide a defensible empirical basis for evaluating whether elevated arsenic concentrations observed in landfill-area groundwater are consistent with naturally occurring background conditions. The resulting data will support future determinations regarding the appropriateness of concluding post-closure care and monitoring requirements at the landfill.

4.2 Project objectives

The primary objective of this project is to collect groundwater samples from up to ten domestic wells located near the Jefferson County Landfill and analyze those samples for total and dissolved arsenic. Sampling will be conducted in accordance with approved Ecology guidance and standard groundwater sampling protocols to ensure data quality and comparability. Field measurements will be collected to document sampling conditions and confirm adequate purging of the well. All data generated by this project will be verified and reported for use by others in subsequent statistical analyses aimed at estimating background arsenic concentrations. This project does not include statistical evaluation or regulatory interpretation of results; its sole objective is the generation of reliable groundwater arsenic data to inform those future efforts.

4.3 Information needed and sources

Existing data to be assembled for this project include available well construction logs and GIS location data for the domestic wells selected for sampling, to document well depth, screened interval, and spatial relationship to the landfill and surrounding hydrogeologic setting. New data to be collected consist of groundwater samples analyzed for total arsenic and dissolved arsenic from eight to ten domestic wells located near the Jefferson County Landfill. These existing and newly collected data will provide the information needed to support subsequent evaluation of background arsenic concentrations.

4.4 Tasks required

- Select and obtain permission to sample 10 domestic wells. Wells will be selected using criteria described in section 7.2.1.
- Sample the 10 wells for total and dissolved arsenic.
- Measure groundwater levels where possible.
- Evaluate results for quality assurance (QA) using standard Environmental Assessment Program (EAP) procedures.
- Enter data into Ecology's Environmental Information Management database (EIM).
- Prepare a final technical memorandum that includes the sampling results.

4.5 Systematic planning process

This Quality Assurance Project Plan (QAPP) serves as the planning document for the project.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

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

Table 1. Organization of project staff and responsibilities.

Staff ¹	Title	Responsibilities
John Price Solid Waste Management Program Southwest Regional Office Phone: 509-202-5623	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Nick Lawlor Jefferson County Public Health Phone: 360-385-9413	Environmental Health Specialist	Contacts domestic well owners to acquire permission and schedule sampling efforts.
Luke Telfer Groundwater Monitoring Unit Statewide Coordination Section Phone: 564-233-5939	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.
Derek Rockett Solid Waste Management Program Southwest Regional Office Phone: 360-995-3176	Field Assistant	Assists with sample collection and recording field notes.
Jacob Carnes Groundwater Monitoring Unit Statewide Coordination Section Phone: 360-688-4413	Project Management Assistant	Provides internal review of the QAPP. Provides technical project and sampling support.
Eugene Freeman Groundwater Monitoring Unit Statewide Coordination Section Phone: 360-338-2874	Unit Supervisor for Project Manager / Licensed Hydrogeologist	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	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Rob Waldrop Manchester Environmental Laboratory Phone: 360-519-2081	Manchester Environmental Laboratory Director	Reviews and approves the final QAPP.
Christina Frans Phone: 360-995-2473	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

¹ All staff except those specifically identified are from EAP

EAP: Environmental Assessment Program

EIM: Environmental Information Management database

QAPP: Quality Assurance Project Plan

5.2 Special training and certifications

A hydrogeologist license is required for the person overseeing hydrogeologic studies (Chapter 18.220.020 RCW). Eugene Freeman will oversee this project.

Field staff are required to maintain First Aid/CPR certification.

All field staff should have detailed working knowledge of the QAPP and any applicable standard operating procedures (SOPs) to ensure credible and usable data are collected. This includes being familiar with the sample equipment and instruments being used. Section 8.0 details equipment and SOPs.

5.3 Organization chart

See Table 1.

5.4 Proposed project schedule

Tables 2 – 4 list key activities, due dates, and lead staff for this project.

Table 2. Schedule for completing field and laboratory work.

Task	Due Date	Lead Staff
Field work	June 2026	Luke Telfer
Laboratory analyses	August 2026	MEL Staff

Table 3. Schedule for data entry.

Task	Due Date	Lead Staff
EIM data loaded ¹	August 2026	Luke Telfer
EIM QA	September 2026	GMU Staff
EIM complete	October 2026	Luke Telfer

¹ EIM Project ID: LTEL0001

EIM: Environmental Information Management database.

Table 4. Schedule for final report.

Task	Due Date	Lead Staff
Draft to supervisor	January 2027	Luke Telfer
Draft to client/ peer reviewer	February 2027	Luke Telfer
Final draft to publications team	March 2027	Luke Telfer
Final report due on web	April 2027	Publications Team

5.5 Budget and funding

Solid Waste Management Program (SWM) will provide funding for laboratory costs. Environmental Assessment Program (EAP) will fund the remaining balance. Itemized costs for the project are listed in Tables 5 and 6.

Table 5. Project budget and funding.

Item	Cost (\$)
Equipment	\$1,000
Travel and other	\$1,000
Laboratory (See Table 6 for details.)	\$1,320
Total	\$3,320

Table 6. Laboratory budget details.

Parameter	Number of Samples	Number of QC Samples	Total Number of Samples	Cost Per Sample (\$)	Lab Subtotal (\$)
Arsenic, Total	10	5	15	\$44	\$660
Arsenic, Dissolved	10	5	15	\$44	\$660
Total	20	10	30	N/A	\$1,320

N/A: Not Applicable

6.0 Quality Objectives

6.1 Data quality objectives

The primary data quality objective (DQO) for this project is to collect acceptable and defensible groundwater samples for total and dissolved arsenic that are representative of background concentrations within the regional aquifer. Samples will be collected in accordance with Standard Operating Procedure EAP098: Collecting Groundwater Samples for Metals Analysis from Water Supply Wells (Ecology 2025). The collected samples will be analyzed using accredited methods (see Table 11) to obtain data that meet the measurement quality objectives (MQOs) described below.

6.2 Measurement quality objectives

Measurement quality objectives (MQOs) are performance or acceptance criteria for individual data quality indicators, including quantitative factors (precision, bias, sensitivity, and completeness) and qualitative factors (comparability and representativeness).

6.2.1 Targets for precision, bias, and sensitivity

The measurement quality objectives (MQOs) for this project are presented in Tables 7 and 8. All water quality data collected for this project will be evaluated against the project MQOs. Providing pre-established criteria for data quality in the MQOs allows the determination of potential sources of error when evaluating precision and bias for the analytical method.

6.2.1.1 Precision

Precision is a measure of the variability between results of replicate measurements that is due to random error. It is assessed using duplicate field measurements or laboratory analysis of duplicate samples. Random error is imparted by the variation in concentrations of samples from the environment as well as other introduced sources of variation (e.g. field and laboratory procedures). Duplicate samples will be collected in the field by filling two sets of bottles at the same time from a pre-selected well. Precision for field and laboratory duplicate samples will be expressed as relative percent difference (RPD) as shown in Table 8. The smaller the RPD, the more precise the measurement process. Good precision is indicative of relative consistency and comparability between different samples.

Table 7. Measurement quality objectives for field measurements and equipment.

Parameter	Equipment	Instrument Resolution	Stabilization Criteria	Post-Use Calibration Acceptance Criteria
pH	YSI EXO	0.01 SU	±0.2 SU	±0.15: Pass, ±0.15–0.5: “EST” Qualify, ±0.5 or greater: “REJ” Qualify
Specific Conductivity	YSI EXO	0.0001 to 0.01 µS/cm (range dependent)	±10 µS/cm	±5%: Pass, ±5%–10%: “EST” Qualify, ±10% or greater: “REJ” Qualify
Dissolved Oxygen	YSI EXO	0.01 mg/L	±0.3 mg/L	±5%: Pass, ±5%–10%: “EST” Qualify, ±10% or greater: “REJ” Qualify
Oxidation Reduction Potential	YSI EXO	0.1 mV	±20 mV	±5%: Pass, ±5%–10%: “EST” Qualify, ±10% or greater: “REJ” Qualify
Turbidity	YSI EXO	0 to 999 = 0.01 FNU, 1000 to 4000 = 0.1 FNU	≤10 FNU	±10%: Pass, ±10%–20%: “EST” Qualify, ±20% or greater: “REJ” Qualify

FNU: Formazin Nephelometric Unit

mg/L: milligrams per liter

mV: millivolts

SU: standard units

µS/cm: microsiemens per centimeter

Table 8. Measurement quality objectives for laboratory analyses of water samples.

Parameter	Field Duplicate (RPD)	Lab Control Standard Duplicate (RPD)	Matrix Spike Duplicate (RPD)	Lab Control Sample (% Recovery)	Matrix Spike (% Recovery)	Surrogate (% Recovery)	Method Detection Limit (Concentration)
Arsenic, Total	≤ 20	≤ 20	≤ 20	85 – 115	75 – 125	N/A	0.1 µg/L
Arsenic, Dissolved	≤ 20	≤ 20	≤ 20	85 – 115	75 – 125	N/A	0.1 µg/L

RPD: Relative Percent Difference

N/A: Not Applicable

6.2.1.2 Bias

Bias is defined as the difference between the sample mean and true value of the parameter being measured. Bias is usually addressed by calibrating field and lab instruments, and by analyzing lab control samples, matrix spikes, and standard reference materials (see Table 8). Bias in field measurements and samples will be minimized by strictly following Ecology's measurement, sampling, and handling protocols.

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a method to detect a substance. It is commonly described as a detection limit. In a regulatory sense, the method detection limit (MDL) is usually used to describe sensitivity. Targets for field and lab measurement sensitivity required for the project are listed in Table 8.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

Comparability expresses the confidence with which one set of data can be compared to another. Comparability will be ensured to the extent possible by implementing standard operating procedures (SOPs) for sampling and analysis. SOPs to be used during this project are listed in Section 8.2. Laboratory analyses will follow the methods described in Section 9.1 (Lab procedures) for each suite of analytes. Laboratory-specific SOPs for the preparation and analysis of samples, data reduction, and data review for each analysis will be followed.

6.2.2.2 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent the actual site conditions. In order to obtain samples representative of the aquifer, we will follow SOPs for groundwater sampling as listed in Section 8.2, ensure that field meters are properly calibrated, and ensure consistency in sampling procedures. Samples are assumed representative of site conditions at the time they are collected.

6.2.2.3 Completeness

Completeness establishes whether a sufficient number of valid measurements were obtained to meet project objectives. The number of samples and results expected establishes a comparative basis for completeness. The completeness goal for this project is to collect and analyze 100% of the measurements and samples. However, problems occasionally arise during sample collection that cannot be controlled; thus, a completeness of 90% is acceptable. Example problems are equipment failure and site access issues.

6.3 Acceptance criteria for quality of existing data

Existing groundwater data for the Jefferson County Landfill consist mainly of long-term post-closure monitoring results from landfill monitoring wells. These data include analytical results, well construction logs, and spatial information describing well locations and site hydrogeology. The data were collected under approved monitoring plans and are considered reliable for evaluating long-term trends. However, they are limited for characterizing natural background arsenic concentrations because the background estimate was based on a single upgradient monitoring well.

This project will collect new environmental data to address this limitation. Total and dissolved arsenic concentrations will be measured in multiple nearby domestic wells. The project is limited to data collection only and does not include statistical analysis or modeling. Those activities will be conducted separately. The new data will improve spatial coverage and provide a more representative dataset for evaluating background arsenic concentrations.

6.4 Model quality objectives

N/A

7.0 Study Design

7.1 Study boundaries

The study boundaries — along with candidate sampling sites — are shown in Figure 3.

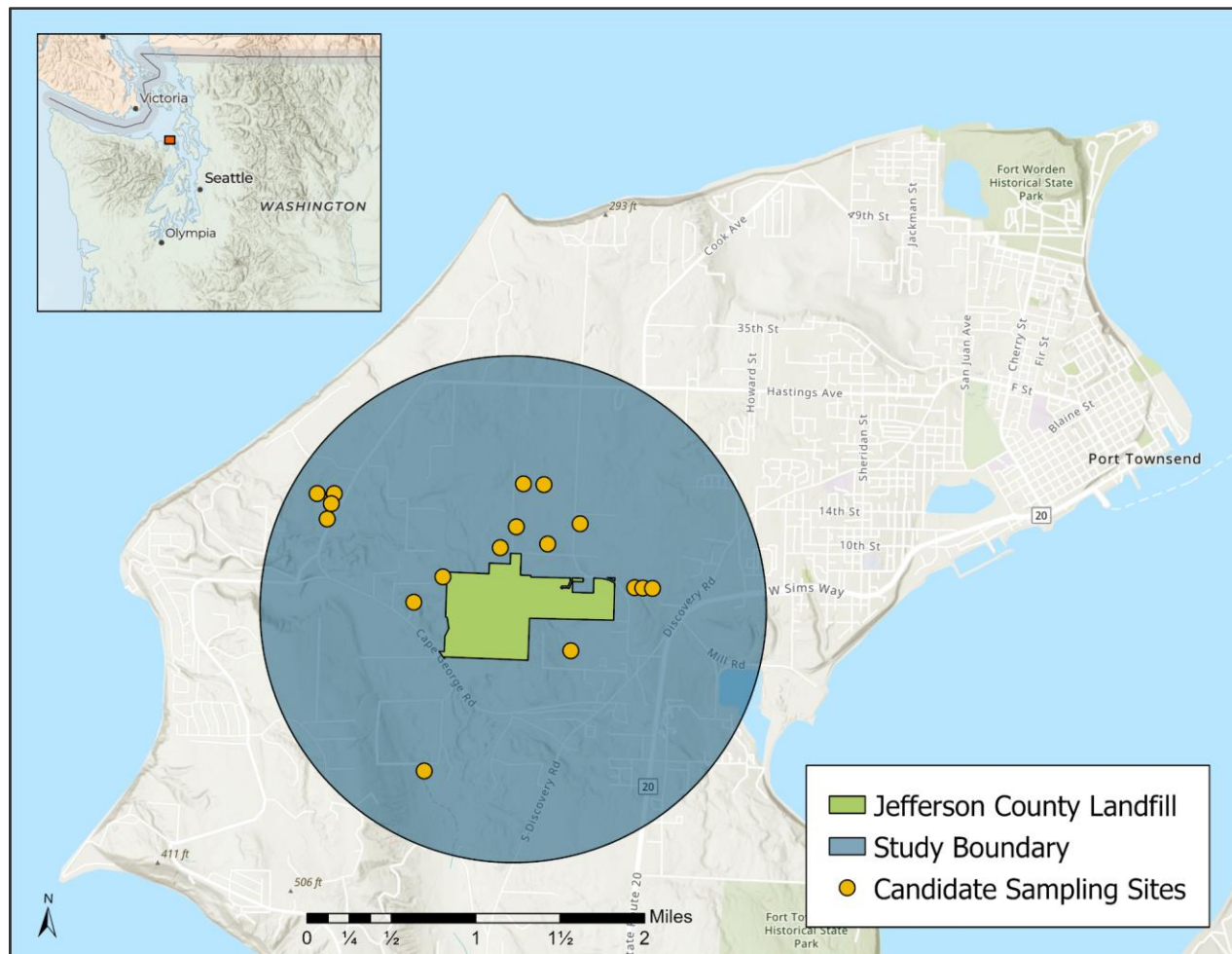


Figure 3. Map showing approximate boundary of project study area with candidate sampling sites.

7.2 Field data collection

7.2.1 Sampling locations and frequency

The 10 sampling locations will be selected from the candidate sites shown in Figure 3, prioritizing the sites nearest to the landfill. Each site will be sampled once.

Wells will be selected using the following criteria:

- Owner permission to access and sample the well.
- The well driller's log is available.
- The well must be completed in the aquifer of interest to provide a representative sample.
- The well construction meets the well construction standards specified in Chapter 173-160 WAC.
- The water must be untreated prior to the sample point (collect sample as close as possible to the well head as possible, before treatment system or storage tank).

7.2.2 Field parameters and laboratory analytes to be measured

The field parameters to be measured include:

- Depth-to-Water (where accessible and owner grants permission)
- Temperature
- pH
- Specific Conductivity
- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (ORP)
- Turbidity

The laboratory analytes to be sampled include:

- Total Arsenic
- Dissolved Arsenic

7.3 Modeling and analysis design

N/A

7.4 Assumptions underlying design

The study design is based on the following assumptions:

- The selected wells for sampling will provide information representative of current site conditions.
- Seasonality is minor and a single sampling event is adequate for characterizing background arsenic levels.
- Sampling 10 domestic water supply wells near the landfill will provide sufficient information to calculate the background concentration of arsenic.

7.5 Possible challenges and contingencies

The primary challenge of this study relates to accessing private property to sample domestic water supply wells over the course of this project.

7.5.1 Logistical problems

This project depends on gaining access to domestic water supply wells. Reconnaissance will occur prior to sampling to ensure selected wells meet the criteria described in section 7.2.1. Miscommunication with property owners is the main potential logistical problem. Property owners will provide verbal or written permission to sample their wells and will have agreed to the date and time of sampling. Property owners will be notified of any schedule changes during the sampling event.

7.5.2 Practical constraints

Availability of field staff, equipment, or other resources is a practical constraint that will be mitigated by early and thorough planning and communication.

7.5.3 Schedule limitations

Changes in project prioritization and workload for EAP staff could affect the project schedule. Factors that can cause delays to the proposed project schedule include:

- Unforeseen field or laboratory complications (e.g. inability to collect samples from selected wells, problems with laboratory equipment, etc.).
- Budgetary constraints.

Unforeseen limitations which affect the project schedule will be discussed with the client and appropriate supervisor as needed and discussed in the final technical memorandum.

8.0 Field Procedures

8.1 Invasive species evaluation

N/A

8.2 Measurement and sampling procedures

Groundwater sampling activities for the study will follow Ecology standard operating procedures:

- EAP052 v1.4 for measuring depth-to-water (Ecology 2023).
- EAP098 v1.3 for purging and sampling water supply wells for metals analysis (Ecology 2025).

All samples will be collected from domestic water supply wells. Staff will measure the depth to water only in wells where the property owner has granted permission. A decontaminated Y-splitter will be attached to an outdoor hose bib as laterally close to the well head as possible. A garden hose will be attached to one side of the Y-splitter and set at a high discharge rate. The other side will be connected to the flow cell of a calibrated YSI EXO multiparameter sonde (Figure 4A) and set to a low-flow rate (< 300 mL/min).

Field parameter measurements for temperature, pH, specific conductivity, oxidation-reduction potential, dissolved oxygen, and turbidity will be recorded at regular intervals until all parameters have stabilized. Stabilization is met once three consecutive readings are within the criteria as specified in Table 7. Once the field parameters have stabilized, the flow cell will be disconnected from the Y-splitter and replaced with a sampling assembly similar to the setup shown in Figure 4B (the 45 µm in-line filter is only used when collecting samples for dissolved arsenic). Samples will be collected with a flow rate of less than 300 mL per minute and stored on ice.

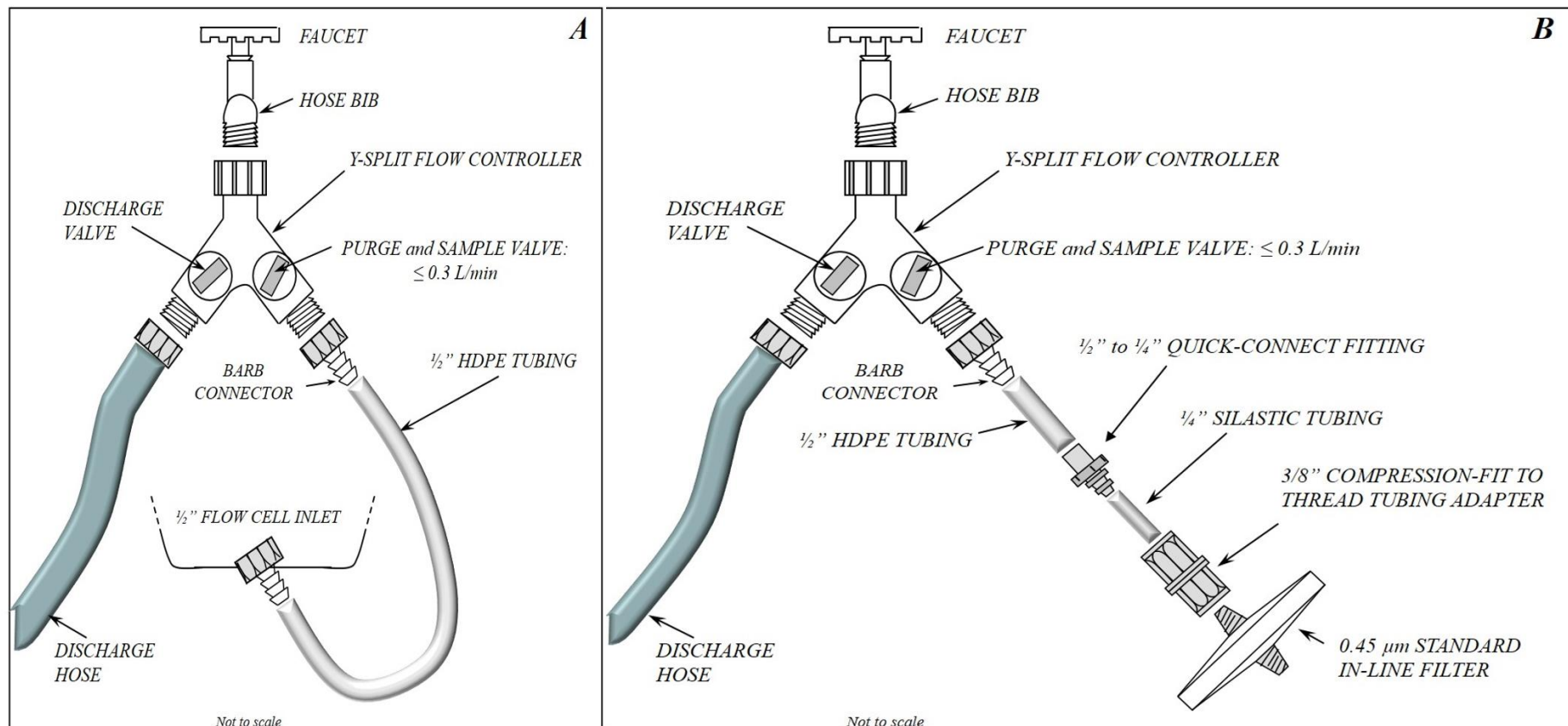


Figure 4. Schematic for typical water supply well purge and sampling — (A) example apparatus for measurement of purge parameters, (B) example apparatus for sampling.

8.3 Containers, preservation methods, holding times

Table 9 presents the parameter, sample containers, preservation, and holding times required to meet project goals and objectives.

Table 9. Sample containers, preservation, and holding times.

Parameter	Matrix	Minimum Quantity Required	Container	Preservative	Holding Time
Arsenic, Total	Water	350 mL	500 mL HDPE bottle	Pre-acidified with 1:1 HNO ₃ ; cool to ≤ 6 °C	6 months
Arsenic, Dissolved	Water	350 mL	500 mL HDPE bottle	Pre-acidified with 1:1 HNO ₃ ; cool to ≤ 6 °C	6 months

HDPE: high-density polyethylene

HNO₃: nitric acid

mL: milliliters

8.4 Equipment decontamination

All reusable, sample-contact equipment (e.g. Y-splitter) will be decontaminated following standard operating procedures outlined in Appendix A of EAP098 (Ecology 2025), which includes the following steps:

1. Tap/phosphate-free detergent brush wash
2. Tap rinse
3. 10% nitric acid rinse (if indicated)
4. Triple rinse with metals-free DI water
5. Foil wrap until use

New sample tubing and filters will be used at each sampled well. Clean gloves will be worn while sampling and discarded upon completion.

8.5 Sample ID

Samples will be identified by a naming convention provided by the field lead. The well locations will be identified using the township, range, section (TRS) and quarter-quarter section convention (Ecology 2006). All sample IDs will be recorded in field logs and in an electronic spreadsheet for tracking purposes.

8.6 Chain of custody

Chain-of-custody procedures will be followed according to MEL protocol (MEL 2016a). Once collected, samples will be properly labeled and stored in an ice-filled cooler inside the sampling vehicle. If the vehicle is left unattended, it will be locked to maintain chain-of-custody. Samples will be transported to Ecology's Operation Center in Lacey, Washington. Upon arrival, sample coolers will be secured with either metal clips or seals and the chain-of-custody sheet will be filled out. The coolers will be placed in the secure walk-in cooler until picked up by the lab courier and transported to MEL in Port Orchard, Washington.

8.7 Field log requirements

A field log will be maintained by the field lead and used during each sampling event. Field logs are used to record project and site specific information, such as:

- Project name
- Site name and location
- Field personnel present
- Field measurement results
- Sample collection details (i.e. date, time, sample ID)
- Identity of QC samples, if applicable
- Pertinent observations or unusual circumstances

Field logs will consist of pre-printed (for ease of recording), waterproof 8.5-inch x 11-inch field sheets that will be kept enclosed in an aluminum storage clipboard. Permanent, waterproof ink or pencil will be used for all entries. Corrections will be made with single-line strikethroughs, initialed and dated.

8.8 Other activities

Additional activities include:

- Field sampling will follow the procedures outlined in this QAPP and all relevant Ecology SOPs listed in section 8.2. Field staff new to this type of sampling will be trained by senior field staff or the project manager.
- The YSI EXO sonde will be calibrated prior to sampling and checked after each day of use. If needed, the instrument will be recalibrated to meet MQOs (Table 7). Any required maintenance will be performed by trained field staff following manufacturer instructions and recommendations.
- The field lead will work with the laboratory for delivery of the necessary sampling containers and promptly notify the laboratory of any changes in the sampling schedule.

9.0 Laboratory Procedures

9.1 Lab procedures table

Analytes for this project along with the expected number of samples and an expected range of results are listed in Table 10.

Table 10. Measurement methods (laboratory).

Analyte	Sample Matrix	Samples (Number)	Expected Range of Results	Detection or Reporting Limit	Analytical (Instrumental) Method
Arsenic, Total	Water	10	<0.10 – 15 µg/L	0.10 µg/L	EPA 200.8 (Creed et al. 1994)
Arsenic, Dissolved	Filtered Water	10	<0.10 – 15 µg/L	0.10 µg/L	EPA 200.8 (Creed et al. 1994)

µg/L: micrograms per liter

9.2 Sample preparation method(s)

Dissolved arsenic samples will be field-filtered using a new in-line 0.45 µm capsule filter. At least one liter of water will be rinsed through the filter before a sample is collected. Both total and dissolved arsenic samples will be collected in pre-preserved bottles supplied by Ecology's Manchester Environmental Laboratory (MEL). The laboratory will follow sample preparation procedures for the analytical methods listed in Table 10.

9.3 Special method requirements

N/A

9.4 Laboratories accredited for methods

All chemical analyses for water samples will be performed by Ecology's Manchester Environmental Laboratory (MEL), which is accredited for methods listed in Table 10.

10.0 Quality Control Procedures

Quality control (QC) procedures provide the information needed to assess the quality of collected data. These procedures can also help identify problems or issues associated with data collection and analysis while the project is underway.

Total precision for field sampling and laboratory analysis will be assessed by collecting duplicate samples. MEL routinely duplicates sample analyses in the lab to determine lab precision. The difference between field variability and lab variability is an estimate of the sample field variability. Field blanks, such as an equipment blank, will be used to check for sample contamination.

The primary types of QC samples used to evaluate and control the accuracy of laboratory analyses are check samples, duplicates, spikes, and blanks (MEL 2016b). Check samples serve as an independent check on the calibration of the analytical system and can be used to evaluate bias. Duplicates are used to evaluate laboratory precision. Matrix spikes are used to check for matrix interference with detection of the analyte and can be used to evaluate bias as it relates to matrix effects. Blanks are used to check for sample contamination in the laboratory process.

10.1 Table of field and laboratory quality control

Table 11 lists the field and laboratory QC requirements for the project.

Table 11. Quality control samples, types, and frequency.

Parameter	Field Blanks ¹	Field Replicates	Laboratory Check Samples ²	Laboratory Method Blanks	Laboratory Matrix Spikes
Arsenic, Total	2	10%	1set/batch*	1/batch	1set/batch*
Arsenic, Dissolved	2	10%	1set/batch*	1/batch	1set/batch*

¹ Field blanks include: 1 equipment blank, 1 trip blank

² Batch is represented by 20 samples or fewer.

*1 set/batch: LCS/LCSD and MS/MSD

Each type of QC sample listed above has an MQO associated with it (Section 6.2) that will be used to evaluate the quality and usability of the results.

10.2 Corrective action processes

Corrective actions will be taken if activities are found to be inconsistent with the QAPP, field procedures, laboratory analyses, data review processes, MQOs or performance expectations, or if some other unforeseen problem arises. Options for corrective actions may include:

- Re-calibrating the analytical instrument.
- Collecting new samples using the method described in the approved QAPP.
- Reanalyzing lab samples that do not meet QC criteria.
- Convening project personnel and technical experts to decide on the next steps that need to be taken to improve performance of project components.

If corrective action is not possible, the results will be appropriately qualified.

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

The Environmental Information System (EIM) Study ID for this project is LTEL0001.

All field data will be recorded on field data sheets. Field data sheets will be checked for missing or improbable measurements by the field lead before leaving each site. Field-generated data will be quality assured and entered into EIM as soon as practical after returning from the field. Data entry will be checked against the field data sheets for any errors and omissions. Missing or unusual data will be brought to the attention of the project manager and client for consultation.

Lab results will be checked for missing and/or improbable data. Data received from MEL through Ecology's Laboratory Information Management System (LIMS) will be checked for omissions against the Request for Analysis forms by the project manager. Data requiring additional qualifiers will be reviewed by the project manager.

11.2 Laboratory data package requirements

Laboratory-generated data reduction, review, and reporting will follow the procedures outlined in the MEL User's Manual (MEL 2016a). Variability will be quantified using the procedures outlined in the MEL User's Manual. Any estimated results will be qualified and their use restricted as appropriate. MEL will send QA/QC results to the project manager for each set of samples.

Laboratory results from MEL analyses will be sent to the Project Manager in pdf format (from LIMS) and be accompanied by a Case Narrative. The Case Narrative will address various data verification checks described in Section 13 below.

11.3 Electronic transfer requirements

MEL will electronically transfer all laboratory-generated data to the project manager through the LIMS to the EIM data feed. There is already a protocol in place for how and what MEL transfers to EIM through LIMS.

11.4 EIM/STORET data upload procedures

All field and laboratory data will be entered into EIM, following existing Ecology business rules and the EIM User's Manual.

11.5 Model information management

N/A

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

Field audits are always appropriate for a project involving either field measurements or sampling. It is likely that insufficient QA resources are currently available for auditing activities; however, there could be a field consistency review of the project by another experienced EAP hydrogeologist. The aim of such reviews is to improve consistency of fieldwork, improve adherence to SOPs, provide a forum for sharing innovations, and strengthen our data QA program.

MEL is an accredited laboratory and is periodically audited by Ecology's Laboratory Accreditation Program.

12.2 Responsible personnel

See Section 12.1.

12.3 Frequency and distribution of reports

A final technical memorandum will be published according to the project schedule shown in Section 5.4.

12.4 Responsibility for reports

The EAP project manager will be the lead on the final technical memorandum. The work will be performed by or under the supervision of a licensed hydrogeologist.

13.0 Data Verification

EPA defines data verification as “the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements.”

13.1 Field data verification, requirements, and responsibilities

Initial field data verification will be performed by the project manager immediately after completing field measurements/sample collection and prior to departing the site. This process involves checking the field data sheet(s) for omissions or outliers. If field data are missing or a measurement is suspected of being an outlier, the measurement will be repeated.

After the sampling event, the project manager will evaluate all field data to determine compliance with MQOs. Values that are out of compliance with the MQOs will be noted and, if necessary, wells will be resampled and or equipment recalibrated. At the conclusion of the study, any values that are not in compliance will be compiled and assessed for usability by the project lead.

13.2 Laboratory data verification

MEL staff will perform the laboratory verification following standard laboratory practices. After the laboratory verification, a secondary verification of each data package will be performed by the project manager. This secondary verification will entail a detailed review of all parts of the laboratory data package with special attention being paid to laboratory QC results. If any issues are discovered, they will be resolved by the project manager.

13.3 Validation requirements, if necessary

N/A

13.4 Model quality assessment

N/A

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

After all laboratory and field data are verified, a detailed examination of the data package will be performed. The project manager will examine the entire data package to determine if all the criteria for MQOs, completeness, representativeness, and comparability have been met. If the criteria have not been met, the project manager will decide if affected data should be qualified or rejected, based upon the decision criteria from the QA Project Plan (Tables 6 and 7). The project manager and client will decide how any qualified data will be used in the technical analysis.

14.2 Treatment of non-detects

Any non-detects will be loaded into EIM with a value equal to half the reporting limit and included in the study analysis. Analytical results that are below the MRL will be flagged with the appropriate data qualifier (e.g., U, J, UJ). For summary statistics and analysis, non-detects will be described in the technical memorandum.

14.3 Data analysis and presentation methods

Once the data have been reviewed, verified, and validated, the project manager will determine if the data can be used toward the project goals and objectives. Verified analytical data will be shared with the client in a technical memorandum. The final technical memorandum will be prepared at the completion of the sampling and will include the following:

- Maps of the study area showing sample sites, analyte concentrations, and distribution.
- Description of field and lab methods.
- Discussion of data quality and the significance of any problems encountered.
- Summary tables of field and analytical data.
- Discussion of water quality results and comparison of results to site's historical data if available.
- Conclusions and recommendations.

14.4 Sampling design evaluation

The project manager will determine the effectiveness of the sampling design following the sampling event. The sampling design will be considered effective if the data package meets the MQOs and criteria for completeness, representativeness, and comparability described in Section 6.2.

14.5 Documentation of assessment

The project manager will include a section in the final technical report summarizing the findings of the data quality assessment.

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16.0 Appendices

Appendix A. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Background Concentration: Concentration of an analyte in groundwater that is not influenced by releases from the site.

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

Groundwater: Water in the subsurface that saturates the rocks and sediment in which it occurs.

Leachate: Liquid that extracts or contains harmful substances from matter, especially landfill waste.

Oxidation-Reduction Potential: The tendency of a chemical species to acquire electrons (be reduced) or lose electrons (be oxidized).

Perennial Stream: Surface water flowing continuously year-round.

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 (base 10), a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

Specific 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.

Turbidity: A measure of water clarity. High levels of turbidity can have a negative impact on aquatic life.

Acronyms and Abbreviations

CPR	Cardiopulmonary Resuscitation
DO	Dissolved Oxygen
DQO	Data Quality Objectives
e.g.	For example
EAP	Environmental Assessment Program
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System software
HDPE	High-Density Polyethylene

HNO ₃	Nitric Acid
MDL	Method Detection Limit
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
N/A	Not Applicable
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SOP	Standard Operating Procedures
SWM	Solid Waste Management Program
USGS	United States Geological Survey
WAC	Washington Administrative Code

Units of Measurement

°C	degrees centigrade
FNU	Formazin Nephelometric Units
ft	feet
g	gram
mg	milligram
mg/L	milligrams per liter
mL	milliliter
mL/min	milliliter per minute
mS/cm	millisiemens per centimeter
mV	millivolt
SU	standard units
µg/L	micrograms per liter (parts per billion)
µm	micrometer
µS/cm	microsiemens per centimeter

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 all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA 1997).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin 2010).

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA 1997).

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology 2004).

Measurement Quality Objectives (MQOs): Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA 1997).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology 2004; Kammin 2010).

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register 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: $[\text{Abs}(a-b)/((a + b)/2)] * 100$ 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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