Quality Assurance Project Plan

City of Dayton Due Diligence Work

February 2024

WA Department of Ecology Office of Columbia River Agreement Number:
WROCR-2325-Dayton-00037

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This plan describes the objectives of the study and the procedures to be followed to achieve those objectives. This QAPP describes a project selected by the WA Department of Ecology Office of Columbia River: Agreement Number WROCR-2325-Dayton-00037.

This Quality Assurance Project Plan is available via Ecology's website at https://apps.ecology.wa.gov/publications/SummaryPages/2412001.html

Data for this project are available in Ecology's Environmental Information Management database (https://apps.ecology.wa.gov/eim/search/default.aspx), under Study ID: WROCR-2325-Dayton-00037 This QAPP is valid through February 28, 2029.

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COVER PHOTO: Touchet River Near Dayton, Washington. PHOTO BY ANDERSON PERRY & ASSOCIATES.

Quality Assurance Project Plan

City of Dayton Due Diligence Work

OCR Agreement Number: WROCR-2325-Dayton-00037

by Anderson Perry & Associates

Published February 2024

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03/12/2024

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2.0 Abstract

The purpose of this project is to collect groundwater quality data with which to determine background groundwater quality conditions to be used in the design of a new wastewater treatment facility for the City of Dayton. The Total Maximum Daily Loads (TMDL) for the Touchet River established restrict the discharge of treated effluent to the river (Ecology, 2007). Prior to defining the TMDLs, Dayton's treated wastewater effluent discharged to Touchet River. Due to this, the City is proposing a mechanical treatment facility followed by a constructed wetland system for treated wastewater polishing and disposal. Prior to developing a constructed wetlands wastewater system, the City must conduct due diligence and groundwater quality testing. Identifying the existing groundwater quality in the vicinity of the constructed wetlands determines the design criteria necessary to ensure groundwater is not degraded. This QAPP establishes the procedures for sample collection, testing, quality control, and data management necessary to generate accurate groundwater data.

3.0 Background

3.1 Introduction and Problem Statement

The City of Dayton's wastewater collection, treatment, and disposal system was initially constructed in 1938, but has undergone multiple renovations, the most recent taking place in 2000. The existing plant consists of headworks, a primary clarifier, a trickling filter, and a secondary clarifier. The system uses ultraviolet (UV) disinfection, and the wastewater is then discharged into the surface waters of the Touchet River.

In 1996, the State of Washington listed the Touchet River on the State's 303(d) list, as required by the EPA's Clean Water Act. The Touchet River was listed due to failure to meet water quality standards for temperature, pH, dissolved oxygen, polychlorinated biphenyls (PCB), chlorinated pesticides, and fecal coliform. Due to the designation on the 303(d) list, the State conducted Total Maximum Daily Load (TMDL) studies which established parameters for the reduction of pollutants discharged to rivers and streams in the Walla Walla Watershed. The Water Quality Improvement Report published in 2007 modeled the Dayton Wastewater Treatment Plant as a point source contributor of TMDL non-compliance within the Touchet River during critical periods of low-flows and high air temperature. As such, the TMDL concluded that there are no available cost-effective technologies currently available which can treat the Dayton WWTP effluent to the required water quality criteria. To improve water quality within the Touchet River and comply with TMDL requirements, the City of Dayton is proposing a mechanical treatment facility followed by constructed wetlands for effluent polishing and disposal to remove effluent discharge into surface waters. The City must conduct due-diligence prior to construction of a new wastewater treatment system which establishes baseline parameters of the groundwater quality in the project vicinity.

3.2 Study Area and Surroundings

The City of Dayton is located in southeastern Washington State and is the County seat for Columbia County. The City lies in the Touchet River Valley at the confluence of the Touchet River and Patit Creek. The Touchet River bisects the City from the northeast to the southwest and parallels Highway 12 for approximately 10 miles. The site for the proposed wastewater treatment facility is located approximately 3 miles west of the City along Highway 12, in Section 3, Township 9 North, Range 38 East, Willamette Meridian (Figure 1).

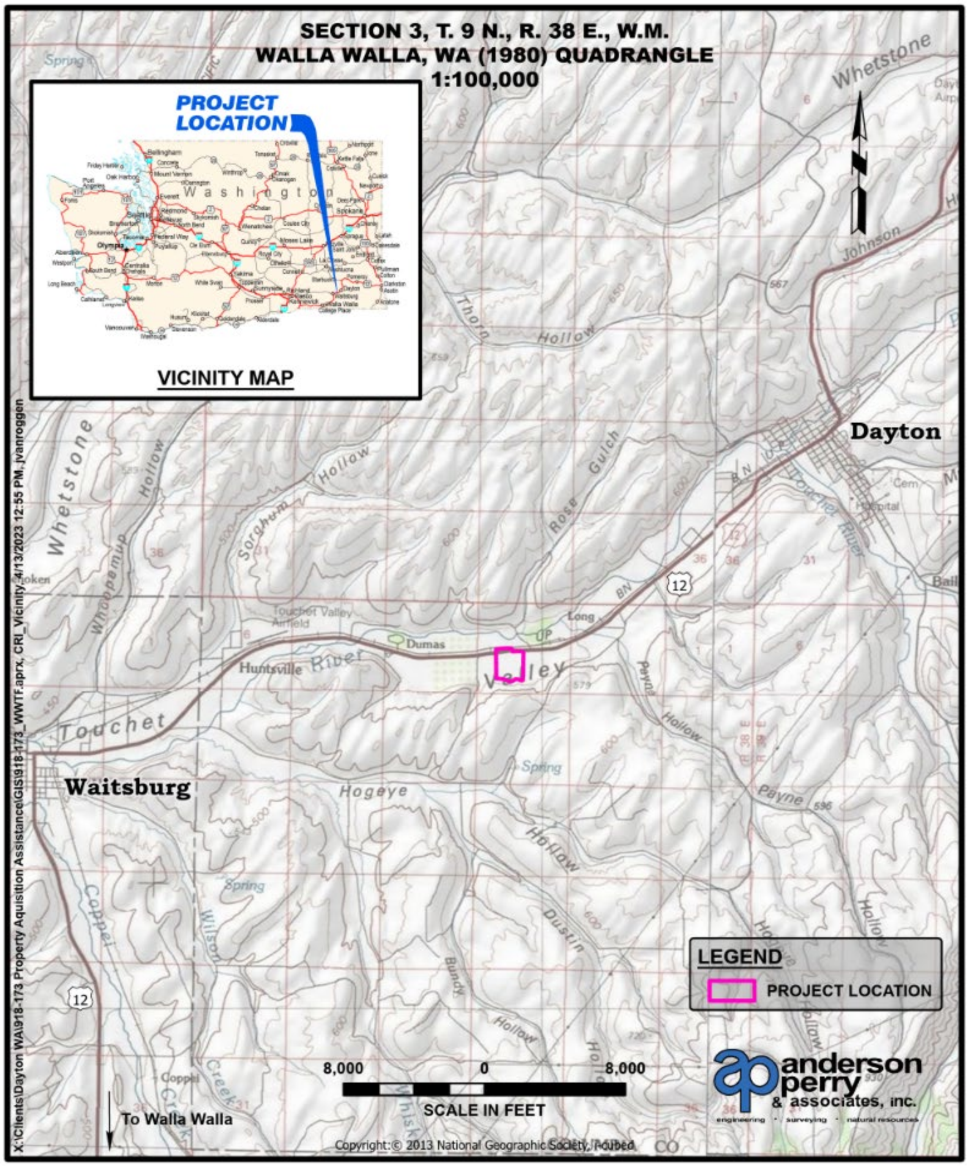

Figure 1. Map of Larger Study Area

3.2.1 Geology

The proposed improvement site is located centrally within the Columbia Plateau Physiographic Province. Geologic mapping (Schuster, 1994) indicates that most of the site is overlain by Holocene age alluvium. In general, this formation consists of unconsolidated deposits of clay, silt, sand, and gravel. Regionally, this alluvium is commonly locally derived from loess and flood deposits and is encountered on the valley floor within the stream channels and on the floodplains adjacent to the stream channel.

The hillside and the plateau above the hillside along the south side of the property is overlain by Holocene to Pleistocene age loess. This formation generally consists of eolian silt and fine sand. The alluvial and loess deposits are underlain by Columbia River Basalt. The upper basalt flows at the site consist of middle Miocene age Grande Ronde Basalt. This basalt can be seen at the surface along portions of the hillside along the south side of the property.

Subsurface exploration indicates most of the site is overlain by approximately 0.8 to 15 feet of fine-grained alluvium consisting of silt with sand. Portions of the south side of the site are overlain by up to 4 feet of loess consisting of silt with sand. A layer of silt with ash was encountered in several test pits (generally the southeast side of the site). The layer of silt with ash was encountered from a depth ranging from 2.8 to 5.0 feet and extends to depth of 3.2 to 7.8 feet. The silt with ash is underlain by silt alluvium. The silt alluvium across the site is underlain by gravel alluvium generally consisting of gravel with silt, sand, and occasional to scattered cobbles. The gravel was encountered from a depth ranging from 0.8 to 20 feet and extends to a depth of 25.5 feet. Three test pits did not encounter the gravel alluvium (TP-6, TP-10, and TP-13). The gravel alluvium is underlain by Basalt bedrock. The basalt was encountered in the borings at a depth of 12 to 25.5 feet below the existing ground surface.

Groundwater was encountered at a depth ranging from 4.8 to 14 feet below the existing ground surface during the excavation of the test pits. Groundwater was not encountered in four of the test pits. Groundwater monitoring wells were installed in all four borings during the subsurface exploration (Figure 4). Groundwater was encountered at depths ranging from 4.8 to 16 feet below the existing ground surface in the monitoring wells.

3.2.2 History of Study Area

The area surrounding Dayton was originally explored by Lewis and Clark who camped along Patit Creek, a nearby tributary to the Touchet River (City of Dayton, 2014). The first settlers arrived in 1859 and primarily used the land for grazing, but adequate rainfall and fertile soil turned the region to dryland farming for wheat and other grains. The town was platted in 1872.

Blue Mountain Railroad, owned by the Port of Columbia, provides freight service to the City, and the commercial and industrial districts are located mainly in the central and western portions of the City and along the railway. Residential areas are concentrated in the north and south, and agricultural land is located around the City’s periphery and in the Urban Growth Area (UGA).

The City’s wastewater treatment plant was built in 1938 with subsequent upgrades and modifications occurring in 1960, 1985, and 2000 to meet the needs of the community as well as more stringent treatment requirements. According to population data, the City population has remained stable between 2010 and 2022 (U.S. Census Bureau, 2022.) See Table 1 for historical population data.

Table 1. City of Dayton Population

Year	Population Estimate
2010	2,544
2011	2,488
2012	2,470
2013	2,482
2014	2,466
2015	2,443
2016	2,445
2017	2,458
2018	2,478
2019	2,442
2020	2,442
2021	2,479
2022	2,512

Looking to the future, an annual growth rate of 0.25 percent was used for the 2046 planning horizon. This results in a projected 2046 population of 2,669. The new treatment facilities will be sized to handle the projected population.

3.2.3 Summary of Previous Studies and Existing Data

The City of Dayton most recently completed upgrades to its wastewater treatment plant in 2000 to extend the operational life of the facility by 10 to 20 years. The Washington Department of Ecology published a Fecal Coliform TMDL study in 2005 (Joy and Swanson, 2005), a pH and Dissolved Oxygen TMDL study in 2007 (Joy et. al. 2007), which triggered a timeline for the City to comply with the water quality regulations, which the recent facility upgrades were unable to meet. The City completed a Wastewater Facilities Plan in August 2016 and revised the plan in October 2017 (Anderson Perry, 2017). The facilities plan documents wastewater generation characteristics of the City as well as conveyance infrastructure. In the facilities plan, it was identified that meeting TMDL requirements would be a lengthy and challenging process to acquire enough property for the proposed wastewater system. The facilities plan provided recommended actions to bring the system to compliance with regulations. The assessed alternatives included upgrading the existing trickling filter, a new oxidation ditch, and a new lagoon system. To avoid discharge of treated effluent to surface waters, the facilities plan recommended a new lagoon system with land treatment via crop irrigation.

3.2.4 Parameters of Interest

The parameters of interest for groundwater testing are defined in Ecology's application for a State Waste Discharge Permit: ECY 040-178 (Ecology, 2000). See Table 2 for the list of parameters.

Table 2. ECY 040-178 Parameters

BOD (5 day)	Magnesium
COD	Potassium
Total Suspended Solids	Sodium
Total Dissolved solids	Sulfate
Conductivity	Alkalinity mg/L as CaCO3
Ammonia-N as N	Arsenic (total)
pH	Barium (total)
Total Residual Chlorine	Cadmium (total)
Fecal Coliform	Chromium (total)
Total Coliform	Copper (total)
Dissolved oxygen	Iron (total)
Nitrate + nitrite-N as N	Lead (total)
Ortho-phospate-P as P	Manganese (total)
Total-phosphorus-P as P	Mercury (total) pg/L
Total Oil & grease	Molybdenum (total)
NWTPH - Dx	Nickel (total)
NWTPH - Gx	Selenium (total)
Calcium	Silver (total)
Chloride	Zinc (total)
Fluoride	

3.2.5 Regulatory Criteria or Standards

Wastewater systems which discharge to groundwater must adhere to non-degradation requirements specified in WAC 173-200. After reviewing the parameters listed in Table 2, Ecology staff concluded that not all of these parameters needed to be tested for this analysis. The required sampling parameters are summarized in Table 7.

3.3 Water Quality Impairment Studies

The Touchet River was listed on Washington's 303(d) list of impaired water bodies due to dissolved oxygen and pH failing to meet Washington Water Quality standards (WAC 173-201). This listing initiated multiple Water Quality Improvement Studies and reports by Ecology with the purpose to develop Total Maximum Daily Loads (TMDL) as required by the federal Clean Water Act. The first study published in 2005 established TMDL's for fecal coliform bacteria in the Walla Walla River basin (Joy and Swanson, 2005). The TMDL studies continued in 2007 with a report which investigated the instream temperature of tributaries to the Walla Walla River and pH and dissolved oxygen in the river basin (Joy et. al. 2007).

3.4 Effectiveness Monitoring Studies

A Water Quality Effectiveness Monitoring (EM) Report was published by Ecology in 2021 (Duggar, 2021). The EM Report assessed water quality data from the 2014-2015 Walla Walla River Basin EM study to the data from the 2002-2003 TMDL Study. The EM Report indicated that a near equal number of sites showed a reduction or increase in fecal coliform bacteria counts. Soluble reactive phosphorus generally decreased among study sites while Dissolved Inorganic Nitrogen increased at most sites. The improvements made to the City's wastewater treatment plant contributed a greater part of the observed reduction in fecal coliform in the receiving waters of Walla Walla and College Place. The EM Report concluded that Wastewater treatment plants in the Walla Walla River Basin may still be impacting downstream water quality. In particular, Touchet River fecal coliform loads in the reach including the Dayton WWTP were much higher than expected, given the reported loads. The City of Dayton should work with Ecology to address excess bacteria loads to the Touchet River.

4.0 Project Description

The purpose of this project is to collect groundwater quality data to use in the siting and design of the City's new wastewater treatment facility. Background groundwater quality data will be collected from monitoring wells installed for this purpose. The data collected will be used to support Dayton's development of a new wastewater treatment facility.

4.1 Project Goals

The major project goals are listed below:

- Determine the elevation of groundwater in the project vicinity as it fluctuates throughout the study period.
- Establish baseline parameters concentrations for groundwater quality in the project vicinity.

4.2 Project Objectives

- Document and record static water levels in four monitoring wells during each sampling event.
- Collect monthly groundwater samples from the monitoring wells (a minimum of eight samples, up to 12 samples total) and submit the samples for laboratory analyzes of constituents listed in Table 9.
- Analyze collected data and laboratory testing results to determine background groundwater quality and compare them to current groundwater standards.

4.3 Information Needed and Sources

This project will require entirely new data acquired from observation well measurements and laboratory test results. The new data collected and described in this QAPP includes groundwater levels and water quality sampling and analyses at the study area monitoring wells.

4.4 Tasks Required

Tasks for this project include:

- Measure static water levels in newly constructed monitoring wells.
- Determine the elevation of the static water level compared to mean sea level elevation to the nearest 0.01 foot.
- Collect groundwater samples and deliver them to the testing laboratory.
- Analyze and document results of laboratory testing.
- Complete required suite of testing and summarize findings.

4.5 Systematic Planning Process

The results of this groundwater monitoring study will be used in the forthcoming design and permitting of the new wastewater treatment facility.

5.0 Organization and Schedule

5.1 Key Individuals and Their Responsibilities

Table 3 shows the responsibilities of those who will be involved in this project.

Table 3. Organization of Project Staff and Responsibilities

Staff	Title	Responsibilities
Ryan Paulson City of Dayton Phone: 509-386-0875	Public Works Director	Quality Assurance Project Plan (QAPP) review and approval, Sample Collection
Jake Hollopeter Anderson Perry & Assoc. Phone: 509-529-9260	Senior Engineer/ Project Manager	Project Management, QAPP Review and Coordination, Field Data Verification, and Data Quality Review
Ben Shaw Anderson Perry & Assoc. Phone: 509-529-9260	Engineering Technician/ Field Staff	Sample Collection, Data Management, Data Quality Review, Final Report
Analytical Laboratory Kathryn Young KUO Testing Lab Phone: 509-547-3838	Lab Director	Reviews draft QAPP, coordinates with Anderson Perry & Associates QA Coordinator.
Scott Tarbutton Department of Ecology Phone: 509-867-6534	Project Manager and Quality Assurance Coordinator	Reviews and approves the draft QAPP and the final QAPP.

5.2 Special Training and Certifications

No certifications will be required for implementation of this plan. Individuals responsible for sample collection and static water level measurements will be trained by staff from Anderson Perry & Associates who are proficient with the procedures and techniques.

5.3 Organization Chart

Not applicable, see Table 3.

5.4 Proposed Project Schedule

Tables 4 through 6 list key activities, due dates, and lead staff for this project.

Table 4. Proposed Project Schedule

Task	Due date
Submit QAPP to Ecology	February 2024
Conduct Sampling & Analysis	Monthly Samples from monitoring wells (up to 12 samples total) February 2024 through June 2024
Submit all data to Ecology's Environmental Information Management database	September 2024
Submit Dayton Due Diligence Analysis and Summary Report to Ecology	November 2024

5.5 Budget and Funding

The project is funded through Ecology Office of Columbia River agreement WROCR-2325-Dayton-00037.

Table 5 shows the budgetary breakdown of the tasks associated with this project.

Table 5. Project Budget and Funding

Cost Category	Cost
Monitoring Well Construction	$8,000
Water Quality Sampling/Analysis	$17,000
Geotechnical Exploration	$30,000

6.0 Quality Objectives

6.1 Data Quality Objectives [1]

The main data quality objective (DQO) for this project is to collect and analyze static water level measurements and water quality data of sufficient accuracy to use in calculating background conditions in the study area. Groundwater samples and static water levels will be collected on a monthly basis. Anticipate collecting a minimum of eight samples, up to twelve total samples.

6.2 Measurement Quality Objectives

Collection and handling of field samples have the potential to affect sample analyses results; field collection blanks and field collected duplicates are used to verify that these aspects of sample collection did not contaminate samples. Laboratory testing has the potential to introduce uncertainty into the measured data. The analyses will use EPA standard methods to determine groundwater quality concentrations from a state accredited laboratory For this reason, measurement quality objectives (MQOs) are necessary to specify the data qualifications required to accomplish the project objectives. The following sections describe the targets for measurement quality objectives.

6.2.1 Targets for Precision, Bias, and Sensitivity

The MQOs for project results, expressed in terms of acceptable precision, bias, and sensitivity are described in this section and summarized in Table 6.

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

Table 6. Measurement Quality Objectives
(e.g., for laboratory analyses of water samples)

MQO		Precision/Bias					Sensitivity
Analyte	**Method**	**Laboratory Duplicate (RPD)**	**Field Duplicate (RPD)**	**Matrix Spike Duplicate (RPD)**	**Matrix Spike Recovery (%Recovery)**	**Blank Spike (%Recovery)**	**Method Detection Limit**
Static Water Level	EAP098 Pressure Transducer[1]	N/A	N/A	N/A	N/A	N/A	0.01 ft[1]
Iron	EPA 200.7	15%	20%	15%	70 to 130%	15%	0.00837 mg/L
Nitrate plus Nitrite as Nitrogen	APHA 4500-NO3	10%	15%	10%	70 to 130%	10%	0.0405 mg/L
Total Dissolved Solids	SM 2540-C	10%	15%	15%	70 to 130%	15%	10.6 mg/L
Total Coliform Quantification	APHA 9223-B	20%	25%	N/A	70 to 130%	N/A	1 MPN/100mL

1. The pressure transducer is a Hobo 30-foot Depth Water Level Data Logger Model Number U20-0001-01. According to the manufacturer, The Water Level Accuracy as a Typical error: ±0.05% FS, 0.5 cm (0.015 ft) water and a Maximum error: ±0.1% FS, 1.0 cm (0.03 ft) water. An additional Hobo will be deployed to measure the barometric pressure. The measuring point is the top of the surface mount monument, which has been professionally surveyed.

6.2.1.1 Precision

Precision is a measure of variability among replicate measurements due to random error. For this study it will be assessed using duplicate field measurements and laboratory analysis of duplicate samples. Field duplicate samples will be collected once during the study period for the parameters measured in the laboratory. Precision for replicate samples will be expressed as the relative percent difference (RPD) as detailed in Table 6.

6.2.1.2 Bias

Bias is the difference between the sample mean and the true value. Bias in field measurements will be reduced by close adherence to Ecology sampling and collection procedures. Bias in field measurements will be assessed by collection and analysis of field collection blanks. KUO Testing Labs will assess laboratory bias by analyzing laboratory blanks, laboratory control standard samples, and matrix spikes.

6.2.1.3 Sensitivity

Sensitivity measures the capability of an analytical method to detect a parameter. For this study it will be described as the Method Detection Limit (MDL) and expressed as the reporting limit for each parameter analyzed. Targets for sensitivity are listed in Table 6 and Table 9.

6.2.2 Targets for Comparability, Representativeness, and Completeness

6.2.2.1 Comparability

To ensure comparability between sampling efforts, this study will adhere to the following Ecology standard operating procedures:

- EAP 052 Manual Well-Depth and Depth-to-Water Measurements.
- EAP 074 Use of Submersible Pressure Transducers During Groundwater Studies.
- EAP 098 Collecting Groundwater Samples for Metals Analysis from Water Supply Wells.
- EAP 099 Collecting Groundwater Samples: Purging and Sampling Monitoring Wells for General Chemistry Parameters.

6.2.2.2 Representativeness

It is important the data collected for the project are representative of existing conditions. Samples will be collected from monitoring wells along the perimeter of the project site. These samples will be representative of in-situ groundwater characteristics by comparing the quality of groundwater upgradient of the proposed project site, to that measured in the wells downgradient. The collected data can be used to interpret the groundwater quality through the project site. The sampling will occur throughout seasonal changes and weather conditions to provide additional information regarding these effects on the region’s shallow groundwater.

6.2.2.3 Completeness

The completeness goal for this project is to collect and analyze 100% of samples from project site monitoring wells. Problems can arise with sample collection which cannot be controlled such as inclement weather, unsafe conditions, or problems arising from inadequate well construction. Additionally, sample collection is truly successful if the laboratory can conduct the analysis within the sample holding time. If holding times are exceeded, then new samples must be collected. Should any of these issues occur, sampling will continue once conditions permit such that collection and analysis can achieve 100% completion.

6.3 Acceptance Criteria for Quality of Existing Data

Groundwater data was collected from MW-1 and MW-2 in June, August, September, October, November, and December 2023 using methods similar to those described in this QAPP. Additionally, KUO Testing Labs provided water quality analysis for these collection events and used analytical methods consistent with the methods presented in this QAPP. Overall, the existing groundwater data is considered usable for analysis of this project due to the data being collected by personnel familiar with the project objectives and groundwater collection methods.

6.4 Model Quality Objectives

Not applicable.

7.0 Study Design

7.1 Study Boundaries

The study area will be located on the south side of Highway 12 approximately 3 miles West of the City of Dayton. This parcel is slated for purchase by the City of Dayton for construction of the mechanical wastewater treatment and wetlands polishing and disposal system. The subject property is approximately 65 acres and has been used for dryland wheat agriculture. The entire study will be contained within Section 03, Township 09N, R38E. See Figure 2 and Figure 3 for project location.

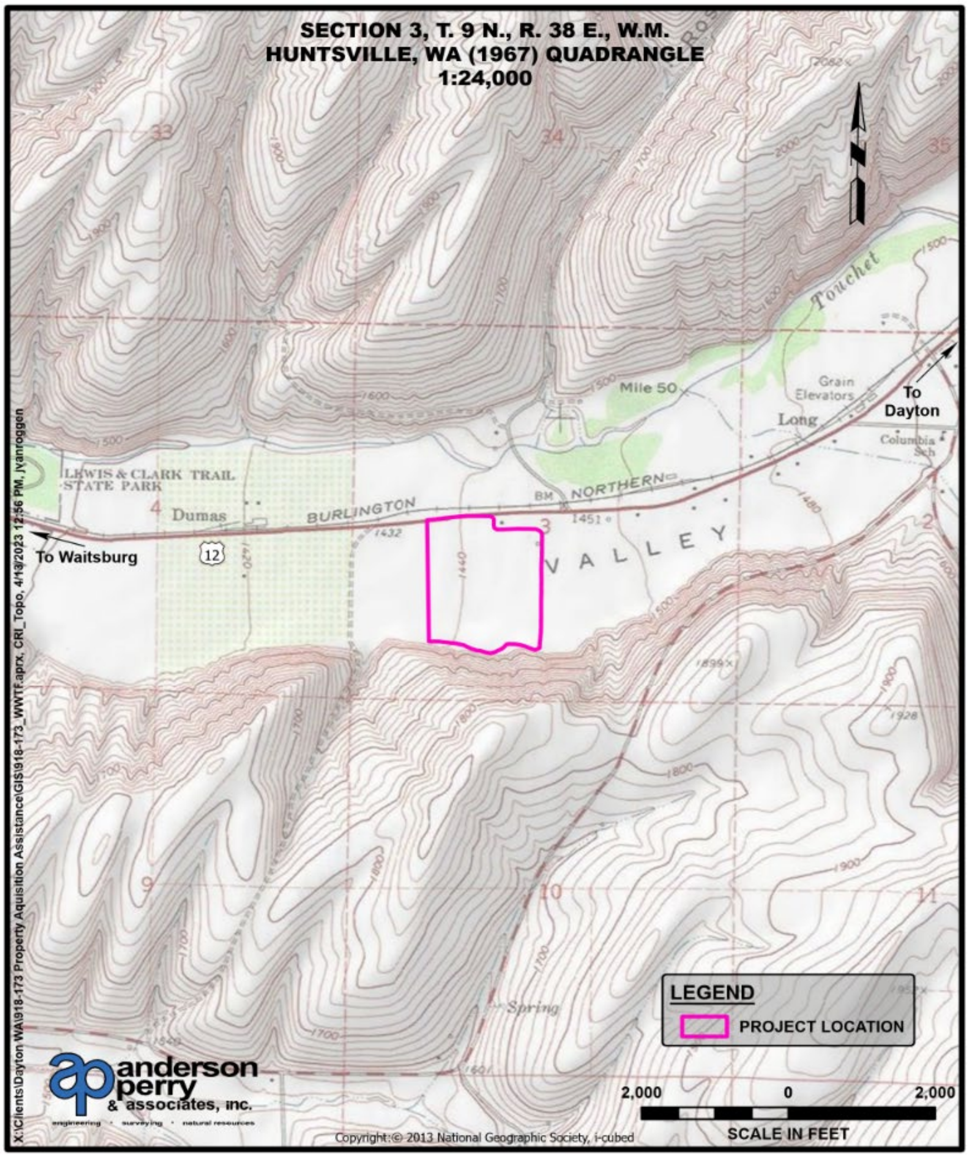

Figure 2. Project Location with Topography

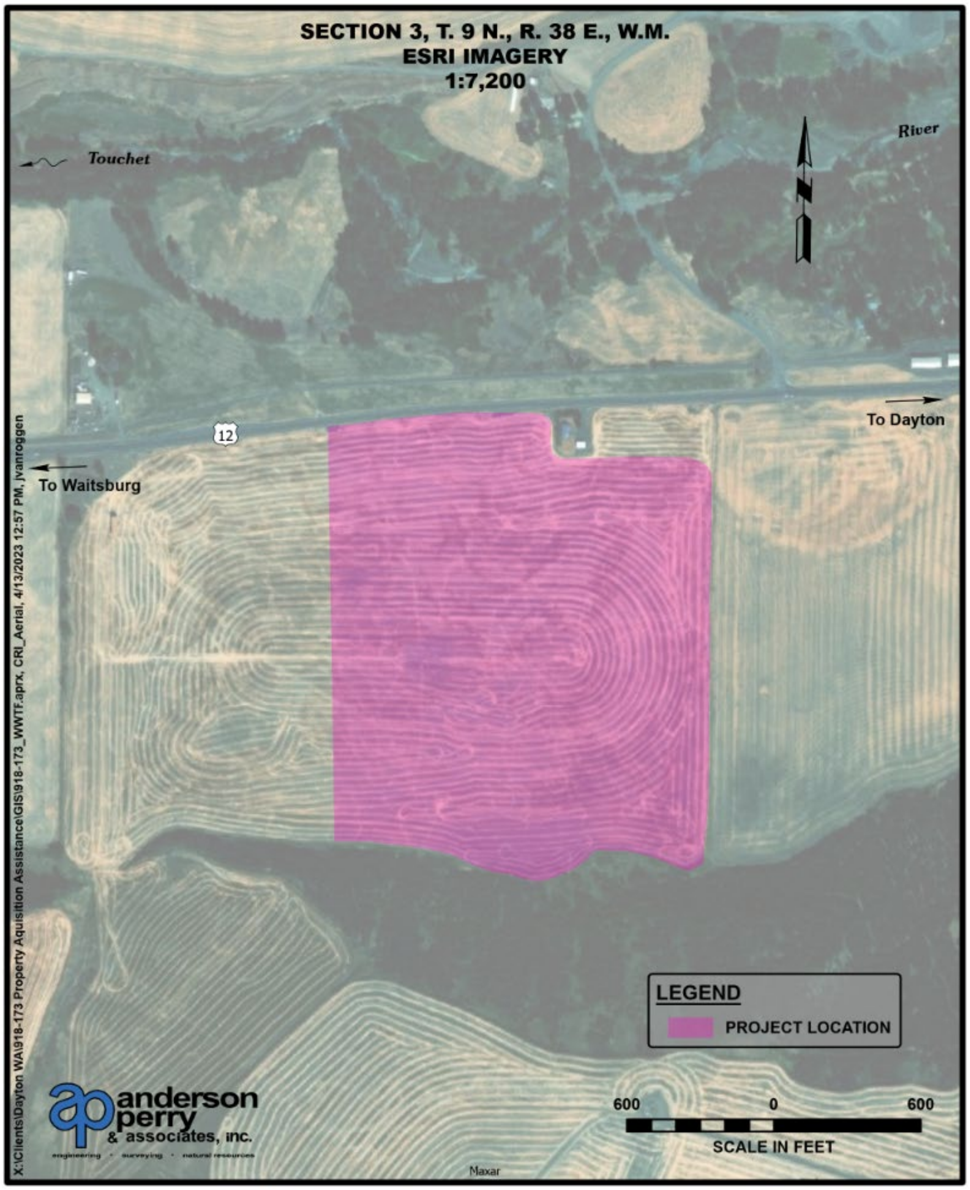

Figure 3. Project Location and Imagery

7.2 Field Data Collection

All data will be collected from monitoring wells installed at the project site. The pressure transducer is a Hobo 30-foot Depth Water Level Data Logger Model Number U20-0001-01. An additional Hobo will be deployed to measure the barometric pressure. The measuring point is the top of the surface mount monument, which has been professionally surveyed. Measurement of static water level within the monitoring wells will adhere to Ecology's SOP EAP052. A pressure transducer will be used to measure the static water level within the monitoring well. The transducer will be situated in the well such that it has 6 inches of space between the bottom of the borehole. Automatic measurements will be taken every 30 minutes and will be stored locally on a data logger connected to the pressure transducer. Measurement data will be retrieved periodically by field staff. A manual measurement of depth-to-groundwater relative to top of casing (TOC) will be taken when digital data is retrieved. The permanent measuring point from which depth-to-water manual measurements will be made will be the TOC for the monitoring well, and the measuring point for each monitoring well will be marked in permanent ink. The manual measurement will be compared to the same day's pressure transducer reading to check the drift of the pressure transducer. See section 8.2 for additional detail.

See Figure 4 for locations of monitoring wells. Monitoring Well 1 (MW-1) and Monitoring Well 2 (MW-2) were constructed and developed in May 2023. Monitoring Wells 3 (MW-3) and 4 (MW-4) were constructed in late November 2023 and are currently being developed. Figures 5 through 8 show the boring logs for each of the monitoring wells.

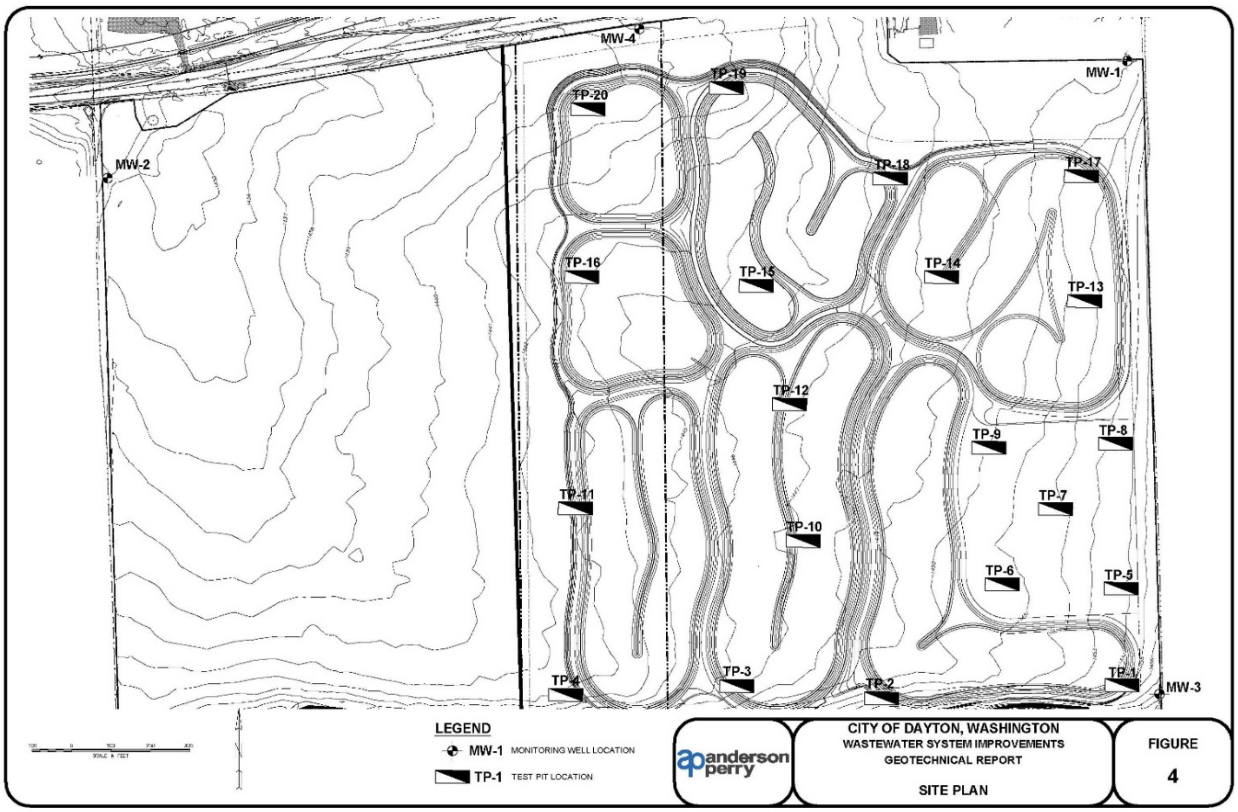

Figure 4. Monitoring Well Locations

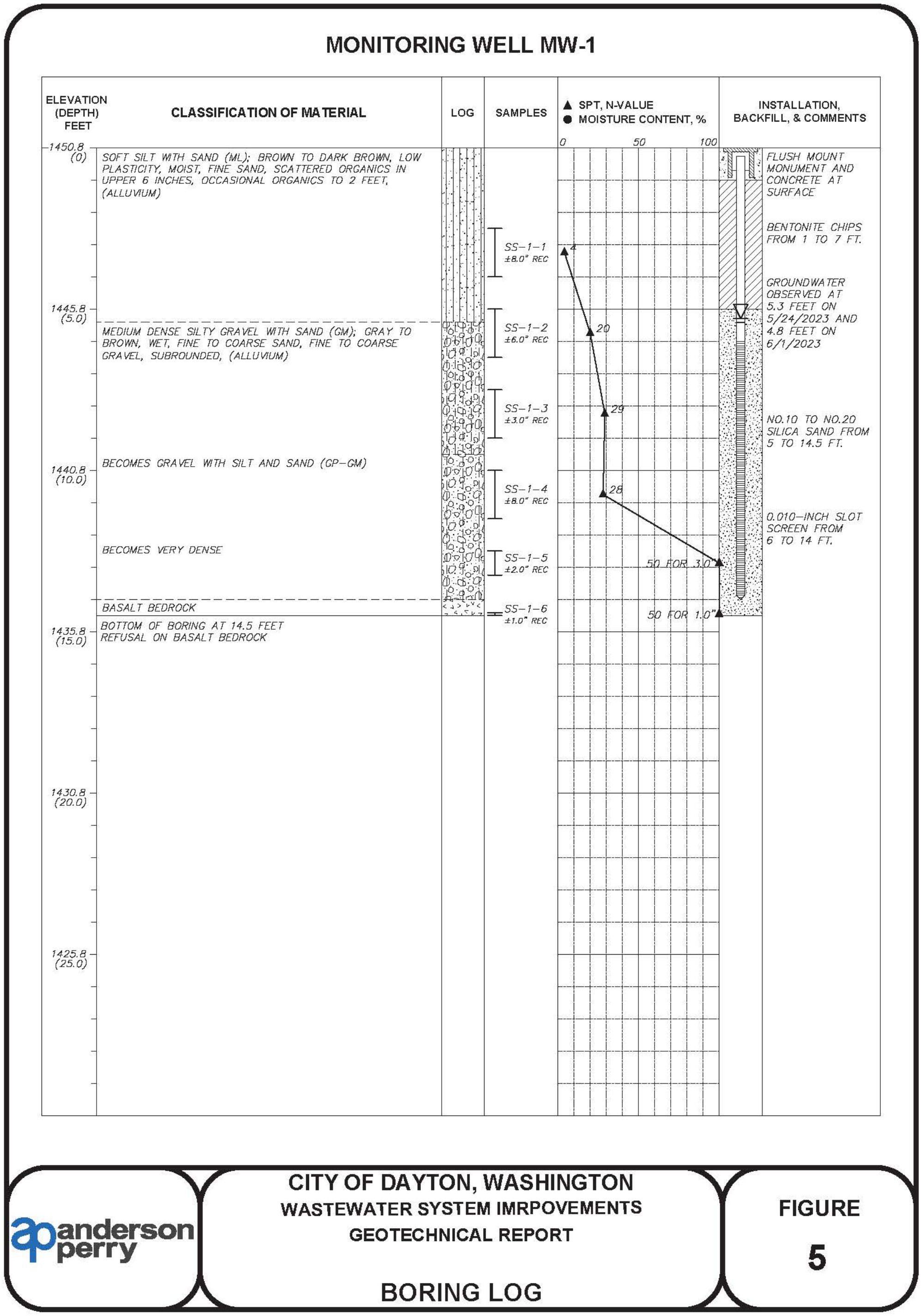

Figure 5. Monitoring Well No. 1 Boring Log

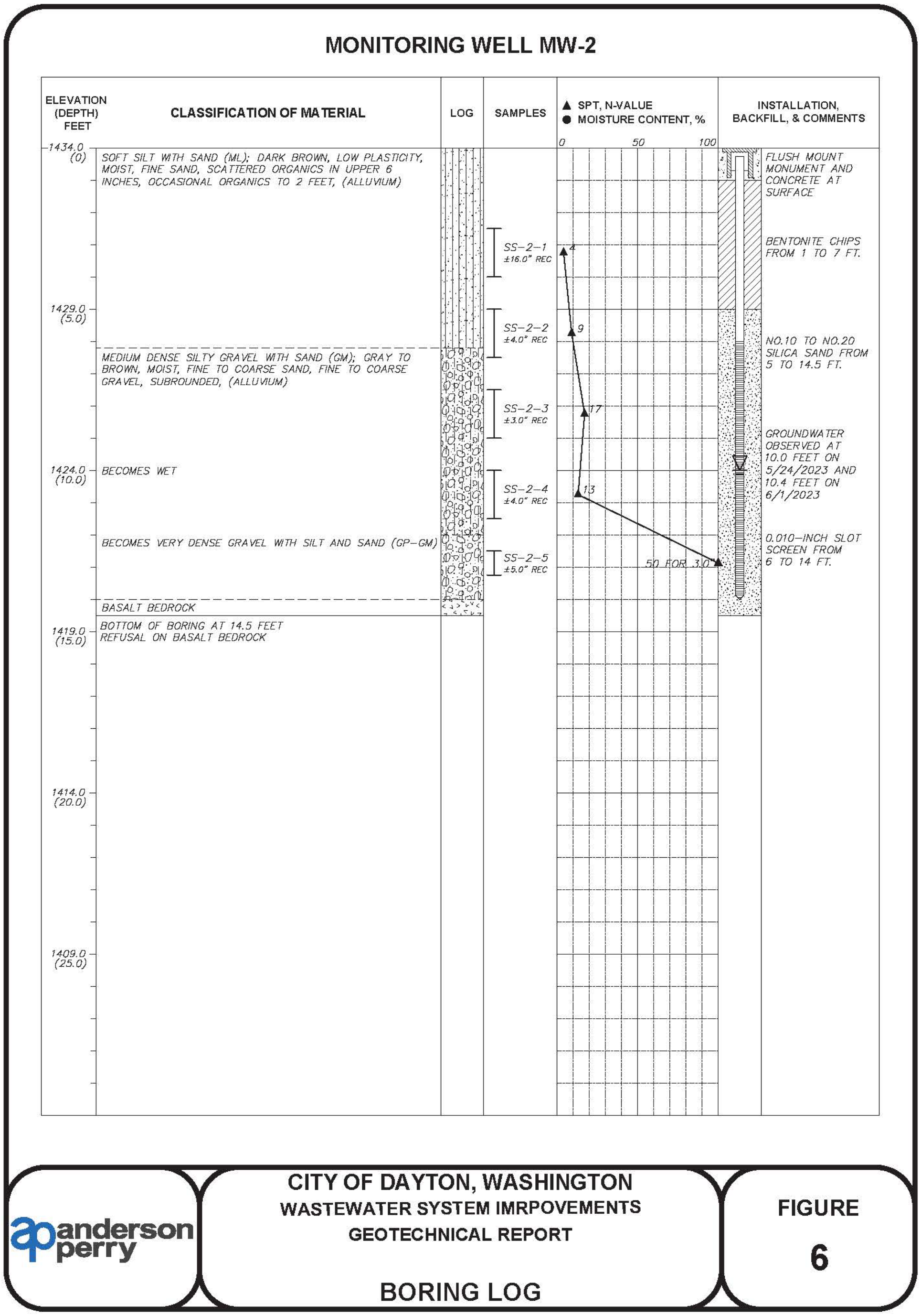

Figure 6. Monitoring Well No. 2 Boring Log

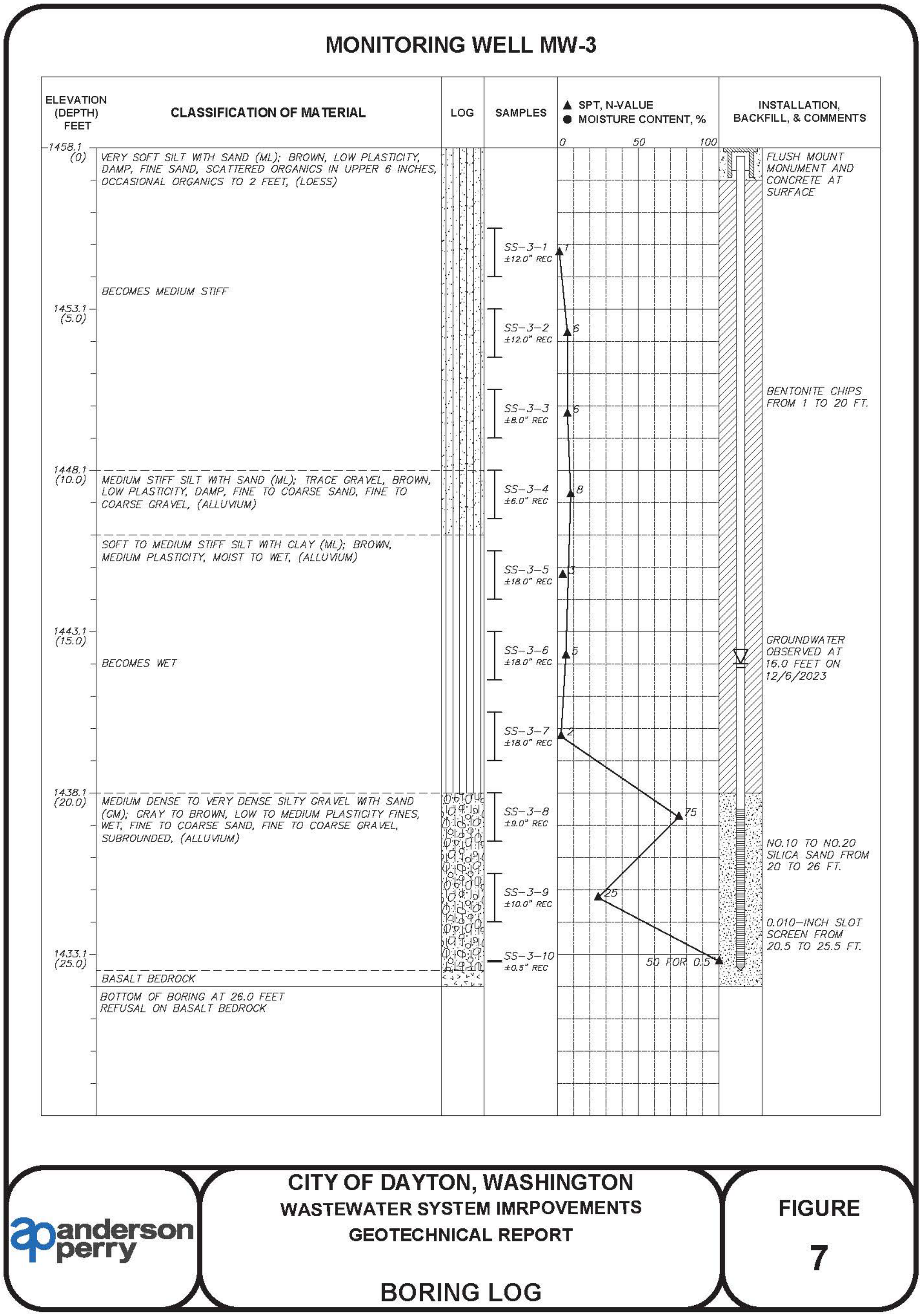

Figure 7. Monitoring Well No. 3 Boring Log

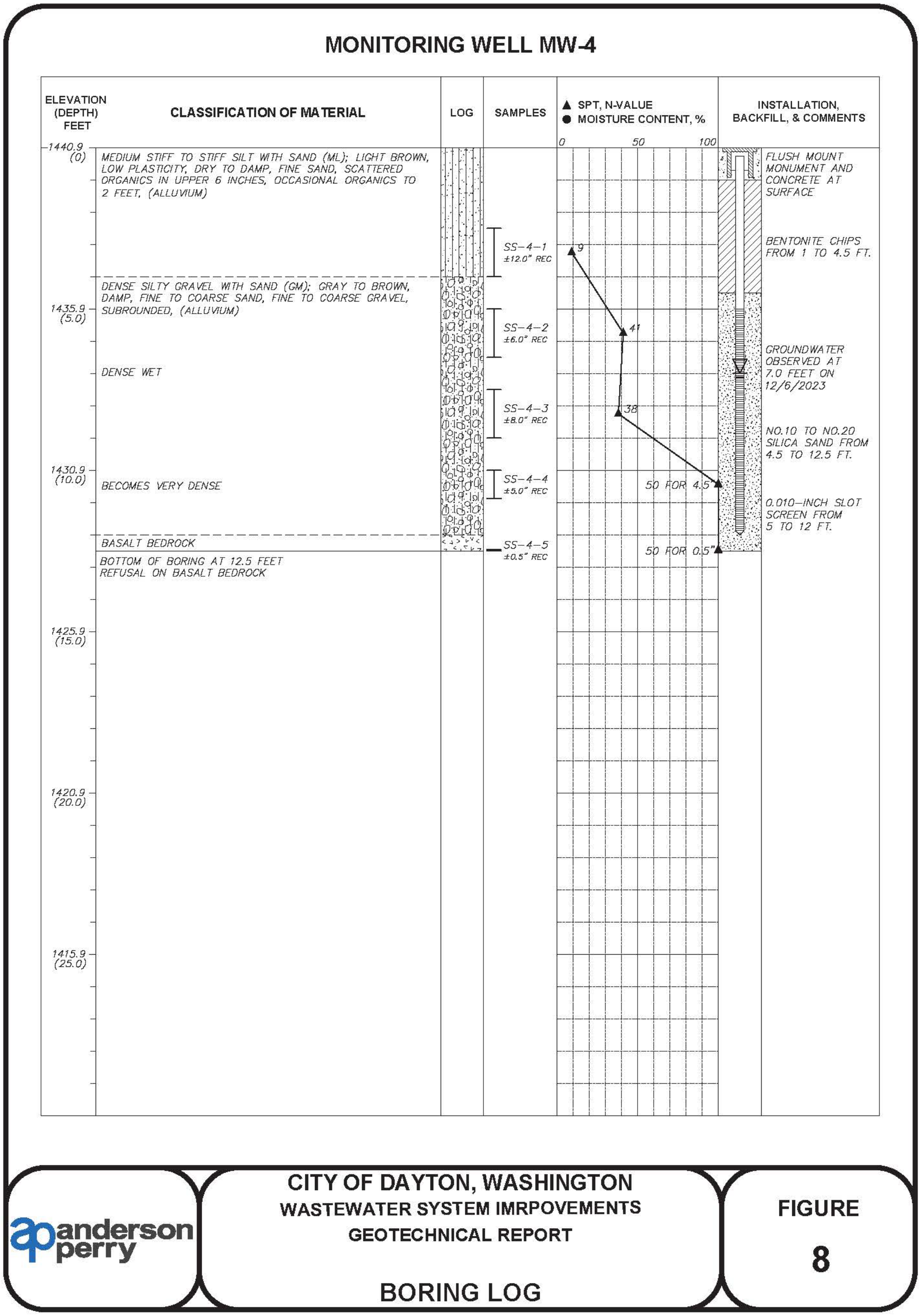

Figure 8. Monitoring Well No. 4 Boring Log

7.2.1 Sampling Locations and Frequency

All samples will be obtained from the monitoring wells installed at the project site as shown on Figure 4. Samples will be collected monthly for each sampling event. Sampling associated with this QAPP is anticipated to occur from February 2024 through June 2024.

7.2.2 Field Parameters and Laboratory Analytes to be Measured

Analytes to be measured are described in ECY 040-178 and presented in the following table. Static water level will also be measured along with water quality sampling.

Table 7. Parameters to be Measured

Static Water Level
Iron
Nitrate plus Nitrite as Nitrogen
Total Dissolved Solids
Total Coliform Quantification

7.3 Modeling and Analysis Design

Not Applicable.

7.3.1 Analytical Framework

Not Applicable.

7.3.2 Model Setup and Data Needs

Not Applicable.

7.4 Assumptions of Study Design

The key assumption of this study design is that groundwater samples obtained from the monitoring wells will be representative of the *in-situ* conditions throughout the project vicinity. The study design provides representative data by situating wells upgradient and downgradient of groundwater flow.

7.5 Possible Challenges and Contingencies

Challenges for this project are minimal and unlikely to occur, but difficulties in accessing and sampling from wells may result from force majeure, such as severe weather or emergency road closure making the site inaccessible. Should any of these events occur, the priority will be to maintain the safety of project personnel and sampling and data collection will occur once the project manager and field staff indicate the project site is safe to access.

7.5.1 Logistical Problems

Logistical problems may arise from coordination with sample collection and laboratory delivery and analysis. The field staff will be responsible for sampling, data recording, and chain of custody of the sample. This issue will be mitigated by coordinating the testing at least two weeks prior to the sampling date. Further challenges may arise from the transportation of samples to the laboratory. All equipment will be properly maintained and in working condition and will be checked prior to sampling.

7.5.2 Practical Constraints

Sampling will occur by approved people trained in the appropriate field collection and data management procedures. The availability of trained individuals may cause constraints on the project. This will be mitigated by ensuring a sufficient number of people are trained in the field procedures, and by coordinating redundancy with the availability of trained sample collectors.

7.5.3 Schedule Limitations

The aforementioned challenges may cause delays in the reporting and upload of data to EIM. Overall, this will not cause major disruptions to the study or the quality of data collected.

8.0 Field Procedures

8.1 Invasive Species Evaluation

No invasive species will be introduced into the monitoring wells or onto field staff and equipment. The only objects entering the wells are clean data loggers and e-tape (Solinst Water Level Meter Model 101), and sanitary, single-use sampling bailers. Neither of these objects will come into contact with invasive species.

8.2 Measurement and Sampling Procedures

Upon arrival at the sampling location Field staff will record the following information in a waterproof field notebook.

- Date
- Time
- Field Staff name
- Sample number/Well Tag
- Weather observation
- Site observations

Water quality sampling procedures will follow applicable portions of Ecology's SOP EAP099. Field staff will generally follow TOC sampling procedures and follow recommended practices provided by Edge Analytical. See Appendix A for Edge Analytical TOC Sampling Procedures. Field staff will wear sanitary nitrile gloves and will only perform their designated tasks for the round of sampling. Prior to sampling, field staff will measure and record groundwater elevation within the monitoring well.

1. Field staff will manually measure the static water level, then purge the standing volume of water within the monitoring well three times prior to sampling. Purged water will be disposed away from the well head.
2. Field staff will open the cooler and retrieve the double-bagged sample bottle and open the outer bag.
3. Field staff will open the inner bag, remove the sampling container, then reseal the inner bag and outer bag.
4. Field staff will lower the bailer into the monitoring well with a securely attached nylon rope, until the bailer is completely submerged. The bailer will be carefully raised to the surface.
5. Field staff will pour water into the sampling container and ensure that the bailer does not come into contact with the sampling container. Field staff will fill the container until it is entirely filled and a meniscus forms on the water surface.
6. Field staff will screw the cap onto the sampling container and ensure that no air has been captured in the container.
7. Field staff will then open the outer plastic bag, and the inner plastic bag, places the containers inside, then seals the inner bag.

8. The Field staff will seal the outer bag and stores it in the cooler.
9. The sample number and any observations will be documented in the sampling log.

For each of the methods used to analyze the samples, field duplicate samples will be collected once during the study period and field blank samples will be collected twice during the study period.

Measurement of static water level within the monitoring wells will adhere to Ecology's SOP EAP052. A pressure transducer will be used to measure the static water level within the monitoring well. The transducer will be situated in the well such that it has 6 inches of space between the bottom of the borehole. Automatic measurements will be taken every 30 minutes and will be stored locally on a data logger connected to the pressure transducer. Measurement data will be retrieved periodically by field staff. A manual measurement of depth-to-groundwater relative to top of casing (TOC) will be taken when digital data is retrieved. The permanent measuring point from which depth-to-water manual measurements will be made will be the TOC for the monitoring well, and the measuring point for each monitoring well will be marked in permanent ink. The manual measurement will be compared to the same day's pressure transducer reading to check the drift of the pressure transducer.

8.3 Containers, Preservation Methods, and Holding Times

Sample containers will be provided by KUO Testing Labs for groundwater collection. Upon completion of field collection, the samples will be immediately placed into a cooler and transported to KUO Testing Labs in Pasco, Washington. See Table 8 for additional information.

Table 8. Sample Containers, Preservation, and Holding Times

Analyte	Method	Container	Preservative	Holding Time
Iron	EPA 200.7	1-L HDPE	Cool to 0-6° C; Lab filter for dissolved, Lab preserve with NHO3	6 Months
Nitrate plus Nitrite as Nitrogen	APHA 4500-NO3	1-L HDPE	Cool to 4° C	2 days
Total Dissolved Solids	SM 2540-C	1-L Plastic	Cool to 0-6° C	7-days
Total Coliform Quantification	APHA 9223-B	150mL Idexx Sterile	Cool to 1° to 4° C, 0.0008% (w/w) NaS2O3	24 hours

8.4 Equipment Decontamination

All sampling equipment is single use, preventing contamination between sampling sites. Additionally, all sampling equipment, bailers, bailer line, gloves, etc. are disposed of following sampling and new equipment is used for subsequent rounds of sampling. Water level measuring equipment will be cleaned between monitoring well measurements using deionized water and will be wiped or air-dried. Water quality sampling containers will be cleaned by the laboratory using methods appropriate for the parameter being sampled.

8.5 Sample ID

Sample containers will have a waterproof sample identification tag which will be labeled prior to the time of sampling. Labeling of samples will include the sample ID, date, time, collector's name, sample location.

8.6 Chain of Custody

The chain of custody procedure aligns with KUO Testing Labs standard procedure. The field staff will store all sample bottles in a cooler with ice during transport to KUO Testing Labs. Upon arrival at the lab, the samples will be transferred to the lab, and the required areas of the field log/chain of custody form will be completed.

8.7 Field Log Requirements

A field log is important for maintaining irreplaceable project information and documenting any deviations or aberrations which may occur during the project. The field log for this project will be a notebook with stitched spine and waterproof pages and shall be maintained by field staff responsible for sample collection. Information that shall be recorded includes:

- Name and location of project
- Date, time, location, sampling event
- Field personnel
- Sequence and timing of events including the time a transducer is removed for download and the time it is reinstalled, so that the time period is removed from the dataset.
- Deviations from the QAPP
- Site conditions and weather
- Descriptions of samples
- Manual static water level measurements
- Pressure transducer identification number

Permanent ink will be used for entries, and any corrections will be made with a single strikethrough line. The correction will be initialed and dated by the personnel making the correction. Page breaks or other deliberately unused page space will be crossed out by a single 'X' and will be initialed and dated by the personnel appending the field log.

8.8 Other Activities

No maintenance is required for any installed field instrumentation. The pressure transducers in each well can collect data for the duration of the study period. Manual measurement of depth-to-groundwater will be taken during each round of sampling to check the measurement drift of the pressure transducers. It is anticipated that field staff will offload data from the pressure transducers as required for reporting purposes.

KUO testing labs will be notified no less than two weeks prior to the desired sampling date to ensure that sampling equipment will be prepared and in the possession of the principal investigator or field assistant.

9.0 Laboratory Procedures

9.1 Lab Procedures Table

The following table provides laboratory procedures for analyzing and reporting groundwater quality metrics.

Table 9. Measurement Methods (Laboratory)

Analyte	Sample Matrix	Number of Samples[1] [2]	Detection Limit	Reporting Limit	Analytical (Instrumental) Method
Iron	Ground water	12 samples	0.00837 mg/L	0.1 mg/L	USEPA 200.7
Nitrate plus Nitrite as Nitrogen	Ground water	12 samples	0.0405 mg/L	0.25 mg/L	APHA 4500-NO3(F)
Total Dissolved Solids	Ground water	12 samples	10.6 mg/L	50 mg/L	SM 2540 C
Total Coliform Quantification	Ground water	12 samples	1 MPN/100mL	1 MPN/ 100mL	APHA 9223-B

[1] Total number of samples collected may vary based on weather, access limitations, and staff availability.
[2] Total number of samples shown does not include the required QAQC samples listed in Table 10.

9.2 Sample Preparation Method(s)

Samples will be filtered by KUO Testing Labs or their subcontractor Anatek Labs upon receipt in preparation for analysis.

9.3 Special Method Requirements

Not Applicable.

9.4 Laboratories Accredited for Methods

All testing for the QAPP will be conducted with KUO Testing Labs (Lab ID C548) in Pasco, Washington or by Anatek Labs (Lab ID C595) in Moscow, Idaho. Both laboratories are accredited by the State of Washington Department of Ecology to perform all methods listed in Table 9.

10.0 Quality Control Procedures

Quality control procedures are necessary to monitor a project's progress and address any issues in data collection or analysis before it is too late to rectify any problems. These procedures can occur in the field and in the laboratory. The following sections describe procedures to ensure that samples and data are collected and analyzed consistent to best practices.

Quality control procedures in the field will include adherence to procedures documented in this QAPP and thorough documentation of all sample collection information. The chain of custody of samples will be enforced to ensure samples arrive at the laboratory intact and within holding times and that each sample is accurately labeled.

Static water level measurements in monitoring wells will follow the protocols listed in this QAPP and will be maintained throughout the project. All field measurement equipment will be cleaned and inspected prior to use with the exception for submerged pressure transducers. Manual measurements of depth to groundwater will be compared to measurements recorded by the submerged pressure transducer to check the accuracy of the equipment with each sampling event.

An accurate field log will be maintained throughout the sampling and measuring effort. This will be done by providing a standard template for recording the date, times, staff names, well tags, and other pertinent observations.

Field duplicates will follow the same procedures for sampling and documentation as required for a regular sample. The field duplicate will be clearly marked on the sample ID as a duplicate. Field staff will ensure the location of the duplicate is accurately recorded in the field log.

KUO Testing Labs and Anatek Labs routinely perform quality control procedures to ensure accuracy and precision of its analyses. These procedures include method blanks reported as relative percent difference, percent recovery of spikes, blanks, and duplicate samples. Quality control requirements will be maintained throughout the project. If quality control requirements are not met, then all affected analyses will be resampled or reanalyzed.

10.1 Table of Field and Laboratory Quality Control

Table 10 presents the quality control requirements for the project.

Table 10. Field and Laboratory Quality Control

Analyte	Field		Laboratory	
	Blanks	Duplicates	Method Blanks	Analytical Duplicates
Iron	2/study period	1/study period	1/10 Samples	1/10 Samples
Nitrate plus Nitrite as Nitrogen	2/study period	1/study period	1/10 Samples	1/10 Samples
TDS	2/study period	1/study period	1/10 Samples	1/10 Samples
Total Coliform Quantification	2/study period	1/study period	1/10 Samples	1/10 Samples

10.2 Corrective Action Processes

Should the sampling or data collection activities be insufficient, or if results do not meet the MQOs in Table 6, then corrective actions will include:

- Collecting new samples using methods described in the QAPP.
- Conduct training on field procedures for sample collecting.
- Re-analyze lab samples which do not meet quality control standards.
- Convene project personnel, technical experts, and the client to determine appropriate actions needed to rectify the issue.

11.0 Data Management Procedures

11.1 Data Recording and Reporting Requirements

Groundwater sample collection and measurements will be conducted by the field staff. Field data and observations will be recorded on waterproof paper and data will be transferred to a digital format which will be compiled with subsequent data collection. Utilizing the spreadsheet software Microsoft Excel will aid in data operability and minimize data entry errors. Multiple rounds of data entry review will occur to further validate the accuracy of the data. Errors in data entry will be resolved immediately by comparing errors to source data from the laboratory or field forms. Multiple versions of data should be stored in various storage locations to prevent loss of data due to file corruption or cloud-based service being unavailable.

11.2 Laboratory Data Package Requirements

KUO Testing Labs will provide an electronic data deliverable of laboratory results for each round of sampling. The results will include laboratory measurements for each analyte, date of analysis, method, and analyst. The data will be entered in an EIM compatible data format which will be usable in Microsoft Excel software which will be uploaded to EIM before the completion of the project.

11.3 Electronic Transfer Requirements

KUO Labs will provide all data electronically to the Project Manager.

11.4 Data Upload Procedures

Data will be formatted and uploaded to EIM by the Public Works Director for the City of Dayton under Study ID: WROCR-2325-Dayton-00037.

11.5 Model Information Management

Not Applicable.

12.0 Audits and Reports

12.1 Audits

Not Applicable.

12.2 Responsible Personnel

The project manager will be responsible for reviewing field records after each sampling event and will sign and date the field log.

12.3 Frequency and Distribution of Reports

Upon completion of the suite of groundwater testing, Anderson Perry & Associates will provide a final report which details the results of the study, an analysis of the groundwater characteristics in the project vicinity, and a recommendation for the City of Dayton's proposed wastewater treatment plant.

12.4 Responsibility for Reports

The report will be completed by Field Staff and the Project Manager.

13.0 Data Verification

13.1 Field Data Verification, Requirements, and Responsibilities

Field data will be verified by Field Staff and the Project Manager. All field logs and quantity of samples will be checked for completeness before departing the project vicinity. Field reports will be reviewed by the project manager after each sampling event.

13.2 Laboratory Data Verification

An Engineer Technician will review the laboratory results and case narratives upon receipt from the laboratory to determine if the results meet the Data Quality Objectives for methods, limits, bias, precision, and accuracy for the sampling event. The data will be accepted or rejected based on these assessments. Field conditions reported in the field log will be included in the verification process. All data will be labeled as “draft” until verification is complete.

13.3 Validation Requirements, if Necessary

Not Applicable.

13.4 Model Quality Assessment

Not Applicable.

13.4.1 Calibration and Validation

Not Applicable.

13.4.1.1 Precision

Not Applicable.

13.4.1.2 Bias

Not Applicable.

13.4.1.3 Representativeness

Not Applicable.

13.4.1.4 Qualitative Assessment

Not Applicable.

13.4.2 Analysis of Sensitivity and Uncertainty

Not Applicable.

14.0 Data Quality (Usability) Assessment

14.1 Process for Determining Project Objectives Were Met

Project objectives will be completed if the entire suite of testing has been completed, laboratory results have been reported, and MQOs are met.

14.2 Treatment of Non-detects

Non-detects will be identified and included in the project analysis. Non-detects will be set as the MDL for parameter for the analysis.

14.3 Data Analysis and Presentation Methods

Data analysis will be conducted using commonly available software such as Excel. This will provide graphical representation of the variation of analyte concentrations and water level elevations in each monitoring well throughout the study period. Data will be presented tabularly and graphically and included in the final project report.

14.4 Sampling design Evaluation

The sampling design is expected to be sufficient to obtain the volume of data necessary to establish baseline groundwater quality throughout seasonal changes.

14.5 Documentation of Assessment

The Project Manager will verify the completeness of the data and determine if the measurement quality objectives have been met. This will be determined by scrutinizing the data for errors or incompleteness and the number of samples that has been collected and analyzed. If the measurement quality objectives are not met, then the Project Manager will make the determination on how to qualify the data, and whether the data can be included in the analysis or rejected.

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16.0 Appendices

Appendix A. Edge Analytical Sampling Procedure

EDGE ANALYTICAL

Burlington, WA	*Corporate Laboratory (a)*	1620 S Walnut St	Burlington, WA 98233	360.757.1400
Bellingham, WA	*Microbiology (b)*	805 W. Orchard Dr Ste 4	Bellingham, WA 98225	360.715.1212
Portland, OR	*Microbiology/Chemistry (c)*	9725 SW Commerce Circle, Ste A2	Wilsonville, OR 97070	503.682.7802
Corvallis, OR	*Microbiology (d)*	1100 NE Circle Blvd., Ste 130	Corvallis, OR 97330	541.753.4946
Bend, OR	*Microbiology (d)*	20332 Empire Ave. Ste. F4	Bend, OR 97703	541.639.8425

Sample Collection Procedure

TOC

Total Organic Compounds

****READ ALL INSTRUCTIONS BEFORE COLLECTION****

TOC SAMPLE KIT CONTENTS:

1 each - 60mL muffled amber vial

-labeled with a Batch date.

-containing 3 drops of concentrated HCl **CAUTION: HCl is highly corrosive.**

(This is done to prevent bacteria growth from occurring and to begin the process of eliminating IC constituents.)

1 each - Water Sample Information (WSI) form

SAMPLE COLLECTION:

DO NOT TOUCH or otherwise contaminate the inside lid or the lip of the vials/bottles during sampling.

1. Remove any potentially contaminating devices such as filters, screens, aerators, hoses, etc. from sampling points.

2. Open the tap and allow water to run, at least 3 minutes, until it reaches a constant temperature.

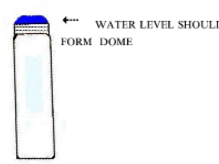
3. Reduce flow to a thin steady stream about the thickness of a pencil.
   DO NOT LET THE VIALS TOUCH THE FAUCET OR SPIGOT as the sample may become contaminated.

4. Fill the 60 mL vial, avoid agitation of the sample while filling.
   Allow the stream of water to gently flow into the vial just to overflowing, **do not rinse out the HCl.**

5. 5. Carefully place the cap onto the vial.
   The shiny side of the Teflon cap liner should be face down in contact with the water sample.

6. Tighten down the cap securely.

7. Fill out the label on bottle, be sure to include the sampling date, time, and location.



AFTER SAMPLE COLLECTION:

IMPORTANT: *TOC Samples MUST be kept cold at 4□ C until they reach the laboratory.*
If the samples become warm or freeze, they will be rejected by the laboratory.

- If samples are to be held for a day or longer prior to shipment, place the bottles in a refrigerator. **Once samples are ready to be shipped, make sure there is plenty of ice in the cooler to keep the samples at 4° C.**

- Place the **completed** Water Sample Information (WSI) form into a plastic bag and place in the cooler with the samples.

ALL SAMPLES MUST BE RECEIVED AT THE LABORATORY NO LATER THAN 4PM FRIDAY OF THE WEEK IN WHICH SAMPLED. We highly suggest *NOT* shipping on Thursday/Friday as samples may sit over the weekend with the shipper and become warm.

Direct ship samples to: Edge Analytical—1620 South Walnut Street—Burlington, WA 98233
~ or ~ Drop off samples at any Edge Analytical laboratory.

 03/09/2018

Appendix B. KUO Testing Lab Chain of Custody Form

KTL KUOTESTING LABS
A Matrix Sciences Company

Ag Lab:
119 E. Main St
Othello, WA 99344
T: (509) 488-0112

Environmental Lab:
1320 E. Spokane St,
Suite C
Pasco, WA 99301
T: (509) 547-3838

Oregon Office:
1300 6th St,
Suite J
Umatilla, OR 97882
T: (541) 922-6435

Matrix Sciences International
Billing/Invoice Questions:
1061 Feehanville Drive
Mt. Prospect, IL 60056
T: (847) 272-8700

Page __ of __

Client Name: **Laboratory Performing Analysis: Kuo Testing Labs, Inc.**

Client Information	Billing Address	Reporting Address (if different from Billing Address)	Results
Contact Person:	Company:	Company:	☐ E-mail
Telephone No.:	Address:	Address:	☐ FAX
Email:	City, St., ZIP:	E-mail:	☐ Mail
Project Name:	Purchase Order Number:	Cell Phone:	
Sampling Location:	Telephone:	Telephone:	

KTL Lab Sample ID	Customer Sample Identification	Date/Time Collected	Sample Type: Potable Water / Non-Potable	# of containers	Analyses Required									Requested Turn-around: ☐ Normal ☐ Rush Comments for the lab:
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
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					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	
					☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sampled By (PRINT):	Sampled By (SIGNATURE)	Date/Time	Received By (PRINT):	Received By (SIGNATURE):	Date/Time
Relinquished By (PRINT):	Relinquished By (SIGNATURE)	Date/Time	Received By (PRINT):	Received By (SIGNATURE):	Date/Time
Relinquished By (PRINT):	Relinquished By (SIGNATURE)	Date/Time	Received By (PRINT):	Received By (SIGNATURE):	Date/Time

KTL | Revised 06/23

FOR LABORATORY USE ONLY

Sample Temp:________°C

MCL Exceedance/Positive Bacteria Contact	Date/Time

Sample Receipt/Preservation Form

Samples Received Intact? Yes No N/A

COC Present/Complete? Yes No N/A

Labels and COC's agree? Yes No N/A

Samples Received within holding time? Yes No N/A

Correct Containers Received? Yes No N/A

-Kuo bottles used? Yes No N/A

Number of Coolers/Boxes: ____________ **Cooler Temp:** _________ **Thermometer Used:**_________________

Date/Time Received:____

Received by (signature):____

Samples Received From: UPS FedEx USPS Client Walk-in Courier Other:_______________________

Custody Seal on Cooler/Box: Yes No N/A

Custody Seals Intact: Yes No N/A

Samples Properly Preserved? Yes No N/A

Preservation Used: HNO3 H2SO4

Number of bottles received? ___________

Additional Comments:_______________________

Drop-Off Locations

Adams County	
Location	*Pickup Day/Time*
Kuo Testing Labs 119 E. Main St. Othello, WA	Sunday: 3:30pm Mon - Thu: 8am to 2:30pm

Grant County	
Location	*Pickup Day/Time*
Grant County Health Dept 1038 W. Ivy Ave. #1 Moses Lake, WA	Mon - Thu: 12pm
Lindsay Water 1229 Basin St. SW Ephrata, WA	Tuesday **ONLY: 11:30AM**

Franklin County	
Location	*Pickup Day/Time*
Kuo Testing Labs 1320 E. Spokane St. Suite C Pasco, Wa	Sunday: 3:30pm Mon - Thu: 8am to 4pm
Simplot Grower Solutions 100 1st Ave. Mesa, Wa	Sunday: 3:30pm Mon - Thu: 8am to 4pm

Umatilla County (OR)	
Location	*Pickup Day/Time*
Kuo Testing Labs 1300 6th St. Suite J Umatilla, OR	Sunday: 2:00 pm Mon - Thu: 4:00 pm

Additional drop off locations in Eltopia, Moxee, Sunnyside, and Yakima. Please call in advance for courier service and availability.

You will receive invoicing after samples have been processed - contact any of our offices to make a payment. We accept Visa, MasterCard, & American Express.
Please make checks or money orders payable to Matrix Sciences (follow invoice instructions).
Cash is NOT accepted

KTL KUO TESTING LABS
A Matrix Sciences Company

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KTL | Revised 06/23

Appendix C. Laboratory Accreditation

The State of Washington
Department of Ecology

Anatek Labs, Inc - Moscow
Moscow, ID

has complied with provisions set forth in Chapter 173-50 WAC and is hereby recognized by the Department of Ecology as an ACCREDITED LABORATORY for the analytical parameters listed on the accompanying Scope of Accreditation. This certificate is effective March 21, 2023 and shall expire March 20, 2024.

Witnessed under my hand on June 27, 2023

Rebecca Wood
Lab Accreditation Unit Supervisor

Laboratory ID
C595

The State of Washington
Department of Ecology

Matrix Sciences International Inc. dba KTL

Pasco, WA

has complied with provisions set forth in Chapter 173-50 WAC and is hereby recognized by the Department of Ecology as an ACCREDITED LABORATORY for the analytical parameters listed on the accompanying Scope of Accreditation.

This certificate is effective September 3, 2023 and shall expire September 2, 2024.

Witnessed under my hand on September 05, 2023.

Rebecca Wood
Lab Accreditation Unit Supervisor

Laboratory ID
C548

Appendix D. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

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.

Critical condition: When the physical, chemical, and biological characteristics of the receiving water environment interact with the effluent to produce the greatest potential adverse impact on aquatic biota and existing or designated water uses. For steady-state discharges to riverine systems, the critical condition may be assumed to be equal to the 7Q10 flow event unless determined otherwise by the department.

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.

Eutrophic: Nutrient rich and high in productivity resulting from human activities such as fertilizer runoff and leaky septic systems.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either:
(1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Hyporheic: The area beneath and adjacent to a stream where surface water and groundwater intermix.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes and (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

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.

Nonpoint source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface-water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

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.

Point source: Source of pollution that discharges at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites where more than 5 acres of land have been cleared.

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

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

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.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a margin of safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

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

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations constitute one type of water quality-based effluent limitation.

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.

1-DMax or 1-day maximum temperature: The highest water temperature reached on any given day. This measure can be obtained using calibrated maximum/minimum thermometers or continuous monitoring probes having sampling intervals of thirty minutes or less.

303(d) list: Section 303(d) of the federal Clean Water Act, requiring Washington State to periodically prepare a list of all surface waters in the state for which beneficial uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited estuaries, lakes, and streams that fall short of state surface water quality standards and are not expected to improve within the next two years.

7-DADMax or 7-day average of the daily maximum temperatures: The arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the three days before and the three days after that date.

7Q2 flow: A typical low-flow condition. The 7Q2 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every other year on average. The 7Q2 flow is commonly used to represent the average low-flow condition in a water body and is typically calculated from long-term flow data collected in each basin. For temperature TMDL work, the 7Q2 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

7Q10 flow: A critical low-flow condition. The 7Q10 is a statistical estimate of the lowest 7-day average flow that can be expected to occur once every ten years on average. The 7Q10 flow is commonly used to represent the critical flow condition in a water body and is typically calculated from long-term flow data collected in each basin. For temperature TMDL work, the 7Q10 is usually calculated for the months of July and August as these typically represent the critical months for temperature in our state.

90th percentile: An estimated portion of a sample population based on a statistical determination of distribution characteristics. The 90th percentile value is a statistically derived estimate of the division between 90% of samples, which should be less than the value, and 10% of samples, which are expected to exceed the value.

Acronyms and Abbreviations

Delete all of the following that aren't used in this QAPP.

BMP	Best management practice
DO	Dissolved oxygen
DOC	Dissolved organic carbon
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
FC	Fecal coliform
GIS	Geographic Information System software
GPS	Global Positioning System
i.e.	In other words
MQO	Measurement quality objective
NPDES	National Pollutant Discharge Elimination System
PBDE	Polybrominated diphenyl ethers
PBT	Persistent, bioaccumulative, and toxic substance
PCB	Polychlorinated biphenyls
QA	Quality assurance
QC	Quality control
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedures
TMDL	Total Maximum Daily Load
TOC	Total organic carbon
TSS	Total suspended solids
WAC	Washington Administrative Code
WQA	Water Quality Assessment
WRIA	Water Resource Inventory Area
WWTP	Wastewater treatment plant

Units of Measurement

°C degrees centigrade

cfs cubic feet per second

cfu colony forming units

cmscubic meters per second, a unit of flow

dw dry weight

ft feet

g gram, a unit of mass

kcfs1000 cubic feet per second

kg kilograms, a unit of mass equal to 1,000 grams

kg/d kilograms per day

km kilometer, a unit of length equal to 1,000 meters

L/s liters per second (0.03531 cubic foot per second)

m meter

mmmillimeter

mg milligram

mgd million gallons per day

mg/d milligrams per day

mg/kg milligrams per kilogram (parts per million)

mg/L milligrams per liter (parts per million)

mg/L/hr milligrams per liter per hour

mL milliliter

mmol millimole or one-thousandth of a mole

mole an International System of Units (IS) unit of matter

ng/g nanograms per gram (parts per billion)

ng/kg nanograms per kilogram (parts per trillion)

ng/L nanograms per liter (parts per trillion)

NTU nephelometric turbidity units

pg/g picograms per gram (parts per trillion)

pg/L picograms per liter (parts per quadrillion)

psu practical salinity units

s.u. standard units

μg/g micrograms per gram (parts per million)

µg/kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)
µm	micrometer
µM	micromolar (a chemistry unit)
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter, a unit of conductivity
ww	wet weight

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data (Kammin, 2010). For Ecology, it is defined according to WAC 173-50-040: "Formal recognition by [Ecology] that an environmental laboratory is capable of producing accurate and defensible analytical data."

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* (USEPA, 2014).

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: Discrepancy between the expected value of an estimator and the population parameter being estimated (Gilbert, 1987; USEPA, 2014).

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, 2014; USEPA, 2020).

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, 2014; USEPA 2020).

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: The process of determining that the data satisfy the requirements as defined by the data user (USEPA, 2020). There are various levels of data validation (USEPA, 2009).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 2014).

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)/LCS duplicate: 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. Monitors a lab's performance for bias and precision (USEPA, 2014).

Matrix spike/Matrix spike duplicate: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias and precision errors 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 (USEPA, 2001).

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): The minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results (USEPA, 2016). MDL is a measure of the capability of an analytical method of distinguished samples that do not contain a specific analyte from a sample that contains a low concentration of the analyte (USEPA, 2020).

Minimum level: Either the sample concentration equivalent to the lowest calibration point in a method or a multiple of the method detection limit (MDL), whichever is higher. For the purposes of NPDES compliance monitoring, EPA considers the following terms to be synonymous: “quantitation limit,” “reporting limit,” and “minimum level” (40 CFR 136).

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:

RPD = [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).

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).

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).

Reporting level: Unless specified otherwise by a regulatory authority or in a discharge permit, results for analytes that meet the identification criteria (i.e., rules for determining qualitative presence/absence of an analyte) are reported down to the concentration of the minimum level established by the laboratory through calibration of the instrument. EPA considers the terms "reporting limit," "quantitation limit," and "minimum level" to be synonymous (40 CFR 136).

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, 1992).

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, 2014).

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, 2014).

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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