DEPARTMENT OF ECOLOGY
State of Washington

Addendum to Quality Assurance Project Plan

City of Moxee ASR Feasibility Study

March 2025

Publication 25-12-002

Publication Information

This Quality Assurance Project Plan Addendum is on the Department of Ecology's website at https://apps.ecology.wa.gov/publications/SummaryPages/2512002.html This is an addition to an original Quality Assurance Project Plan (QAPP). It is not a correction (errata) to the original plan.

This QAPP addendum was approved to begin work in January 2025. It was finalized and approved for publication in February 2025.

Suggested citation for this addendum:
Aspect Consulting. 2025. Addendum to Quality Assurance Project Plan, City of Moxee ASR Feasibility Study. Publication 25-12-002. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2512002.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at EIM Database. Search Study ID WRYBIP-2325-00048.

Original Quality Assurance Project Plan:
Aspect Consulting. 2023. Quality Assurance Project Plan, City of Moxee ASR Feasibility Study. Publication 23-12-015. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/documents/2312015.pdf.

Contact Information

Publications Coordinator
Environmental Assessment Program
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
Phone: 360-407-6764

Washington State Department of Ecology – ecology.wa.gov

Headquarters, Olympia	360-407-6000
Northwest Regional Office, Bellevue	425-649-7000
Southwest Regional Office, Olympia	360-407-6300
Central Regional Office, Union Gap	509-575-2490
Eastern Regional Office, Spokane	509-329-3400

Addendum to
Quality Assurance Project Plan

City of Moxee ASR Feasibility Study

by Ian Lauer, Derek Holom, and Tyson Carlson

Published January 2025

Approved by:

Signature: Date: 3/4/2025
Ian Lauer, LHG, Project Hydrogeologist, Aspect Consulting, Author

Signature: Date: 3/4/2025
Tyson Carlson, LHG, Principal Hydrogeologist, Aspect Consulting, Author, Project Manager

Signature: Date: 3/5/2025
Derek Holom, LHG, Senior Hydrogeologist, Aspect Consulting, Author

Signature: Date: 3/5/2025
Justin Bellamy, [illegible] Engineer, HLA Engineering and Surveying Inc., City Engineer

Signature: Date: 3/5/2025
Jeff Burkett, Public Works, City of Moxee, Client

Signature: Date: 3/6/2025
Jeff Dermond, Hydrogeologist, Office of the Columbia River, Department of Ecology

Signature: Date: 3/10/2025
Llyn Doremus, LHG, Water Quality Program, Department of Ecology

Signature: Date: 03/11/2025
McKenna Murray, QAPP Coordinator, Office of the Columbia River, Department of Ecology

Signature: Date: 03/05/25
Randee Arrington, Laboratory Project Manager, Eurofins

Signatures are not available on the Internet version.
OCR: Office of Columbia River

1.0 Table of Contents

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

No tasks from the original project QAPP will be eliminated. This addendum addresses modification to the list of analytes, sampling schedule, and inclusion of geochemical modeling. The laboratory has also been substituted and all relevant analytical methods and detection limits updated.

3.0 Background

3.2.3 Parameters of Interest

Updated to include additional analytes to Washington State Groundwater Quality Standards (Chapter 173-200 WAC) and Drinking Water Standards (Chapter 246-290 WAC) and to support geochemical modeling.

Field Parameters
Field parameters will be measured to provide independent corroboration of laboratory results, and to analyze constituents that have short hold times and can be reliably measured in the field. Field parameters also include measurements to develop groundwater elevation contour maps. These include:

- Specific conductivity
- Dissolved Oxygen (DO)
- Oxidation Reduction Potential (ORP)
- pH
- Temperature
- Turbidity
- Continuous and discrete groundwater depth-to-water
- Groundwater level measuring point elevation

General Chemistry
The general chemistry suite includes inorganic constituents and conventional water quality parameters. Groundwater and surface water samples will be analyzed for this suite of constituents in both the dissolved (field-filtered to 45 microns) and total fractions. Geochemical analysis will evaluate chemical compatibility of native groundwater and surface water and model for potential chemical reactions of the recharge water with aquifer material (mineral dissolution and precipitation) during aquifer storage. This analytical suite will also inform source treatment requirements in the context of Chapter 173-200 WAC (Groundwater Quality Standards) and WAC 246-290-310 (Drinking Water standards). Constituents will include:

Alkalinity	Silica	Lead
Bicarbonate	Arsenic	Magnesium
Chloride	Ammonia	Manganese
Total Dissolved Solids (TDS)	Antimony	Molybdenum
Total Suspended Solids (TSS)	Aluminum	Mercury

Total and Dissolved Organic Carbon (TOC, DOC)	Barium	Nickel
Phosphorus	Beryllium	Potassium
Bromide	Cadmium	Selenium
Fluoride	Calcium	Silver
Nitrate-N	Chromium	Sodium
Nitrite-N	Copper	Thallium
Sulfate	Iron	Titanium
	Zinc	Uranium

Volatile and Semivolatile Organic Compounds
As described in Section 3.2.2, baseline characterization was completed for the native groundwater in the target storage aquifer (Ellensburg Formation aquifer at City water supply wells). As required by the Washington State Department of Health (DOH), the City has three decades of groundwater quality data including both volatile organic compounds (VOCs) and synthetic organic compounds (SOCs). Over the period of record (1990-present) neither SOCs nor VOCs were detected in the City's water supply wells that are completed in the source aquifer.

The Study will evaluate potential surface water sources (e.g., SMID Canal and Roza Main Canal) for both VOCs and SOCs. Therefore, measurement of VOCs and SVOCs is necessary to accurately assess surface water quality.

Herbicides and Pesticides
The City has evaluated herbicides and pesticides for DOH drinking water compliance. Over the period of record (1990-present) neither herbicides nor pesticides were detected in the City's water supply wells that are completed in the source aquifer.

The Study will evaluate potential surface water sources (e.g., SMID Canal and Roza Main Canal) for both herbicides and pesticides. Therefore, herbicides and pesticides will be measured at potential surface water sources as part of this Study. This will include the analytes specified in U.S. Environmental Protection Agency (EPA) Methods:

- Chlorinated Pesticides
- Chlorinated Acid Herbicides
- Pesticides as carbamates
- Herbicides – diquat, paraquat, endothall, and glyphosate

Bacteriological Constituents
The Study will evaluate bacteriological constituents (total coliform and E. Coli) in native groundwater and potential surface water sources (e.g., SMID Canal and Roza Main Canal) to determine baseline conditions. The Study will evaluate the following constituents:

- E. coli (presence/absence)
- Fecal Coliform
- Total coliforms (plate count)

Radionuclides
Radionuclides were detected in groundwater at City wells. In addition, radionuclides have not been analyzed for potential surface water sources. Thus, the Study will evaluate the following radionuclides in potential surface water sources:

- Radium 226 + Radium 228
- Gross Alpha radiation
- Gross Beta radiation

Per- and polyfluoroalkyl substances (PFAS)
PFAS were not detected in groundwater at City wells. PFAS have not been analyzed for potential surface water sources. Thus, the Study will evaluate the following PFAS in potential surface water sources:

- Perfluorooctanoic acid (PFOA)
- Perfluorooctane sulfonate (PFOS)
- Perfluorohexane sulfonate (PFHxS)
- Perflourononanoic acid (PFNA)
- Perfluorobutane sulfonate (PFBS)

4.0 Project Description

4.2 Project Objectives

The objectives of the Study are updated to include:

- Refine the hydrogeologic conceptual model to evaluate ASR feasibility and address informational requirements of Chapter 173-157-120 WAC;
- Assessment of source water quality including geochemical modeling;
- Assessment of groundwater quality in the target aquifer; and
- Collection of groundwater level measurements in the target aquifer.

4.4 Tasks Required

Task 1.1 is updated to include geochemical modeling.

Task 1.1: Water Quality Sampling and Geochemical Modeling. This task includes sampling of potential surface water sources (e.g., SMID Canal and Roza Main Canal) and groundwater. Source water quality data will be used to determine water treatment requirements for municipal and ASR uses. Groundwater sampling will be collected from at least two and up to four City wells during multiple sampling events to assess spatial and temporal variability of water quality within the target aquifer. During both groundwater and surface water sampling, field water quality parameters (i.e., pH, specific conductance, temperature, ORP, dissolved oxygen, and turbidity) will be collected. This data will also be used to develop a PHREEQC thermodynamic geochemical equilibrium model (Parkurst et al., 1980) for the target aquifer. This model will evaluate the potential for physiochemical changes (mineral dissolution and/or precipitation) to occur as a result of recharge operations.

5.0 Organization and Schedule

5.1 Key Individuals and Their Responsibilities

Key individuals are updated to include substitution of the laboratory and Ecology's Quality Assurance Coordinator. Revised Table 5 shows the responsibilities of those who will be involved in this project.

Table 5. Organization of Project Staff and Responsibilities

Staff	Title	Responsibilities
McKenna Murray Office of Columbia River Phone: (509) 823-0996	OCR Interim Quality Assurance Coordinator	Provides internal review of the QAPP and approves the final QAPP
Jeff Dermond Office of Columbia River Phone: (509) 268-1784	OCR Project Manager	Provides oversight for the Study and Ecology Grant. Clarifies scope of the project. Provides review of the QAPP.
Jeff Burkett City of Moxee Phone: (509) 575-8851	Public Works	Reviews the draft and final QAPP and project deliverables, submittals for the Ecology Grant
Justin Bellamy HLA Engineering Phone: (509) 966-7000	City Engineer	HLA Project Manager, Completes the Engineering Evaluation of Water System
Tyson Carlson Aspect Consulting Phone: (509) 895-5923	Principal Investigator and Project Manager	Co-author of QAPP, Aspect Project Manager, approach development, data analysis, QA/QC
Derek Holom Aspect Consulting Phone: (206) 496-1475	Senior Hydrogeologist	Technical oversight on data analysis
Ian Lauer Aspect Consulting Phone: (208) 540-1964	Project Hydrogeologist	Co-author of QAPP. Plans/schedules field dates/logistics. Procures equipment. Performs field work.
Lea Beard Aspect Consulting Phone (206) 780-7749	Data Scientist	Reviews and uploads EIM data.
Randee Arrington Eurofins (509) 924-9200	Business Unit Manager	Prepares laboratory reports
Nicole Irons Eurofins (509) 924-9200	Quality Assurance Manager	Conducts laboratory QA/QC.

5.4 Proposed Project Schedule

Table 6 is updated to include the revised project schedule.

Table 6. Tentative Project Schedule

Task	Completion Date	Note
Final QAPP	September 2023	--
Groundwater and Surface Water Quality Testing	May 2025	--
Submit Draft Feasibility Analysis Report	June 2025	--
Receive Ecology Comments	June 2025	--
Database uploaded to EIM	July 2025	--
Complete Final Report	July 2025	Following receipt and discussion of Ecology comments on the draft report.

6.0 Quality Objectives

6.2.1 Targets for Precision, Bias, and Sensitivity

Table 8 is updated to include analytes using standard analytical methods that meet the specified MQOs.

Table 7. Field Method MQOs and Field Equipment Information

Parameter	Equipment /Method	Bias (median)	Precision Field Duplicates (median)	Equipment Information			Expected Range
				Accuracy	Resolution	Range	
Air Monitoring							
Temperature	Van Essen Baro-Diver	--	--	0.1°C	0.01°C	-10 to 50°C	-7 to 31°C
Barometric Pressure	Van Essen Baro-Diver	--	--	0.016 ft-H_2O	0.003 ft-H_2O	--	29 to 33 ft-H_2O
Groundwater Level Measurements							
Temperature	Van Essen TD-Diver	--	--	0.1°C	0.01°C	0 to 50°C	1 to 25°C
Pressure	Van Essen TD-Diver	--	--	0.016 ft-H_2O	0.007 ft-H_2O	max 330 ft-H_2O	20 to 200 ft-H_2O

Parameter	Equipment /Method	Bias (median)	Precision Field Duplicates (median)	Equipment Information			Expected Range
				Accuracy	Resolution	Range	
	Weiss	--	--	0.5% Full Scale	0.01 PSI	Max 200 PSI	
Depth to Water Table	Electronic Water level	--	--	0.05 ft	0.01 ft	--	250 to 750 ft
Wellhead Position (GPS)	Arrow Gold+ GNSS Receiver	--	--	0.3 feet	0.01 ft	--	--
Field Water Quality Parameters							
pH	AquaTroll 600	--	--	0.1 SU	0.01 SU	0 to 14 SU	6.5 to 8.5 SU
Specific conductivity		--	--	±0.5% + 1 uS/cm	0. 1 uS/cm	0 to 350,000 uS/cm	150 to 500 uS/cm
Dissolved oxygen		--	--	± 0.1mg/L	0.01 mg/L	0 to 20 mg/L	0 to 10 mg/L
Oxidation-Reduction Potential		--	--	±5 mV	0.1 mV	-1400 to +1400 mV	-300 to +300 mV
Temperature		--	--	±0.1°C	0.01°C	-5 to 50°C	1 to 25°C
Turbidity		--	--	±2% or 0.5 NTU	0.01 NTU	0 – 4,000 NTU	0 – 100 NTU

Notes: mV = millivolts; ft H_2O = feet of water; PSI = pounds per square inch; SU = standard units; uS/cm = microsiemens per centimeter; mg/L = milligrams per liter; °C = temperature in Celsius

Table 8. Laboratory MQOs of Water Samples

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
General Chemistry, Inorganics									
SM 2330B	Corrosivity	0	0	0	-	0	-	0	GW
SM 2120B	Color		5	CU	-		80-120	20	GW, DW
SM 2320B	Alkalinity	5	20	mg/L	80-120	20	90-110	20	
SM 2320B	Bicarbonate	5	20	mg/L	80-120	20	90-110	20	
EPA 300.0	Chloride	0.42	0.8	mg/L	80-120	10	90-110	20	GW, DW
EPA 245.1	Mercury (Dissolved)	0.09	0.2	ug/L	70-130	20	85-115	20	
EPA 300.0	Fluoride	0.1	0.2	mg/L	80-120	20	90-110	20	GW, DW
EPA 245.1	Mercury	0.09	0.2	ug/L	70-130	20	85-115	20	GW, DW
EPA 300.0	Nitrate (as N)	0.057	0.2	mg/L	80-120	12.1	90-110	20	GW, DW
EPA 300.0	Nitrite (as N)	0.0689	0.2	mg/L	80-120	10	90-110	20	DW
EPA 300.0	Sulfate	0.128	0.5	mg/L	80-120	10	90-110	20	GW, DW
SM 4500	Ammonia (as N)	0.134	0.3	mg/L	90-100	20	90-110	20	
SM 2540C	Total Dissolved Solids	13	25	mg/L	-		80-120	20	GW, DW
EPA 365.1	Total Phosphorous	0.031	0.15	mg/L	80-120	20	90-110	20	
SM 2540D	Total Suspended Solids	4	10	mg/L	-		80-120	20	
SM 4500_H+	pH	-	0.1	SU	-		98.6-101.4	20	GW
SM 2150B	Odor		1	TON	-		-		GW
EPA 100.2	Asbestos				-		-		DW
EPA 335.4	Cyanide				-		-		DW
SM 2510B	Total Organic Carbon	0.088	0.3	mg/L	120-80	20	90-110	20	
SM 2510B	Specific conductivity				-		-		DW
SM 5310C	Dissolved Organic Carbon	0.088	0.3	mg/L	80-120	20	90-110	20	

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
Metals by ICP or ICP/MS									
EPA 200.8	Aluminum	3.94	20	ug/L	70-130	20	85-115	20	
EPA 200.8	Antimony	0.479	1	ug/L	70-130	20	85-115	20	DW
EPA 200.8	Arsenic	0.245	1	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.8	Barium	0.215	2	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.8	Beryllium	0.115	0.3	ug/L	70-130	20	85-115	20	DW
EPA 200.8	Cadmium	0.0811	0.5	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.7	Calcium	0.0705	1	mg/L	70-130	20	85-115	20	
EPA 200.8	Chromium	0.326	0.9	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.8	Copper	0.275	1	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.7	Iron	0.00217	0.01	mg/L	70-130	20	85-115	20	GW, DW
EPA 200.8	Lead	0.0835	0.5	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.7	Magnesium	0.00994	0.1	mg/L	70-130	20	85-115	20	
EPA 200.8	Manganese	0.41	2	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.8	Molybdenum	0.219	2	ug/L	70-130	20	85-115	20	
EPA 200.8	Nickel	0.378	1	ug/L	70-130	20	85-115	20	
EPA 200.7	Potassium	0.12	1	mg/L	70-130	20	85-115	20	
EPA 200.8	Selenium	0.248	2	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.7	Silica (as SiO2)	0.0334	0.428	mg/L	-		-		
EPA 200.7	Silicon	0.0156	0.2	mg/L	70-130	20	85-115	20	
EPA 200.8	Silver	0.3	0.5	ug/L	70-130	20	85-115	20	GW, DW
EPA 200.7	Sodium	0.41	1	mg/L	70-130	20	85-115	20	DW
EPA 200.8	Thallium	0.1	0.3	ug/L	70-130	20	85-115	20	DW
EPA 200.8	Titanium	0.137	1	ug/L	70-130	20	85-115	20	
EPA 200.8	Uranium	0.116	1	ug/L	70-130	20	85-115	20	DW
EPA 200.8	Zinc	4.28	20	ug/L	70-130	20	85-115	20	GW, DW

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
EPA 245.7	Mercury	0.41	2	ug/L	130-70	20	85-115	20	
EPA 200.8	Aluminum (Dissolved)	3.94	20	ug/L	70-130	20	85-115	20	
EPA 200.8	Antimony (Dissolved)	0.479	1	ug/L	70-130	20	85-115	20	
EPA 200.8	Arsenic (Dissolved)	0.245	1	ug/L	70-130	20	85-115	20	
EPA 200.8	Barium (Dissolved)	0.215	2	ug/L	70-130	20	85-115	20	
EPA 200.8	Beryllium (Dissolved)	0.115	0.3	ug/L	70-130	20	85-115	20	
EPA 200.8	Cadmium (Dissolved)	0.0811	0.5	ug/L	70-130	20	85-115	20	
EPA 200.7	Calcium (Dissolved)	0.0705	1	mg/L	70-130	20	85-115	20	
EPA 200.8	Chromium (Dissolved)	0.326	0.9	ug/L	70-130	20	85-115	20	
EPA 200.8	Copper (Dissolved)	0.275	1	ug/L	70-130	20	85-115	20	
EPA 200.7	Iron (Dissolved)	0.00217	0.01	mg/L	70-130	20	85-115	20	
EPA 200.8	Lead (Dissolved)	0.0835	0.5	ug/L	70-130	20	85-115	20	
EPA 200.7	Magnesium (Dissolved)	0.00994	0.1	mg/L	70-130	20	85-115	20	
EPA 200.8	Manganese (Dissolved)	0.41	2	ug/L	70-130	20	85-115	20	
EPA 200.8	Molybdenum (Dissolved)	0.219	2	ug/L	70-130	20	85-115	20	
EPA 200.8	Nickel (Dissolved)	0.378	1	ug/L	70-130	20	85-115	20	
EPA 200.7	Potassium (Dissolved)	0.12	1	mg/L	70-130	20	85-115	20	
EPA 200.8	Selenium (Dissolved)	0.248	2	ug/L	70-130	20	85-115	20	
EPA 200.7	Silica (as SiO2) (Dissolved)	0.0334	0.428	mg/L	-		-		
EPA 200.7	Silicon (Dissolved)	0.0156	0.2	mg/L	70-130	20	85-115	20	
EPA 200.8	Silver (Dissolved)	0.3	0.5	ug/L	70-130	20	85-115	20	
EPA 200.7	Sodium (Dissolved)	0.41	1	mg/L	70-130	20	85-115	20	
EPA 200.8	Thallium (Dissolved)	0.1	0.3	ug/L	70-130	20	85-115	20	
EPA 200.8	Titanium (Dissolved)	0.137	1	ug/L	70-130	20	85-115	20	
EPA 200.8	Uranium (Dissolved)	0.116	1	ug/L	70-130	20	85-115	20	
EPA 200.8	Zinc (Dissolved)	4.28	20	ug/L	70-130	20	85-115	20	

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
Bacteriological									
SM 2510B	Total Coliform Bacteria				-		-		GW
Volatile Organic Compounds									
EPA 524.2	1,1,1-Trichloroethane	0.2	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	1,1,2-Trichloroethane	0.2	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	1,1-Dichloroethane	0.2	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	1,1-Dichloroethylene	0.2	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	1,2,4-Trichlorobenzene	0.3	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	1,2-Dichloroethane	0.2	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	1,2-Dichloropropane	0.1	0.25	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	1,3-Dichloropropene	0.1	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	1,4-Dichlorobenzene	0.2	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Acrylonitrile	0.4	1	ug/L	70-130	20	80-120		GW
EPA 524.2	Benzene	0.1	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Bromodichloromethane	0.1	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	Bromoform	0.2	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	Carbon tetrachloride	0.2	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Chlorobenzene	0.1	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	Chlorodibromomethane	0.1	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	Chloroform	0.2	0.5	ug/L	70-130	20	80-120		GW
EPA 524.2	cis-1,2-Dichloroethylene	0.2	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	Dibromochloropropane				-		-		DW
EPA 524.2	Epichlorohydrin	0.8	1	ug/L	35-170	20	80-120		GW
EPA 524.2	Ethyl acrylate	0.4	1	ug/L	70-130	20	80-120		GW
EPA 524.2	Ethylbenzene	0.1	0.5	ug/L	70-130	20	80-120		DW

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
EPA 524.2	Ethylene dibromide (EDB)	0.1	0.2	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Methylene chloride	0.42	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	o-Dichlorobenzene	0.1	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	Styrene	0.2	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	Tetrachloroethylene	0.2	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Toluene	0.1	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	trans-1,2-Dichloroethylene	0.2	0.5	ug/L	70-130	20	80-120		DW
EPA 524.2	Trichloroethylene	0.1	0.5	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Vinyl chloride	0.2	0.2	ug/L	70-130	20	80-120		GW, DW
EPA 524.2	Xylenes (Total)	0.5	0.5	ug/L	-		-		DW
EPA 8260D	Benzyl chloride	0.5	1	ug/L	56-129	15	56-129	15	GW
EPA 8270D	Bis(chloromethyl) ether				-		-		GW
EPA 8270D	N-Nitrosodiphenylamine				-		-		GW
EPA 8270E	2-Methylaniline hydrochloride	4	10	ug/L	31-120	42	31-120	42	GW
EPA 8270E	3,3'-Dimethoxybenzidine				-		-		GW
EPA 8321	Ethylene thiourea	2	5	ug/L	70-130	30	70-130	30	GW
Synthetic / Semivolatile Organic Compounds									
EPA 1613B	2,3,7,8-TCDD (Dioxin)	3.71	10	pg/L	67-158	50	67-158	50	GW, DW
EPA 505	Chlordane	0.032	0.1	ug/L	65-135	20	70-130	20	GW, DW
EPA 505	PCBs	0.085	0.1	ug/L	65-135	20	70-130	20	GW, DW
EPA 505	Toxaphene	0.083	0.5	ug/L	65-135	20	70-130	20	GW, DW
EPA 515.3	2,4,6-Trichlorophenol	0.02	0.1	ug/L	70-130	40	80-120		GW
EPA 515.3	Pentachlorophenol	0.02	0.04	ug/L	70-130	29	80-120		DW
EPA 515.3	2,4,5-TP (Silvex)	0.03	0.1	ug/L	70-130	22	80-120		GW, DW
EPA 515.3	2,4-D	0.08	0.1	ug/L	70-130	41	80-120		GW, DW

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
EPA 515.3	Dalapon	0.5	1	ug/L	70-130	40	80-120		DW
EPA 515.3	Dinoseb	0.09	0.2	ug/L	70-130	24	80-120		DW
EPA 515.3	Picloram	0.04	0.1	ug/L	70-130	43	80-120		DW
EPA 525.2	Alachlor	0.024	0.05	ug/L	70-130	20	70-130	20	DW
EPA 525.2	Aldrin	0.01	0.01	ug/L	70-130	20	70-130	20	GW
EPA 525.2	Atrazine	0.013	0.05	ug/L	70-130	20	70-130	20	DW
EPA 525.2	Benzo(a)pyrene	0.004	0.02	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Bis(2-ethylhexyl) phthalate	0.19	0.6	ug/L	70-130	20	70-130	20	GW
EPA 525.2	Chlorthalonil	0.051	0.1	ug/L	70-130	20	70-130	20	GW
EPA 525.2	DDT (includes DDE and DDD)	0.041	0.1	ug/L	70-130	20	70-130	20	GW
EPA 525.2	Di(2-ethylhexyl) adipate	0.063	0.6	ug/L	70-130	20	70-130	20	DW
EPA 525.2	Di(2-ethylhexyl) phthalate	0.19	0.6	ug/L	70-130	20	70-130	20	DW
EPA 525.2	Dieldrin	0.007	0.01	ug/L	70-130	20	70-130	20	GW
EPA 525.2	Endrin	0.005	0.01	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Heptachlor	0.005	0.01	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Heptachlor epoxide	0.004	0.01	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Hexachlorobenzene	0.015	0.05	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Hexachlorocyclopentadiene	0.01	0.05	ug/L	70-130	20	70-130	20	DW
EPA 525.2	Lindane	0.003	0.01	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Methoxychlor	0.044	0.05	ug/L	70-130	20	70-130	20	GW, DW
EPA 525.2	Simazine	0.016	0.05	ug/L	70-130	20	70-130	20	DW
EPA 531.2	Aldicarb	0.16	0.5	ug/L	70-130	30	70-130	30	DW
EPA 531.2	Aldicarb sulfone	0.172	0.5	ug/L	70-130	30	70-130	30	DW
EPA 531.2	Aldicarb sulfoxide	0.142	0.5	ug/L	70-130	30	70-130	30	DW
EPA 531.2	Carbofuran	0.104	0.5	ug/L	70-130	30	70-130	30	DW
EPA 531.2	Oxamyl (Vydate)	0.173	0.5	ug/L	70-130	30	70-130	30	DW

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
EPA 547	Glyphosate	1.6	6	ug/L	80-120	20	80-120	20	DW
EPA 548.1	Endothall	2.65	5	ug/L	80.0-120	30	80-120	30	DW
EPA 549.2	Diquat	0.296	2	ug/L	-		-		DW
EPA 8081B	Hexachlorocyclohexane (technical)				-		-		GW
EPA 8141B	Dichlorvos	0.5	2	ug/L	52-120	24	52-120	24	GW
EPA 8270E	1,2-Diphenylhydrazine	4	10	ug/L	54-120	32	54-120	32	GW
EPA 8270E	2,4-Dinitrotoluene	4	10	ug/L	67-122	30	67-122	30	GW
EPA 8270E	2,6-Dinitrotoluene	4	10	ug/L	65-120	30	65-120	30	GW
EPA 8270E	3,3'-Dichlorobenzidine	10	30	ug/L	48-132	30	48-132	30	GW
EPA 8270E	Acrylamide	200	500	ug/L	10-120	100	10-120	100	GW
EPA 8270E	Aniline	4	10	ug/L	10-120	84	10-120	84	GW
EPA 8270E	Azobenzene	1	4	ug/L	54-120	32	54-120	32	GW
EPA 8270E	Benzidine	50	100	ug/L	5-120	100	5-120	100	GW
EPA 8270E	Carbazole	1	4	ug/L	66-123	30	66-123	30	GW
EPA 8270E	Diallate	5	20	ug/L	49-126	30	49-126	30	GW
EPA 8270E	N-Nitrosodiethylamine	4	10	ug/L	40-120	31	40-120	31	GW
EPA 8270E	N-Nitrosodimethylamine	4	10	ug/L	25-120	37	25-120	37	GW
EPA 8270E	N-Nitroso-di-n-butylamine	4	10	ug/L	52-139	32	52-139	32	GW
EPA 8270E	N-Nitroso-di-n-propylamine	4	10	ug/L	48-120	32	48-120	32	GW
EPA 8270E	N-Nitroso-N-methylethylamine	4	10	ug/L	34-120	37	34-120	37	GW
EPA 8270E	N-Nitrosopyrrolidine	4	10	ug/L	37-120	31	37-120	31	GW
EPA 8270E	o-Toluidine	4	10	ug/L	31-120	42	31-120	42	GW
EPA 8270E_SIM	1,4-Dioxane	0.036	0.2	ug/L	78-130	13	78-130	13	GW
EPA 8290A	Hexachlorodibenzo-p-dioxin, mix				-		-		GW

Analytical Method	Analyte	Method Detection Limit	Method Reporting Limit	Units	Matrix Spike (% Rec.)	Matrix Spike (RPD)	Blank Spike (LCS % Rec.)	Blank Spike (RPD)	Regulatory Authority[1]
SM 5540 C	Foaming Agents				-		-		GW
SM 5540 C	PAH				-		-		GW
Disinfection Byproducts									
EPA 300.1	Bromate				-		-		DW
EPA 300.1	Chlorite				-		-		DW
EPA 524.2	Total Trihalomethanes (TTHMs)	0.2	0.5	ug/L	70-130	20	80-120		DW
SM 6251B	Total Haloacetic Acids 5 (HAA5)	0.054	2	ug/L	-		-		DW
Disinfection Residuals									
SM 4500-Cl G	Chlorine (as Cl2)				-		-		DW
SM 4500-Cl G	Chloramines (as Cl2)				-		-		DW
SM 4500-ClO2 D	Chlorine dioxide (as ClO2)				-		-		DW
Radiological									
EPA 906.0	Tritium		500	pCi/L	60-140	25	75-125	25	GW
EPA 905.0	Strontium-90		3	pCi/L	60-140	25	75-125	25	GW
EPA 903.0	Radium-226		1	pCi/L	60-140	25	75-125	25	GW
SM 5540 C	Radium 226 & 228				-		-		GW, DW
PFAS									
EPA 537.1	HFPO-DA	1.0	2	ng/L	-		-		DW
EPA 537.1	PFBS	0.37	2	ng/L	-		-		DW
EPA 537.1	PFHxS	0.32	2	ng/L	-		-		DW
EPA 537.1	PFNA	0.4	2	ng/L	-		-		DW
EPA 537.1	PFOA	0.38	2	ng/L	-		-		DW
EPA 537.1	PFOS	0.43	2	ng/L	-		-		DW

Notes: Dup. = Duplicate Sample, RPD = relative percent difference, LCS = laboratory control sample, %Rec = percent recovered, Surr. = Surrogate; GW = WAC 173-200-040 Antidegradation standards; DW = WAC 246-290-310 Drinking water standards; mg/L = milligrams per liter; ug/L = micrograms per liter; ng/L = nanograms per liter; pCi/L = pico Curies per liter; CU = color units; SU = standard units (pH); TON = threshold odor units; mL = milliliters; umhos/cm = microOhms per centimeter

6.3 Acceptance Criteria for Quality of Existing Data

Acceptance criteria is updated to include existing data.

Water quality sampling conducted by the City at each of its groundwater wells complies with DOH drinking water source approved standards and procedures. Acceptance of the results by DOH is acceptable criteria under this study.

6.4 Model Quality Objectives

Model quality objectives are added to include geochemical modeling.

The potential for physiochemical changes (mineral dissolution and/or precipitation) to occur due to recharge operations will be evaluated from the data collected during the test by developing a PHREEQC thermodynamic geochemical equilibrium model (Parkurst et al., 1980) for the target aquifer. The model will consider changes in Saturation Indices (SIs) for the primary minerals found in the storage aquifer. A range of combinations for potential mineral assemblages will be evaluated by the model as part of a sensitivity analysis and quality evaluation (Section 13.4).

The qualitative quality objective for the modeling is that the SIs calculated for water quality at various stages of future testing shall agree with the trends predicted from water quality data collected prior to any pilot testing. The results of the model will be used to identify potential constituents and/or well performance trends to monitor during pilot testing. Model results will be compared to water quality measurements using graphical representation. Such visual comparisons are useful in evaluating model quality and uncertainty.

The model will evaluate potential changes in water quality that may occur due to mineral dissolution and precipitation. Predicted water quality constituent concentrations will be compared to measured water quality during pilot testing, if implemented. The rates of the predicted reactions will not be explicitly modeled (i.e., a kinetic geochemical model will not be developed for this project). Therefore, no quantitative quality objectives are set for a comparison of the geochemical modeling to observed water chemistry.

7.0 Study Design

7.2.1 Sampling Locations and Frequency

Sample location and frequency has been updated to include the following.

Water Quality Sampling Schedule

To characterize ambient water quality conditions in the target aquifer, water quality samples will be collected from during multiple sampling events detailed in Table 9 to assess spatial and temporal variability of water quality within the target aquifer. The analyte suite is described in Sections 3.2.3 and 6.2 and will be sampled according to the quality objectives described in Section 6. Following sampling, laboratory results will be evaluated to determine effectiveness of the chosen analyte lists. Select contaminants which have been shown to be non-detect in two or more samples will be submitted to Ecology for approval to be removed from subsequent sampling events. All samples for a sampling event will be collected within a 48 hour period.

Table 9. Water Quality Sampling and Groundwater Level Monitoring Schedule

Date	Sample Location	Sample Type	Analytical Suite	
			WAC 173-200-040	Dissolved Metals
February 2025	Well No. 1	Groundwater	✓	
	Well No. 3	Groundwater	✓	✓
	Well No. 4	Groundwater	✓	✓
March 2025	Well No. 3	Groundwater	✓	
	Well No. 4	Groundwater	✓	
April 2025	Well No. 1	Groundwater	✓	
	Well No. 3	Groundwater	✓	
	SMID Canal[1]	Surface Water	✓	✓

Notes:

Field parameters will be measured during every sampling event.

1.Collection of water from the SMID canal is subject to operational condition of the canal. If canal is not sufficiently operational during April, an alternative collection time or place may be proposed.

One field duplicate and data validation (DV) sample will be collected for every ten samples. The DV sample for a trip blank will include the VOC and general chemistry, as applicable based on analytical suite in table above.

7.3.2 Modeling and Analysis Design

The following section was added to address geochemical modeling.

Water quality modeling will be conducted using the PHREEQC geochemical software developed by the U.S. Geological Survey (USGS). The model simulations will incorporate water quality results for native groundwater in the target storage aquifer Ellensburg Aquifer) and from the source water (Yakima River via SMID Canal).

The PHREEQC model will evaluate the potential for common primary and secondary minerals to dissolve or precipitate based on the predicted chemistry of mixed waters and calculated mineral saturation indices. Mixed water chemistry will be predicted by the model based on water quality data collected for City Wells 1,3, and 4 and the SMID Canal as described in Section 7.2.1.

Geochemical modeling will begin by adding water from the potential sources to groundwater at assumed mixing ratios of 50/50 and 80/20 (source water / groundwater). The stored water will also be modeled in equilibrium with common alluvial/outwash aquifer minerals (based on LLNL equilibrium and speciation data for aqueous and mineral compounds) to simulate potential water quality impacts from interaction with the target aquifer. Following mixing, saturation indices (SIs) for common indurated sandstone minerals deemed to have potentially applicable reaction kinetics (i.e., with potential to react within the timeframe considered for storage) will be calculated to assess the potential for mineral precipitation or dissolution.

The results of the model will be used to identify potential constituents and/or well performance trends to monitor for during future pilot testing.

9.4 Laboratories Accredited for Methods

The following section is updated for substitution of the analytical laboratory.

Analysis of water quality samples will be performed by Eurofins at their Spokane, Washington office. Eurofins is accredited by Ecology for analysis of all parameters included in this project (see Appendix A).

Contact information for the laboratory is:
Eurofins Spokane
11922 East 1st Ave
Spokane, WA 99206

Project Manager: Randee Arrington
Phone: (509) 924-9200
Email: Randee.Arrington@et.eurofinsus.com

Bacteriological, nitrate, and nitrite analysis will be performed by LabTest of Yakima, Washington, to minimize holding times for analysis. LabTest is accredited by Ecology for these analyses (see Appendix A).

Contact information for the laboratory is:
LabTest
201 East D Street
Yakima, WA

Lab Supervisor: Giles Hamilton
Phone: 509-575-3999
Email: vws155@gmail.com

11.0 Data Management Procedures

11.5 Model Information Management

The following section was added to address geochemical modeling.

Modeling will be completed using the PHREEQC code and existing peer-reviewed geochemical databases (Section 6.4). Aspect will maintain the final version of the model files, including input, output, and executables, for archiving at the completion of the task. Electronic copies of the data and supporting documentation will be made available upon request. Aspect will maintain copies in a task subdirectory, subject to regular system backups, for a minimum period of 3 years after task termination, unless otherwise directed. Maintenance of computer resources will be conducted by Aspect's in-house computer specialists.

13.0 Data Verification

13.4 Model Quality Assessment

The following section is added to address geochemical modeling.

The geochemical model to be used in this project is a thermodynamic equilibrium model developed by the USGS. The model uses an existing database of mineral phase equilibria (Section 6.5) to evaluate the potential for reactions to occur without consideration for reaction kinetics. The model is intended to be used to "bookend" potential water quality changes that may occur through ASR and will be used primarily to identify potential trends to monitor for during pilot testing.

Quality assessment is defined as the process by which QC is implemented in the model development task. All modelers will conform to the following guidelines:

- All modeling activities including data interpretation are subject to audit or peer review. Thus, the modelers are instructed to maintain careful written and electronic records for all aspects of model development.
- If historical data are used, a written record on where the data were obtained and any information on their quality will be documented in the final report. A written record on where this information is on a computer or backup media will be maintained in the task files.
- If new theory is incorporated into the model framework, references for the theory and how it is implemented in any computer code will be documented and peer-reviewed.

Model results will be compared to water quality measured during the ASR pilot test, and to data obtained from other ASR projects operating in similar geologic settings (e.g., the City of Yakima ASR program). The model quality assessment will be entirely qualitative and will be discussed in the Feasibility Study Report and future reports on pilot testing.

A sensitivity analysis of input parameters and assumed mineral assemblages will be completed to assess the dependence of the geochemical model results on key input parameters. The resulting changes in mineral SI's will be assessed and discussed in the Feasibility Study Report.