CLASS VI INJECTION WELL: QUALITY ASSURANCE AND SURVEILLANCE PLAN

MAY 22, 2025

RUSSELL CO_2 CAPTURE AND SEQUESTRATION

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List of Abbreviations and Acronyms

ºC = Celsius
A = Composition
Ag = Silver
Al = Aluminum
AoR = area of review
API = American Petroleum Institute
ASTM = ASTM International
As = Arsenic
B = Boron
Ba = Barium
Br = Bromide
Ca = Calcium
$CaCO_3$ = Calcium carbonate
Cd = Cadmium
CERCLA = Comprehensive Environmental Response, Compensation, and

MIT = mechanical integrity test
mL = milliliter
Mg = Magnesium
mg/L = milligrams per liter
MMA = maximum monitoring area
Mn = Manganese
mol = mole
mS/cm = milli Siemens per centimeter
MS/MSD = matrix spikes/matrix spike duplicates
N_2 = Nitrogen
Na = Sodium
NACE = NACE International
NO_3 = Nitrate
NTU = nephelometric turbidity units
O_2 = Oxygen

Liability Act
CH_4 = Methane
Cl = Chloride
Cr = Chromium
CO_2 = carbon dioxide
CoC = chain of custody
Cu = Copper
δ13C of DIC = Ratio of two stable carbon isotopes in dissolved inorganic carbon
D = Density
ºF = Fahrenheit
F= Fluoride
Fe = Iron
Fl = Flow
ft = feet
ft bgs = feet below ground surface
GS = geologic sequestration
H_2S = Hydrogen sulfide
HCl = Hydrochloric acid
ICP-MS = Inductively coupled plasma mass spectrometry
ISBT = International Society of Beverage Technologists
K = Potassium
KGS = Kansas Geological Survey
LCS/LCSDs = laboratory control samples/laboratory control sample duplicates
L = liter
m = meter
meq/L = milliequivalent per liter
MDL = Method Detection Limit
NDVI = normalized difference vegetation index
P = Pressure
Pb = Lead
PCC = PureField Carbon Capture, LLC
ppm = parts per million
ppmv = parts per million by volume
QA = Quality Assurance
QASP = Quality Assurance and Surveillance Plan
QC = Quality Control
RCRA = Resource Conservation and Recovery Act
RPD = relative percent difference
RIH = run-in-hole
RL = reporting limit
Sb = Antimony
Se = Selenium
Si = Silicon
SiO_2 = Silicon dioxide
SM = Standard Method
SO_4 = Sulfate
SOP = standard operating procedure
T = Temperature
TDS = total dissolved solids
Tl = Thallium
µg/L = micrograms per liter
UIC = Underground Injection Control
USDW = Underground Source of Drinking Water
US EPA = United States Environmental Protection Agency
USGS ANSS = United States Geological Survey Advanced National Seismic System
V = Vanadium
X = Passive Seismic

TITLE AND APPROVAL SHEET

This Quality Assurance and Surveillance Plan (QASP) is approved for use and implementation at the Russell Carbon Dioxide (CO_2) Storage Complex. The signatures below denote the approval of this document and intent to abide by the procedures outlined within it.

Signature Aaron Buettner Chief Executive Officer PureField Carbon Capture, LLC (PCC)	Date
Signature Ben Meissner US EPA Region 7: Water Division Groundwater & Drinking Water Branch UIC Class VI Program – Project Manager	Date
Signature Diane E. Harris US EPA Region 7: Water Division Groundwater & Drinking Water Branch Regional Quality Assurance Manager	Date

DISTRIBUTION LIST

Individuals fulfilling the roles listed below will receive the completed QASP and all future updates for the duration of the project:

Chief Executive Officer
Vice President of Operations
Plant Manager
Operations Manager
Maintenance Manager
Quality Assurance Manager
Field Team Lead
Environmental Health and Safety Manager

The Personnel Contact List attachment provides names and contact information for the individuals currently fulfilling these roles. The Chief Executive Officer is currently:

Aaron Buettner, Chief Executive Officer
13632 W 95th Street
Lenexa, KS 66215
Phone: (785) 261-0355

The Personnel Contact List will be updated throughout the duration of the project.

The following EPA personnel will also receive the completed QASP and all future updates for the duration of the project:

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E.I.1. Project Management

E.I.1.1. Project/Task Organization

E.I.1.1.a/b. Key Individuals and Responsibilities

- Chief Executive Officer Overall project responsibility
- Vice President of Operations Overall responsibilities for the operations, maintenance, and environment, health, and safety aspects of the project
- Plant Manager Overall responsibilities for operations and maintenance
- Operations Manager Responsible for operations
- Maintenance Manager Responsible for maintenance
- Quality Assurance Manager Responsible for data quality and management. The Quality Assurance Manager reports to the Plant Manager and is independent of the Field Team Lead
- Field Team Lead Responsible for field sampling and analysis. The Field Team Lead reports to the Plant Manager and is independent of the Quality Assurance Manager
- Environmental Health and Safety Manager Responsible for environment, health, and safety

E.I.1.1.c. Independence from Project Quality Assurance (QA) Manager and Data Gathering

The Quality Assurance Manager and Field Team Lead for the project have independent responsibilities as shown in Figure E.I.1-1. The majority if not all of the physical samples collected and data gathered as part of the program are analyzed, processed, or witnessed by third parties with their own internal independent roles for Quality Assurance and Data Gathering.

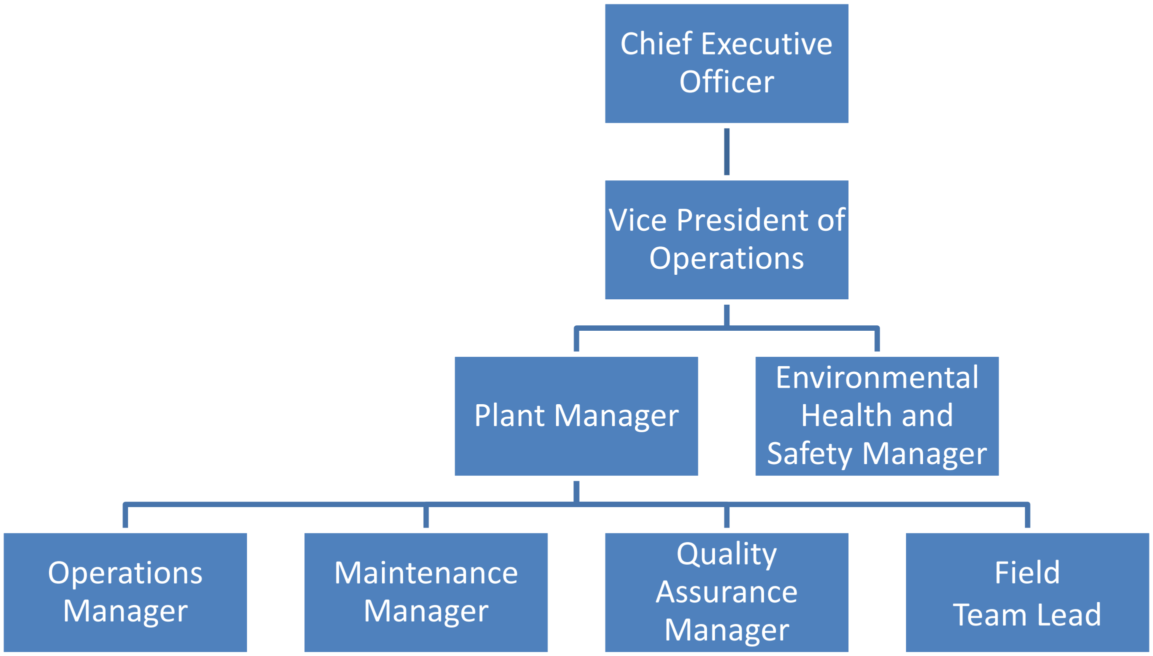
E.I.1.1.d. QA Project Plan Responsibility

PCC is responsible for maintaining and distributing the official, approved Quality Assurance Surveillance Plan (QASP). This QASP will be reviewed annually to ensure it remains current. Every five years the QASP will be updated and resubmitted to the US EPA for review and approval. PCC will be responsible for updating, reviewing, and distributing the QASP to all individuals on the Distribution List.

E.I.1.1.e. Organizational Chart for Key Project Personnel

Figure E.I.1-1 shows the organizational structure of the project.

Figure E.I.1-1. Organizational Structure of the Project



E.I.1.2. Problem Definition/Background

E.I.1.2.a. Reasoning

The project will inject 1,800,000 metric tons of CO_2 (i.e., up to 150,000 metric tons per year over a 12-year injection period) into a target subsurface interval in the Arbuckle Group for geologic sequestration (GS). Operational monitoring, verification, and accounting are required to confirm that the CO_2 is indeed fully sequestered in the target subsurface interval. Operational monitoring is used to ensure safety with the procedures associated with fluid injection, monitor the response of the geological storage unit, and the development of the CO_2 plume. Verification will provide information to confirm that leakage of CO_2 through the caprock is not occurring. Environmental monitoring will confirm that CO_2 is not being released into the shallow subsurface or biosphere.

E.I.1.2.b. Reasons for Initiating the Project

The project was initiated because of strong performance projections on the three foundational pillars of sustainability:

- Environmental: The project creates environmental benefits by reducing greenhouse gas emissions associated with the production and use of renewable liquid transportation fuel.
- Social: The project creates social benefits by strengthening employment in a rural community.
- Economic: The project creates financial benefits by enabling the production and sale of high value low-carbon liquid transportation fuel.

E.I.1.2.c. Regulatory Information, Applicable Criteria, Action Limits

Federal requirements for the US EPA UIC Program for CO_2 geologic sequestration wells are located in 40 CFR Parts 124, 144, 145, 146, and 147. The final rule establishing the Class VI well program was published by the US EPA in the Federal Register on December 10, 2010. The rule established minimum Federal requirements under the Safe Drinking Water Act for underground injection of CO_2 for the purpose of GS. The rule applies to owners or operators of wells that will be used to inject CO_2 into the subsurface for the purpose of long-term storage. It established a new class of well, Class VI, and sets minimum technical criteria for the permitting, geologic site characterization, area of review (AoR) and corrective action, financial responsibility, well construction, operation, mechanical integrity testing (MIT), monitoring, well plugging, post-injection site case, and site closure of Class VI wells for the purposes of protecting Underground Sources of Drinking Water (USDWs). The elements of the rulemaking are based on the existing UIC regulatory framework with modifications to address the unique nature of CO_2 injection for geologic sequestration. This QASP details the measurements which will be taken and the steps to ensure the quality of the data taken during the project is such that the data can be used confidently for rational decision making throughout the entire project duration.

E.I.1.3. Project/Task Description

E.I.1.3.a/b. Summary of Work to be Performed

Table E.I.1-1 describes the Testing and Monitoring tasks. Tables E.I.1-2 provides a summary of the instrumentation.

Table E.I.1-1. Summary of Testing and Monitoring

Activity	Location	Primary Method	Analytical Technique	Lab/Custody	Purpose
Internal Mechanical Integrity Testing	CSS #1	Monitoring of Operational Parameters	Direct Measurement	Not Applicable	Wellbore Integrity
External Mechanical Integrity Testing	CSS #1, MW #1	Oxygen Activation Log, Temperature Log, or Noise Log	Wireline Logging, or DTS	Not Applicable	Wellbore Integrity
Analysis of CO_2 Stream	CSS #1	Direct Sampling	Laboratory Analysis	Qualified Laboratory	Monitor Injectate
Monitoring of Operational Parameters	CSS #1	Online Instruments	Direct Measurement	Not Applicable	Compliance with Permit Conditions
Corrosion Monitoring	CSS #1	Coupon Testing	Direct Measurement	Qualified Laboratory	Wellbore Integrity
Pressure Fall-Off Testing	CSS #1	Pressure Measurement During Well Shut-in	Data Plots for Reservoir Properties	Not Applicable	Reservoir Integrity (Near Wellbore)
Groundwater Quality	MMA	Online Instruments w/ Telemetry	Direct Measurement	Not Applicable	Verify Containment
Geochemical Monitoring	MMA	Direct Sampling	Laboratory Analysis	Qualified Laboratory	Verify Containment
Plume Tracking (Direct)	MW #1	Direct Sampling	Laboratory Analysis	Qualified Laboratory	Plume Tracking
Plume Tracking (Indirect)	MMA	Time-lapse Surface Seismic Surveys	Measurements of Source Reflections	Not Applicable	Plume Tracking
Pressure Front Tracking (Direct)	CSS #1, MW #1	Bottom-hole Pressure Measurements	Direct Measurement	Not Applicable	Pressure Front Tracking
Pressure Front Tracking (Indirect)	MMA	Passive Seismic Array	Track micro-seismic events	Not Applicable	Pressure Front Tracking

Activity	Location	Primary Method	Analytical Technique	Lab/Custody	Purpose
Soil Gas Monitoring	MMA	Online Instruments w/ Telemetry	Direct Measurement	Not Applicable	Verify Containment
	MMA	Direct Sampling	Chemical Analysis	Qualified Laboratory	Verify Containment
	MMA	CO_2 Efflux Measurements	Direct Measurement	Not Applicable	Verify Containment
Ecosystem Stress Monitoring	MMA	Remote Sensing (Satellite-based & field verified)	Multispectral vegetative indices	Not Applicable	Verify Containment
Surface CO_2 Monitoring	CSS #1, MW #1	Air Sampling	Spectroscopy	Not Applicable	Verify Containment
Seismic Monitoring	MMA	Continuous Monitoring of Networks	Not Applicable	Not Applicable	Reservoir Integrity (Overall)

Table E.I.1-2. Instrumentation Summary

Monitoring Location	Instrument Types(1)	Monitoring Target (Formation or Other)	Data Collection Location	Explanation
Injectate Monitoring Station	P, T, Fl, D, A	Injectate Stream	Pipeline, Proximate to CSS #1	Compliance with Permit Conditions
CSS #1	P, T	Injection Tubing	Downhole, Surface	Monitoring of Operational Parameters
	P, T, Fl	Annulus System	Downhole, Surface	Compliance with Permit Conditions
	A	Surface Air	Wellhead	Verify Containment
MW #1	P, T	Surface, Subsurface	Downhole, Surface	Verify Containment
	A	Surface Air	Wellhead	Verify Containment
MS-1 through MS-6	A	Upper and Lower Vadose Zones	Soil Gas Monitoring Wells	Verify Containment
	P, T, A	Water Table and Lowermost USDW	Groundwater Monitoring Wells	Verify Containment
	A	Surface Air	Closed Chamber Soil Collars	Verify Containment
MS-1 through MS-10 (except MS-4)	X	All Subsurface Formations	Seismometer Wells	Reservoir Integrity

(1) Key: P = Pressure, T = Temperature, Fl = Flow, D = Density, A = Composition, X = Passive Seismic

E.I.1.3.c. Geographic Locations

Figure E.I.1-2 is a map illustrating geographic locations for the overall project including the surface equipment, transport pipeline, and the GS site. Figure E.I.1-3 is a map illustrating geographic locations for the various components of the overall GS site.

Figure E.I.1-2. Overall Project Map

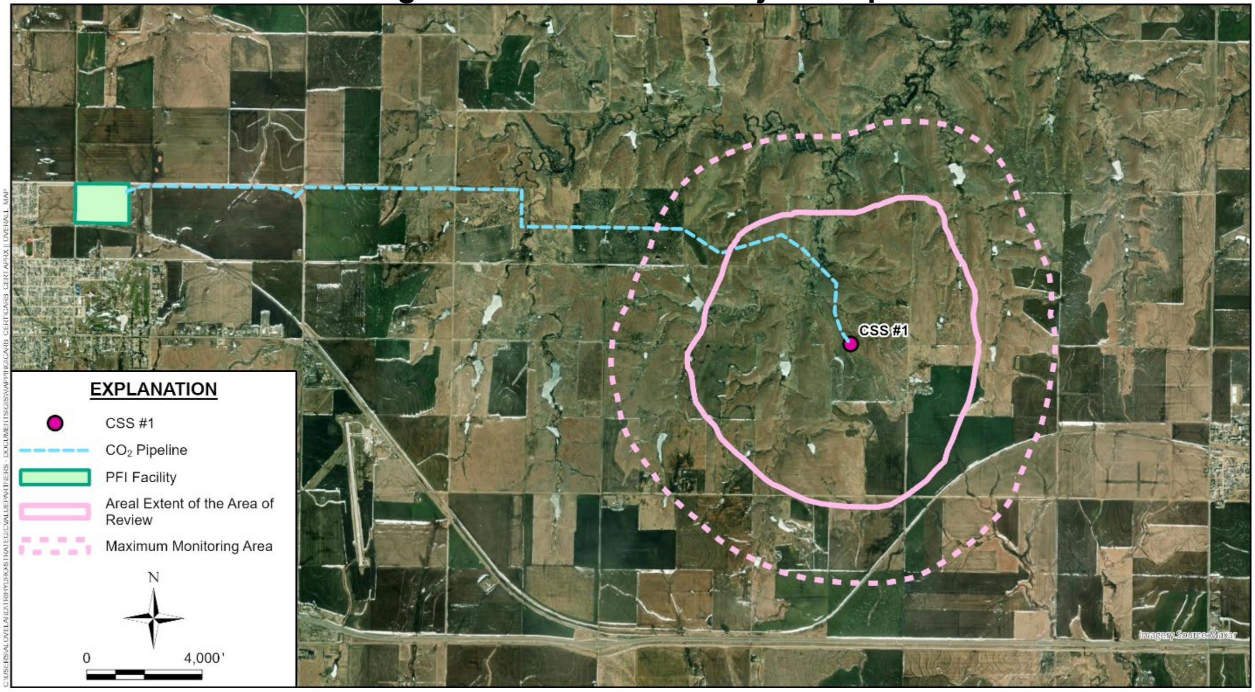
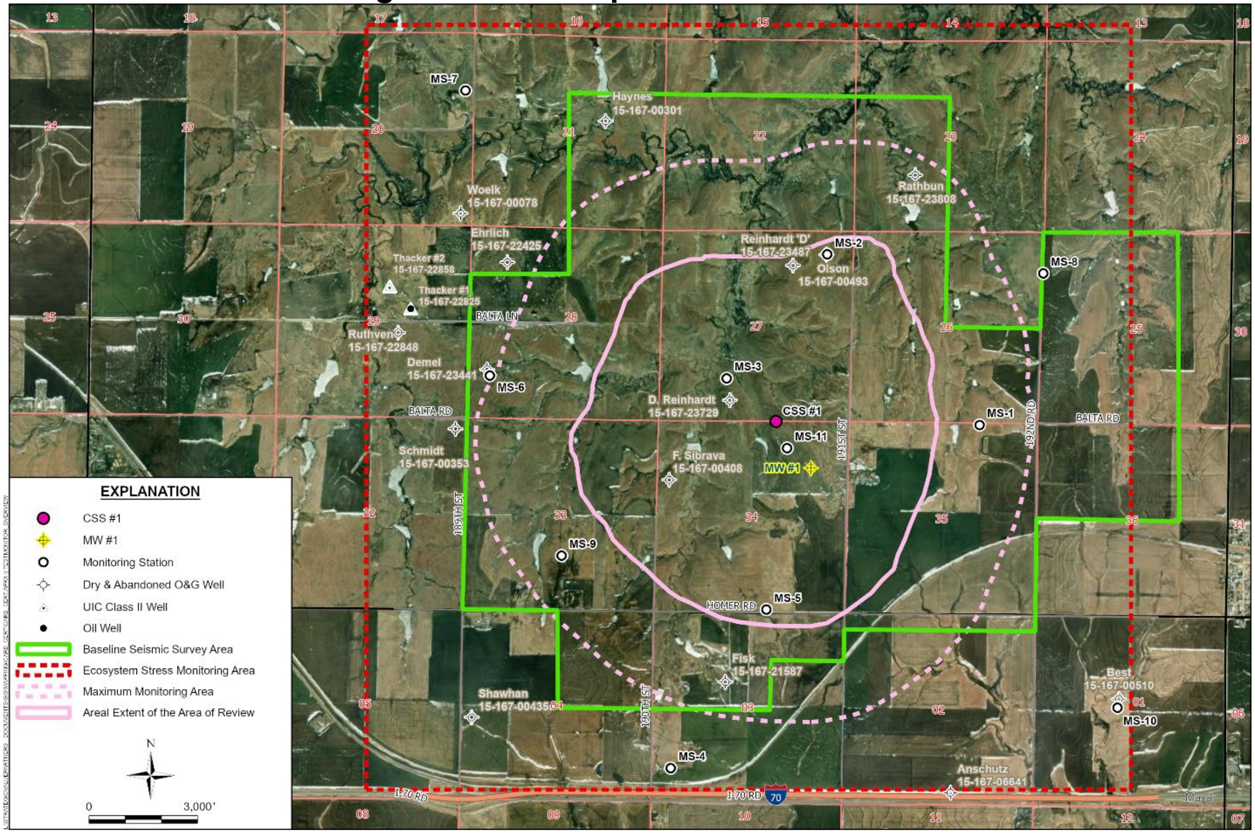


Figure E.I.1-3. Map of Overall GS Site



E.I.1.3.d. Resource and Time Constraints

There are no access constraints for the injection and monitoring infrastructure over the planned timeframe of the project. In addition, the monitoring infrastructure was installed so as to be accessible in expected weather conditions (e.g., wind, precipitation, the range of low and high temperatures for the area). The one exception is CO_2 efflux measurements. These are conducted at ground surface with soil collars that have stickup heights of only a few inches. Under heavy snow conditions, the collars could be buried and inaccessible. In addition, CO_2 efflux measurements are most viable in dry weather conditions. If the surface soil is very moist or saturated, CO_2 transport is limited and the efflux signal can be dampened. For these reasons, there may be sample events during which CO_2 efflux measurements are not possible. This is addressed in the sampling design by having multiple stations for monitoring, including a background location. It will be possible to compare results across stations, rather than only focusing on results over time at a given station. If a sample event is missed due to weather, this will not significantly impact the ability to evaluate the results.

E.I.1.4. Quality Objectives and Criteria

E.I.1.4.a. Performance/Measurement Criteria

The overall quality assurance objective for monitoring is to develop and implement procedures for subsurface monitoring, field sampling, laboratory analysis, and reporting which will provide results that will meet the characterization and non-endangerment goals of this project. Tables E.I.1-3 through E.I.1-7 list analytes and parameters to be monitored. The list of analytes and parameters may be reassessed periodically and adjusted to include or exclude components based on their effectiveness to the overall monitoring program goals. The methodologies will be verified at each External QASP Assessment.

Table E.I.1-3. Summary of Analytical and Field Parameters for All Above Confining Zone Fluid Samples

Parameters	Analytical Methods[1,2]	Detection Limit/Range	Typical Precisions	QC Requirements
Cations: Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb, Se, and Tl	ICP-MS EPA Method 6020	Al: 50 μg/L Ba: 1 μg/L Mn: 1 μg/L As: 1 μg/L Cd: 0.50 μg/L Cr: 1 μg/L Cu: 1 μg/L Pb: 1 μg/L Sb: 1 μg/L Se: 1 μg/L Tl: 1 μg/L	Al: ±1 μg/L Ba: ±0.1 μg/L Mn: ±0.1 μg/L As: ±0.1 μg/L Cd: ±0.01 μg/L Cr: ±0.1 μg/L Cu: ±0.1 μg/L Pb: ±0.1 μg/L Sb: ±0.1 μg/L Se: ±0.1 μg/L Tl: ±0.1 μg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Cations: Ca, Fe, Mg, Na, K, and Si	ICP EPA Method 6010D	Ca: 200 μg/L Fe: 50 μg/L K: 500 μg/L Mg: 50 μg/L Na: 500 μg/L Si: 500 μg/L	Ca: ±100 μg/L Fe: ±1 μg/L K: ±100 μg/L Mg: ±100 μg/L Na: ±50 μg/L Si: ±10 μg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Anions: Br, Cl, F, NO_3, and SO_4	Ion Chromatography EPA Method 300.0	Br: 1 mg/L Cl: 1 mg/L F: 0.2 mg/L NO_3: 0.1 mg/L SO_4: 1 mg/L	Br: ±0.1 mg/L Cl: ±0.1 mg/L F: ±0.01 mg/L NO_3: ±0.01 mg/L SO_4: ±0.1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Isotopes: $\delta^{13}C$ of DIC	Isotope ratio mass spectrometry (3)	Not applicable	0.20 ‰	Lab Duplicates
Total Dissolved Solids	SM 2540C	10 mg/L	±1 mg/L	Method Blank Lab Control Sample Sample Duplicate

Parameters	Analytical Methods[1,2]	Detection Limit/Range	Typical Precisions	QC Requirements
Alkalinity, Total (as $CaCO_3$)	SM 2320B	20 mg/L	±1 mg/L	Method Blank Lab Control Sample Sample Duplicate
Alkalinity, Carbonate (as $CaCO_3$)	SM 2320B	20 mg/L	±1 mg/L	Method Blank Lab Control Sample Sample Duplicate
pH (field)	Field Meter	0 to 14 pH units	±0.2 pH units	Equipment calibration performed in the field per manufacturer recommendation
Dissolved CO_2 (field)	Field Meter	0 to 1,000 ppm	±0.5%	Recalibration every 12 – 18 months with equipment manufacturer or calibration check with known CO_2 calibration gas
Dissolved Oxygen (field)	Field Meter	0 to 500% air saturation or 0 to 50 mg/L	For 0 to 200% air saturation: ±2% of the reading or ±2% air saturation, whichever is greater. For 200 to 500% air saturation, ±6% of the reading.	Equipment calibration performed in the field per manufacturer recommendation

Parameters	Analytical Methods(1,2)	Detection Limit/Range	Typical Precisions	QC Requirements
Turbidity (field)	Field Meter	0 to 1,000 NTU	For 0 to 49.99 NTU: ±5% of the reading or 0.5 NTU, whichever is greater. For 50 to 1,000 NTU: ±5% of the reading or 5 NTU, whichever is greater.	Equipment calibration performed in the field per manufacturer recommendation
Specific conductance (field)	Field Meter	0 to 200 mS/cm	±0.5% of the reading or +0.001 mS/cm, whichever is greater	Equipment calibration performed in the field per manufacturer recommendation
Temperature (field)	Field Meter	-5 to 45 ^{o}C	±0.15 ^{o}C	Equipment calibration performed in the field per manufacturer recommendation
Depth to water (field)	Field Meter	0 to 300 m	±0.01 ft	Not Applicable

Parameters	Analytical Methods(1,2)	Detection Limit/Range	Typical Precisions	QC Requirements
Water pressure/depth, temperature, and conductivity/salinity (field)	Field Meter (continuous measurements)	Water pressure: 0 to 50 m water (DI282 model for shallower wells) and 0 to 100 m water (DI283 model for deeper wells) Temperature: -20 to 80 °C Conductivity: 0 to 300 mS/cm	Water pressure: ±2.5 m- on DI282 and ±5 m on DI283 Temperature: ±0.2 °C Conductivity: ±2% of reading	Field calibrated every 2 years.

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director

Note 2: All chemical analyses will be performed by a certified laboratory under the Environmental Laboratory Approval Program protocols; field measurements will be recorded by a qualified professional

Note 3: Gas evaluation technique by Atekwana and Krishnamurthy 1998, with modifications made by Hackley et al. 2007

°C = Celsius
Al = Aluminum
As = Arsenic
Ba = Barium
Br = Bromide
Ca = Calcium
$CaCO_3$ = Calcium carbonate
Cd = Cadmium
Cl = Chloride
Cr = Chromium
Cu = Copper
δ13C of DIC = ratio of two stable carbon isotopes in dissolved inorganic carbon

F = Fluoride
Fe = Iron
ft = feet
ICP-MS = Inductively coupled plasma mass spectrometry
K = Potassium
m = meter
Mg = Magnesium
mg/L = milligrams per liter
Mn = Manganese
mS/cm = milli Siemens per centimeter
Na = Sodium
NO_3 = Nitrate

NTU = nephelometric turbidity units
Pb = Lead
ppm = parts per million
QC = Quality Control
Sb = Antimony
Se = Selenium
Si = Silicon
SM = Standard Method
SO_4 = Sulfate
Tl = Thallium
µg/L = micrograms per liter

Table E.I.1-4. Summary of Analytical and Field Parameters for: MW #1 Injection Zone Fluid Samples, and Samples Collected During Drilling of CSS #1 and MW #1

Parameters	Analytical Methods(1,2)	Detection Limit/Range	Typical Precisions	QC Requirements
Cations: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Ni, K, Se, SiO_2, Si, Ag, Na, Sr, V, Zn	ICP EPA Method 6010C	Al: 50 μg/L	Al: ±1 μg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
		Sb: 1 μg/L	Sb: ±0.1 μg/L	
		As: 1 μg/L	As: ±0.1 μg/L	
		Ba: 1 μg/L	Ba: ±0.1 μg/L	
		Be: 1 μg/L	Be: ±0.1 μg/L	
		B: 100 μg/L	Be: ±10 μg/L	
		Cd: 0.50 μg/L	Cd: ±0.01 μg/L	
		Ca: 200 μg/L	Ca: ±100 μg/L	
		Cr: 1 μg/L	Cr: ±0.1 μg/L	
		Co: 5 μg/L	Co: ±0.5 μg/L	
		Cu: 1 μg/L	Cu: ±0.1 μg/L	
		Fe: 50 μg/L	Fe: ±1 μg/L	
		Pb: 1 μg/L	Pb: ±0.1 μg/L	
		Li: 10 μg/L	Li: ±0.1 μg/L	
		Mg: 50 μg/L	Mg: ±100 μg/L	
		Mn: 1 μg/L	Mn: ±0.1 μg/L	
		Ni: 5 μg/L	Ni: ±0.5 μg/L	
		K: 500 μg/L	K: ±100 μg/L	
		Se: 1 μg/L	Se: ±0.1 μg/L	
		SiO_2: 1070 μg/L	SiO_2: ±100 μg/L	
		Si: 500 μg/L	Si: ±10 μg/L	
		Ag: 70 μg/L	Ag: ±7 μg/L	
		Na: 500 μg/L	Na: ±50 μg/L	
		Sr: 10 μg/L	Sr: ±1 μg/L	
		V: 10 μg/L	V: ±1 μg/L	
		Zn: 50 μg/L	Zn: ±5 μg/L	

Parameters	Analytical Methods(1,2)	Detection Limit/Range	Typical Precisions	QC Requirements
Anions:(3) Br, Cl, F, NO_3, and SO_4	Ion Chromatography EPA Method 300.0	Br: 1 mg/L Cl: 1 mg/L F: 0.2 mg/L NO_3: 0.1 mg/L Nitrite: 0.1 mg/L SO_4: 1 mg/L	Br: ±0.1 mg/L Cl: ±0.1 mg/L F: ±0.01 mg/L NO_3: ±0.01 mg/L Nitrite: ±0.01 mg/L SO_4: ±0.1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Ammonia, as Nitrogen	EPA 350.1	0.1 mg/L	±0.1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Sodium Adsorption Ratio (SAR)	EPA 6010C	Not applicable	Not applicable	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Mercury	EPA 7470A	0.2 µg/L	±0.02 µg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Phenol	EPA 8270C	9.6 µg/L	±0.1 µg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate

Parameters	Analytical Methods[1,2]	Detection Limit/Range	Typical Precisions	QC Requirements
Oil and grease	EPA 1664B	4.8 mg/L	±0.5 µg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Ferric and Ferrous Iron	SM 3500- Fe B-2011	Ferric iron: 0.05 mg/L Ferrous iron: 0.2 mg/L	Ferric iron: ±0.005 mg/L Ferrous iron: ±0.02 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Total Dissolved Solids	SM 2540 C-2020	10 mg/L	±1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Alkalinity, Total (as $CaCO_3$)	SM 2320 B-2021	20 mg/L	±1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
pH	SM 4500- H+ B-2021	0 to 14 pH units	±0.1 pH units	Per method
Total sulfide and sulfide as H_2S	SM 4500- F-2021	Total sulfide: 0.05 mg/L Sulfide as H_2S: 1 mg/L	Total sulfide: ±0.005 mg/L Sulfide as H_2S: ±0.1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate

Parameters	Analytical Methods(1,2)	Detection Limit/Range	Typical Precisions	QC Requirements
Total CO_2	SM 4500-CO_2 D-2018	20 mg/L	±2 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Cyanide	SM 4500- CN E-2021	0.005 mg/L	±0.0005 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate
Total organic carbon	SM 5310C-2014	1 mg/L	±0.1 mg/L	Method Blank Lab Control Sample Matrix Spike/Matrix Spike Duplicate

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director

Note 2: All chemical analyses will be performed by a certified laboratory under the Environmental Laboratory Approval Program protocols; field measurements will be recorded by a qualified professional

Note 3: Suitable and sufficient parameters will be analyzed to prepare a complete cation/anion balance evaluation.

Ag = Silver
B = Boron
H_2S = Hydrogen sulfide
SiO_2 = Silicon dioxide
V = Vanadium

Table E.I.1-5. Summary of Analytical Parameters for CO_2 Stream

Parameters	Analytical Methods(1)	Detection Limit/Range	Typical Precisions	QC Requirements
Carbon Dioxide	ASTM D1946	0.03 mol %	Repeatability: 0.5 Reproducibility: 1.0	Per Analytical Method
	ASTM D1945	0.01 mol %	Repeatability: 0.10 Reproducibility: 0.15	Per Analytical Method
	GPA 2261	0.02 mol %	Repeatability: $0.0042x^{1/3}$ Reproducibility: $0.12x^{1/3}$	Per Analytical Method
	GPA 2177	0.02 mol %	Repeatability: $0.0210x^{3/8}$ Reproducibility: $0.1018x^{2/5}$	Per Analytical Method
	ASTM E1747	Per Laboratory	Per Laboratory	Per Analytical Method
	EPA Method 3/3C	0.2 mol %	Per Laboratory	Per Analytical Method
	ISBT 2.0	99.0 mol %	0.05%	Per Analytical Method
Nitrogen	ASTM D1946	0.03 mol %	Repeatability: 0.05 Reproducibility: 0.1	Per Analytical Method
	ASTM D1945	0.01 mol %	Repeatability: 0.01 Reproducibility: 0.02	Per Analytical Method
	GPA 2261	0.02 mol %	Repeatability: $0.039x^{1/4}$ Reproducibility: $0.158x^{1/2}$	Per Analytical Method
	GPA 2177	0.02 mol %	Repeatability: $0.0431x^{1/2}$ Reproducibility: $0.0962x^{1/2}$	Per Analytical Method
	EPA Method 3/3C	Per Laboratory	Per Laboratory	Per Analytical Method
	ISBT 4.0	Not Stated	Not Stated	Per Analytical Method

Parameters	Analytical Methods[(1)]	Detection Limit/Range	Typical Precisions	QC Requirements
Oxygen	ASTM D1946	0.03 mol %	Repeatability: 0.05 Reproducibility: 0.1	Per Analytical Method
	ASTM D1945	0.01 mol %	Repeatability: 0.01 Reproducibility: 0.02	Per Analytical Method
	GPA 2261	Not Stated	Not Stated	Per Analytical Method
	ASTM E1747	5 ppm	Per Laboratory	Per Analytical Method
	EPA Method 3/3C	0.2 mol %	Per Laboratory	Per Analytical Method
	ISBT 4.0	0 - 100 ppmv	5-10%	Per Analytical Method
Isotopes: $\delta^{13}C$ of DIC	Isotope ratio mass spectrometry[(2)]	Not applicable	0.30 ‰	Lab Duplicates

Note 1: References for CO_2, N_2, and O_2 analytical methods provided below. An equivalent method may be employed with the prior approval of the UIC Program Director.

ASTM D1946: Current version is ASTM D1946-90(2019) available at https://www.astm.org/d1946-90r19.html
ASTM D1945: Current version is ASTM D1945-14(2019) available at https://www.astm.org/d1945-14r19.html
GPA 2261: Current version is GPA 2261-20 available at https://my.midstreamassociation.org/publications-store/publications
GPA 2177: Current version is GPA 2177-20 available at https://my.midstreamassociation.org/publications-store/publications
ASTM E1747: Current version is ASTM E1747-95(2019) available at https://www.astm.org/e1747-95r19.html
EPA Method 3/3C: Available at https://www.epa.gov/emc/method-3c-carbon-dioxide-methane-nitrogen-and-oxygen-concentrations-thermal-conductivity
ISBT 2.0: Available at www.isbt.com
ISBT 4.0: Available at www.isbt.com

Note 2: Gas evaluation technique by Atekwana and Krishnamurthy 1998, with modifications made by Hackley et al. 2007

ASTM = ASTM International
ISBT = International Society of Beverage Technologists
mol = mole
ppmv = parts per million by volume

Table E.I.1-6. Summary of Analytical Parameters for Corrosion Coupons

Parameters	Analytical Methods(1)	Detection Limit/Range	Typical Precisions	QC Requirements
Mass	NACE SP0775-2018-SC	± 0.1 mg	Not Stated	Per Laboratory
Thickness	NACE SP0775-2018-SC	Not Stated	Not Stated	Per Laboratory

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director
NACE = NACE International

Table E.I.1-7. Summary of Analytical and Field Parameters for Soil Gas Samples

Sample Type	Parameters	Analytical Methods(1)	Detection Limit/Range	Typical Precisions	QC Requirements
Soil Gas/Vapor	CO_2, O_2, CH_4, and N_2 in shallow soil gas	Gas Chromatograph	CO_2: 0.005 to 100% O_2: 0.01 to 20.9% CH_4: 0.0002 to 100% N_2: 0.01 to 100%	CO_2: 0.005 to 100% O_2: 0.01 to 20.9% CH_4: 0.0002 to 100% N_2: 0.01 to 100%	Start of Day run is a standard. Run 5 samples, 6th run is a standard - repeat until End of Day. Each standard is evaluated when ran; air runs or additional standard runs to clear GC as necessary
	CO_2, O_2, and CH_4 in shallow soil gas	Field meter (to confirm stabilization of sample prior to collection)	CO_2: 0 to 100% O_2: 0 to 25% CH_4: 0 to 100%	CO_2 For 0 to 5%: ±0.3% For 5 to 60%: ±0.5% For 60 to 100%: ±1.5% of reading O_2: ±1.0% of the reading CH_4 For 0 to 5%: ±0.3% For 5 to 70%: ±0.5% For 70 to 100%: ±1.5% of reading	3-gas (CO_2, O_2, CH_4) calibration prior to start of field sampling event
Soil Gas/Vapor	CO_2 in shallow soil gas	Field sensor (continuous measurements)	0 to 10,000 ppm	0 to 3,000 ppm: ±40 ppm 3,000 to 10,000 ppm: ±2% of reading 10,000 to 30,000 ppm: ±3.5% of reading	Field calibrated every 2 years using two mixtures (100% N_2: 0% CO_2 and 99% N_2: 1% CO_2)
	Isotopes: $\delta^{13}C$ of CO_2	SRI 8610C	Reportable at CO_2 concentrations greater than 2,300 ppm	+/-0.10 ‰	Start of Day run is a standard. Run 5 samples, 6th run is a standard - repeat until End of Day. Each standard is evaluated when ran; air runs or additional standard runs to clear GC as necessary

Sample Type	Parameters	Analytical Methods(1)	Detection Limit/Range	Typical Precisions	QC Requirements
CO_2 Efflux	CO_2 accumulation in dynamic closed chamber at ground surface, corrected for gas water content, converted to CO_2 efflux	Field instrument	CO_2 concentration: 0 to 20,000 ppm H_2O concentration: 0 to 60 mmol mol-1	CO_2 concentration: ±1.5% of reading H_2O concentration: ±1.5% of reading	Per method

Note 1: An equivalent method may be employed with the prior approval of the UIC Program Director.

CH_4 = Methane

N_2 = Nitrogen

O_2 = Oxygen

Table E.I.1-8. Summary of Measurement Parameters for Field Gauges

Parameters	Analytical Methods[1]	Detection Limit/Range	Typical Precisions	QC Requirements
Pressure Field Gauge Specifications – PT-0501A Pipeline Supply Pressure	ISO.10474:2013/EN10204:2004 (calibration certs)	+/- 0.001 psi (0-4000 psi)	+/- 0.04% of Span (Ref Accuracy)	Annual Calibration of Scale (3rd Party) - maximum of 5 years stability
Temperature Field Gauge Specifications – TE-0501 Pipeline Supply Temperature	ISO.10474 3.1/EN1020 3.1 (calibration certs)	+/- 0.001 °F (Customized Range from Factory)	+/- 0.1 °C + 0.02% of Span	Annual Calibration of Scale (3rd Party) - for 1 yr Thermocouples and 2 yr RTD
Pressure Field Gauge Specifications – PT-0503 CSS #1 Wellhead Pressure	ANSI Z540-I-1994- or equivalent	0-5000 psi	+/-0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors	In accordance with MFG specifications
Pressure Field Gauge Specifications – PT-0504 CSS #1 Annulus Pressure	ANSI Z540-I-1994- or equivalent	0-5000 psi	+/-0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors	In accordance with MFG specifications
Temperature Field Gauge Specifications – CSS #1 Wellhead Temperature	ANSI Z540-I-1994- or equivalent	-50 °F to 750 °F (-50 °C to 400 °C)	±0.06% (±0.15 °C) at 0 °C, Class A	In accordance with MFG specifications

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director.

Table E.I.1-9. Summary of Measurement Parameters for Ecosystem Stress Monitoring

Parameters	Analytical Methods	Detection Limit/Range	Typical Precisions	QC Requirements
Broadband multispectral vegetative indices (VIs) from remote sensing Sentinel -2 satellite	NDVI and other potentially relevant VIs	Sentinel-2 satellite imagery data 10m (~33 ft) pixel resolution	Sentinel-2 provides higher quality data than older satellites	Includes field verification and follows routine remote sensing protocols

Table E.I.1-10. Summary of Analytical and Field Parameters for Surface CO_2 Monitoring

Parameters	Analytical Methods$^{(1)}$	Detection Limit/Range	Typical Precisions	QC Requirements
N_2O, CO_2 in surface/atmospheric gas	MIRA Ultra N2O/CO2 High Accuracy Analyzer (mid-infrared region laser analyzer)	N_2O: 2 ppb to 500 ppm CO_2: 10 ppm to 10%	N_2O: <2 ppt/s CO_2: <200 ppb/s	Per manufacturer instructions
CO_2, O_2, and CH_4 with LANDTEC GEM 2000™[2]	Field meter – portable gas analyzer	CO_2: 0 to 100% (vol.) O_2: 0 to 25% (vol.) CH_4: 0 to 100% (vol.)	CO_2 For 0 to 5%: ±0.3% For 5 to 60%: ±0.5% For 60 to 100%: ±1.5% of the reading O_2: ±1.0% of the reading CH_4 For 0 to 5%: ±0.3% For 5 to 70%: ±0.5% For 70 to 100%: ±1.5% of the reading	Per manufacturer instructions

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director.
Note 2: LANDTEC and GEM are US trademarks owned by LANDTEC North America – A QED Company.

Table E.I.1-11. Summary of Measurement Parameters for Passive Seismic Sensors

Parameters	Analytical Methods[(1)]	Detection Limit/Range	Typical Precisions	QC Requirements
Micro-Seismicity	ANSI Z540-I-1994- or equivalent	1500 V/m/sec (optional different sensitivity can be set under request	Wide response 10sec-98Hz	In accordance with MFG specifications

Note 1: An equivalent method may be employed with the prior approval of the US EPA UIC Program Director.

Table E.I.1-12. Actionable Testing and Monitoring Outputs

Activity or Parameter	Project Action Limit	Detection Limit	Anticipated Reading
PT-0505 CSS #1 Downhole Pressure	2,133 psig (max) 2,147 psia (max)	See Table E.I.1-13	< 2,123 psig < 2,147 psia
PT-0504 less PT-0503, CSS #1 Annulus Pressure Differential	100 psi (min)	See Tables E.I.1-16 and E.I.1-17	< 100 psi
CSS #1 Internal or External MIT	Test results shows presence of an anomaly	Dependent upon test method	No Anomaly
MW #1 External MIT	Test results shows presence of an anomaly	Dependent upon test method	No Anomaly
Seismic Event	Verified triggering event within 24 hr with either ≥ 3.5 M_L or SAS ≥ 17	< 2.0 M_L	Below Detection Limit

SAS = Seismic Action Score

E.I.1.4.b. Precision

Precision is the measure of agreement, or reproducibility, between duplicate or replicate measurements taken under a given set of conditions. The level of agreement is measured as relative percent difference (RPD), which is a quantitative measure of group variability compared to group average.

Field duplicates will be collected to evaluate field precision. Field duplicate samples will be analyzed for each constituent analyzed in field samples, providing precision data for each analyte, and indicating the presence of possible contaminants. The goal for precision with respect to acceptable levels of variability in field samples and their duplicates is less than 30% RPD for groundwater samples, less than 50% RPD for soil samples, and less than 25% RPD for air samples. Field duplicates will be collected at a rate of 1 field duplicate sample per 10 field samples (10%).

Laboratory precision will be evaluated using RPDs calculated from the analyses of laboratory control samples/laboratory control sample duplicates (LCS/LCSD), matrix spikes/matrix spike duplicates (MS/MSD), and laboratory duplicates. These QC samples will be collected at a rate of at least 1 per 20 field samples (5%). These QC samples are analytical method-specific, and their performance criteria are specified in the methods, the laboratory standard operating procedure (SOP), and/or the US EPA data review and data validation guidance documents.

E.I.1.4.c. Bias

Bias, measured by accuracy, is the measure of agreement between a laboratory measurement and a known/standard value. It is measured through a variety of QC samples that undergo analyses at the laboratory. Key accuracy indicators include LCS/LCSDs, MS/MSDs, internal standards, laboratory blanks, and surrogates.

The performance of accuracy with respect to laboratory analyses will be detailed in the individual data validation reports. A summation of project accuracy will be provided in the investigation report.

Each laboratory will be responsible for the assessment of analytical accuracy as required by their SOPs and analytical methodologies. Direct pressure and logging measurements do not include assessments of accuracy.

E.I.1.4.d. Representativeness

Representativeness is defined as the degree to which sample data represent the population being examined. Representativeness is a qualitative parameter and is dependent on the design of the investigation and proper laboratory protocol. The sampling design as described in the work plan is proposed to address collection of samples that are representative of the facility.

E.I.1.4.e. Completeness

Completeness is defined as the number of valid sample results obtained compared to the total number of results expected. Samples scheduled within the Testing and Monitoring Plan that are not completed, either due to safety reasons, samples damaged or lost in transit, etc., will lower the project's completeness. Sample results that are rejected as unusable due to quality control non-conformances and failures will also lower the project's completeness. The completeness goal for each sampling matrix is 90%. For direct pressure and temperature measurements, data will be recorded no less than 90% of the time.

E.I.1.4.f. Comparability

Comparability is the measurement of confidence that can be assigned when two data sets are compared to each other or combined. To evaluate comparability, the sampling techniques, laboratory methods, data distributions, and data quality must be considered for each data set before direct comparisons can be performed. Comparability of data gathered during the investigation will be achieved by consistently following standard field and laboratory procedures and by using standards. Historical data from prior sampling efforts will be considered, to the extent possible, when the data are of known and verifiable quality and the sampling methods are comparable with the proposed techniques used for this effort.

E.I.1.4.g. Method Sensitivity

Field data sensitivity is dependent on the equipment maintenance, calibration, performance, and operator, as well as collection methods and sample handling. For the parameters being measured in the field, standard equipment is readily available to ensure the data collected meets project goals and are of adequate quality to be used in decision making. The field team will follow procedures detailed in this QASP and SOPs to ensure usability of the data. Field meter operator manuals are provided in Attachment E.I.1 (groundwater) and Attachment E.I.2 (soil gas).

Like field data, laboratory data sensitivity is dependent on equipment maintenance, calibration, performance, and operator, as well as collection or extraction methods and sample handling. However, laboratories usually can provide lower detection limits with a higher degree of confidence given the controlled environment for the equipment and technician. Laboratories report their method detection limits and provide qualifiers if those values are uncertain. The laboratory should report all results down to the Method Detection Limits (MDLs).

Table E.I.1-13. Pressure and Temperature – Downhole Gauge Specifications

Parameters	Detection Limits/Range
PT-0505 CSS #1 Downhole Pressure	
Calibrated working pressure range	14.7 to 10,000 psi
Initial pressure accuracy	< ± 1.2 psi over the full scale
Pressure resolution	< ± 0.006 psi/sec
Pressure drift stability	< ± 2 psi per year over full scale
TE-0505 CSS #1 Downhole Temperature	
Calibrated working temperature range	0 - 150 (^{o}C)
Initial temperature accuracy	< ± 0.5 ^{o}C
Temperature resolution	< ± 0.005 ^{o}C/sec
Temperature drift stability	< ± 0.1 ^{o}C per year @ 177 ^{o}C
Maximum temperature	200 ^{o}C

Table E.I.1-14. Representative Well Logging Tool Specifications

Parameters	RST Reservoir Saturation Tool	CBL Cement Bond Log	ACX Acoustic Conformance .Xaminer	USI Ultrasonic Imager	IBC Isolation Behind Casing Scanner
Investigation	External MIT Formation (CO_2 / Salinity / Temp)	Well Integrity: Cement-Casing / Cement-Formation	External MIT: Tubing Casing Annulus Temperature	Well Integrity: Casing (Material Loss) Micro Annulus Cement Integrity	Well Integrity: Same as USI, but used for low contrast acoustic impedance
Method	Pulse Neutron / Oxygen Activation	Sonic Amplitude (Attenuation and Transit Times)	Noise Tool	Ultrasonic (Acoustic Impedance)	Ultra Sonic Acoustic Impedance and Flexural Attenuation
Logging Speed (ft/hr)	1,800	3,000	1500	Std res: 2,700 High res: 563	Std res: 2,700 High res: 563
Vertical Resolution	15 inches	3 ft	N/A from Vendor	Std res: 0.6 in High res: 6 in	Std res: 0.6 in High res: 6 in
Investigation Target(s)	Formation	Annulus, formation	Tubing, Casing and annulus	Casing and annulus	Casing and annulus
Temperature Rating	302 ^{o}F	350 ^{o}F	350 ^{o}F (1 hr)	350 ^{o}F	350 ^{o}F
Pressure Rating	15,000 psi	20,000 psi	15,000 psi	20,000 psi	20,000 psi

Table E.I.1-15. Pressure Field Gauge: PT-0501A Pipeline Supply Pressure

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0-4000 psi
Initial pressure accuracy	± 0.04% of Span (Ref Accuracy)
Pressure resolution	± 0.003% of Span
Pressure drift stability	± 0.2% of Upper Range Limit over 10 yrs

Table E.I.1-16. Pressure Field Gauge: PT-0503 CSS #1 Wellhead Pressure

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 psig to 100 psig through 0 psig to 8,000 psig
Initial pressure accuracy	+/-0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors
Pressure resolution	4-20 mA transmitter, resolution depends upon span
Pressure drift stability	± 0.2% full scale for 1 year, non-accumulating

Table E.I.1-17. Pressure Field Gauge: PT-0504 CSS #1 Annulus Pressure

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 psig to 100 psig through 0 psig to 8,000 psig
Initial pressure accuracy	± 0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors)
Pressure resolution	4-20 mA transmitter, resolution depends upon span
Pressure drift stability	± 0.2% full scale for 1 year, non-accumulating

Table E.I.1-18. Pressure Field Gauge: PT-0510 MW #1 Surface Pressure – Tubing

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 psig to 100 psig through 0 psig to 8,000 psig
Initial pressure accuracy	± 0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors
Pressure resolution	4-20 mA transmitter, resolution depends upon span
Pressure drift stability	± 0.2% full scale for 1 year, non-accumulating

Table E.I.1-19. Pressure Field Gauge: PT-0511 MW #1 Surface Pressure – Annulus

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 psig to 100 psig through 0 psig to 8,000 psig
Initial pressure accuracy	± 0.50% full scale (BFSL) (Includes the effects of non-linearity, hysteresis, non-repeatability, zero point and full scale errors
Pressure resolution	4-20 mA transmitter, resolution depends upon span
Pressure drift stability	± 0.2% full scale for 1 year, non-accumulating

Table E.I.1-20. Pressure Field Gauge: PT-0512 MW #1 Downhole Pressure – Upper Zone

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 to 10,000 psig
Initial pressure accuracy	< ± 1.2 psig over the full scale
Pressure resolution	< ± 0.006 psig/sec
Pressure drift stability	< ± 2 psig per year over full scale

Table E.I.1-21. Pressure Field Gauge: PT-0513 MW #1 Downhole Pressure – Lower Zone

Parameters	Specifications/Sensitivities
Calibrated working pressure range	0 to 10,000 psig
Initial pressure accuracy	< ± 1.2 psig over the full scale
Pressure resolution	< ± 0.006 psig/sec
Pressure drift stability	< ± 2 psig per year over full scale

Table E.I.1-22. Temperature Field Gauge: TE-0501 Pipeline Supply Temperature

Parameters	Specifications/Sensitivities
Calibrated working temperature range	Factory Calibrated to Desired Range
Initial temperature accuracy	± 0.02% of Span
Temperature resolution	0.001 °F
Temperature drift stability	± 0.25% or 0.25 °C whichever is greater of reading over 5 year range

Table E.I.1-23. Temperature Field Gauge: TE-0503 CSS #1 Wellhead Temperature

Parameters	Specifications/Sensitivities
Calibrated working temperature range	-50 °F to 750 °F (-50 °C to 400 °C)
Initial temperature accuracy	± 0.06% (±0.15 °C) at 0 °C, Class A
Temperature resolution	4-20 mA transmitter, resolution depends upon span
Temperature drift stability	Drift < ±0.9 °F/yr (< ±0.5 °C/yr)

Table E.I.1-24. Temperature Field Gauge: TE-0504 CSS #1 Annulus Temperature

Parameters	Specifications/Sensitivities
Calibrated working temperature range	-50 °F to 750 °F (-50 °C to 400 °C)
Initial temperature accuracy	± 0.06% (±0.15 °C) at 0 °C, Class A
Temperature resolution	4-20 mA transmitter, resolution depends upon span
Temperature drift stability	Drift < ±0.9 °F/yr (< ±0.5 °C/yr)

Table E.I.1-25. Temperature Field Gauge: TE-0510 MW #1 Surface Temperature – Tubing

Parameters	Specifications/Sensitivities
Calibrated working temperature range	-50 °F to 750 °F (-50 °C to 400 °C)
Initial temperature accuracy	± 0.06% (±0.15 °C) at 0 °C, Class A
Temperature resolution	4-20 mA transmitter, resolution depends upon span
Temperature drift stability	Drift < ±0.9 °F/yr (< ±0.5 °C/yr)

Table E.I.1-26. Temperature Field Gauge: TE-0511 MW #1 Surface Temperature – Annulus

Parameters	Specifications/Sensitivities
Calibrated working temperature range	-50 °F to 750 °F (-50 °C to 400 °C)
Initial temperature accuracy	± 0.06% (±0.15 °C) at 0 °C, Class A
Temperature resolution	4-20 mA transmitter, resolution depends upon span
Temperature drift stability	Drift < ±0.9 °F/yr (< ±0.5 °C/yr)

Table E.I.1-27. Temperature Field Gauge: XT-0500 CSS #1 DTS System

Parameters	Specifications/Sensitivities
Calibrated working range	0-150 °C (5 km)
Accuracy	± 2 °C max, ± 0.75 °C typical
Temperature resolution	<0.1 °C
Spatial resolution	1 m
Sampling resolution	0.5 m

Table E.I.1-28. Temperature Field Gauge: XT-0510 MW #1 DTS System

Parameters	Specifications/Sensitivities
Calibrated working range	0-150 °C (5 km)
Accuracy	± 2 °C max, ± 0.75 °C typical
Temperature resolution	<0.1 °C
Spatial resolution	1 m
Sampling resolution	0.5 m

Table E.I.1-29. Mass Flow Rate Field Gauge: FE-0501 Injection Flow

Parameters	Specifications/Sensitivities
Calibrated working flow range	0-350 GPM (US)
Initial mass flow rate accuracy	± 0.25% of rate
Mass Flow Rate resolution	0.005% full scale
Mass Flow Rate drift stability	Negligible drift (per vendor)

Table E.I.1-30. Density Field Gauge: DE-0501 Injection Density

Parameters	Specifications/Sensitivities
Calibrated working range	Set per customer request
Density accuracy	± 0.5 kg/m³ (±0.0005 g/cm³)
Density repeatability	0.2 kg/m³ (0.0002 g/cm³)
Drift stability	Negligible drift (per vendor)

Table E.I.1-31. Level Field Gauge: LT-0501 CSS #1 Annulus Tank Level

Parameters	Specifications/Sensitivities
Calibrated working range	0-1000 L/D
Initial accuracy	± 0.05% FS
Resolution	0.01 mA
Drift stability	0.2% per year

Table E.I.1-32. Composition Field Gauge: AN-0501 Injection Composition

Parameters	Specifications/Sensitivities
Calibrated working range	90-100% concentration
Initial accuracy	3% of range
Resolution	< 0.2% of span
Drift stability	< 1% of measured value per week

Table E.I.1-33. Composition Field Gauge: AN-0502 CSS #1 Surface Air Sensor

Parameters	Specifications/Sensitivities
Calibrated working range	10ppm – 10%
Sensitivity	<200 ppb/s
Resolution	4-20 mA transmitter, resolution depends upon span
Drift stability	< 1 ppm

Table E.I.1-34. Composition Field Gauge: AN-0503 MW #1 Surface Air Sensor

Parameters	Specifications/Sensitivities
Calibrated working range	10ppm – 10%
Sensitivity	<200 ppb/s
Resolution	4-20 mA transmitter, resolution depends upon span
Drift stability	< 1 ppm

Table E.I.1-35. Seismic Field Gauge: Passive Seismic Sensors

Parameters	Specifications/Sensitivities
Dynamic Range	>136db
Sensitivity	1500 V/m/sec (optional different sensitivity can be set under request)
Bandwidth	10sec to 98Hz (or 5s,2s 1s, 4.5Hz low cut)
Noise Level	Below NLNM into recording band

E.I.1.5. Special Training/Certifications

E.I.1.5.a. Specialized Training and Certifications

The geophysical survey equipment and wireline logging tools will be operated by trained and qualified personnel, according to the service company which provides the equipment. Field gauges will be operated by personnel that have reviewed and/or been trained with field manuals. Environmental (e.g., groundwater soil gas) sampling will be conducted by personnel trained to understand and follow the project specific sampling procedures. 8- or 40-hour Hazwoper, equipment competency, lockout tagout, or well control training may be required for personnel depending on the specific task performed.

E.I.1.5.b/c. Training Provider and Responsibility

PCC is responsible to ensure proper training of its staff and all selected subcontractors. Training will be provided directly by PCC, or alternatively by a training subcontractor with PCC oversight of the training activity.

E.I.1.6. Documentation and Records

E.I.1.6.a. Report Format and Package Information

PCC will provide US EPA with reports that contain all required project information as specified in the US EPA UIC Class VI permit. All information will be provided in an electronic format unless otherwise specified by the US EPA UIC Program Director. This includes periodic reviews, revisions, approvals, and distribution of the QASP to ensure the current approved version of the QASP is available as outlined previously in Section E.I.1.1.d. of this document.

E.I.1.6.b. Other Project Documents, Lab Analyses, Field Sampling Records, other Records, and Electronic Files

Other documents, records, and electronic files (i.e., well logs, test results, field sampling records, lab data, narratives for field sampling and/or lab analyses) will be provided by PCC as specified in the US EPA UIC Class VI permit and additional requirements of the US EPA UIC Program Director.

E.I.1.6.c/d. Data Storage and Duration

PCC or a designated contractor will store and maintain the required project data on a cloud-based repository. Records will be retained in accordance with 40 CFR 146.91(f) as follows:

1. All data collected under § 146.82 for Class VI permit applications shall be retained throughout the life of the geologic sequestration project and for 10 years following site closure.
2. Data on the nature and composition of all injected fluids collected pursuant to § 146.90(a) shall be retained until 10 years after site closure. The Director may require the owner or operator to deliver the records to the Director at the conclusion of the retention period.
3. Monitoring data collected pursuant to § 146.90(b) through (i) shall be retained for 10 years after it is collected.
4. Well plugging reports, postinjection site care data, including, if appropriate, data and information used to develop the demonstration of the alternative post-injection site care timeframe, and the site closure report collected pursuant to requirements at §§ 146.93(f) and (h) shall be retained for 10 years following site closure.
5. The Director has authority to require the owner or operator to retain any records required in this subpart for longer than 10 years after site closure.

E.I.1.6.e. QASP Distribution Responsibility

PCC is responsible for distribution of the current approved QASP to all personnel on the Distribution List provided at the front of this document.

E.I.2. Data Generation and Acquisition

E.I.2.1. Sampling Process Design

E.I.2.1.a. Design Strategy

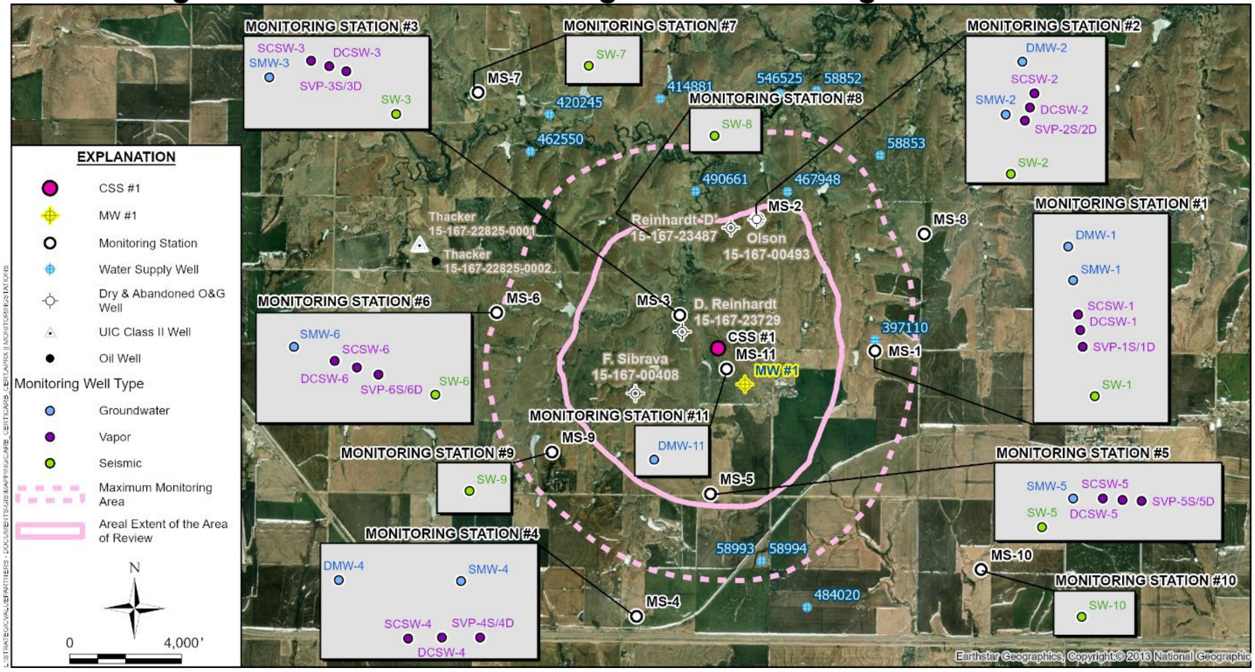
Continuous Recording of Operational Parameters Strategy
The primary objective of continuous recording of operational parameters is to verify compliance with Class VI permits conditions and to inform AoR reevaluations. Additionally, anomalies in injection rate and/or pressure may be an indicator of deviation from planned operations due to field conditions or leakage from the authorized zone.

CO_2 Stream Monitoring Strategy
The primary objective of analyzing the carbon dioxide stream is to evaluate the potential interactions of carbon dioxide and/or other constituents of the injectate with formation solids and fluids. This analysis can also identify (or rule out) potential interactions with well materials. Establishing the chemical composition of the injectate also supports a determination that the injectate does not meet the qualifications of hazardous waste under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6901 et seq. (1976), and/or the Comprehensive Environmental Response, Compensation, and Liability Act, (CERCLA) 42 U.S.C. 9601 et seq. (1980). Additionally, monitoring the chemical and physical characteristics of the carbon dioxide may help distinguish the injectate from the native fluids and gases in case of a leak. Injectate grab samples are taken and analyzed per the minimum requirement of 40 CFR 98.444(b)(2) and in conformance with 40 CFR 146.90(a) – see Section A.7.2 of the Application Narrative and Section E.5.1 of the Testing and Monitoring Plan for further definition and justification of monitoring frequency.

Corrosion Monitoring Strategy
The primary objective of corrosion monitoring is early detection of deterioration of well components (casing, tubing, packer) that may cause loss of mechanical integrity. Corrosion coupon testing supplemented with information from Internal MITs and External MITs will be used to monitor corrosion.

Strategy for Monitoring Fluids Above Confining Zone
The above confining zone groundwater monitoring strategy includes use of six stations that each have two wells screened at two different depths. All these monitoring wells have already been installed. The surficial groundwater well at each station has a 20-ft long screen, with total depths of the shallower wells ranging from 90 to 117.5 feet below ground surface (ft bgs). This surficial groundwater zone is comprised of generally low permeability silts, clays, and sandstones with some limestone, shale, and calcite components, depending on location. The deeper well at each station has a 20-ft long screen with total depths of the deeper wells ranging from 173 to 234 ft bgs. The deeper groundwater zone is the saline water-bearing Dakota formation, comprised primarily of sandstones. The shallow monitoring well at MS-3 actually monitors the Dakota formation due to its location at a lower elevation on the side slope of a ridge. The stations were installed to give a spatial distribution around the injection location (Figure E.I.2-1).

Figure E.I.2-1. Above Confining Zone Monitoring Well Locations



Strategy for Monitoring Fluids in Injection Zone

The injection zone groundwater monitoring strategy includes one injection zone groundwater monitoring well, MW #1, which will monitor the injection zone. Groundwater samples, including geochemical and isotope analyses of the fluid samples, will be collected at this well until the plume reaches the location, at which time groundwater sampling will no longer provide usable data.

Soil Gas Monitoring Strategy

At each of the monitoring stations (Figure E.I.2-1), soil gas will be monitored by three methods. The first method will be sampling for laboratory analysis from soil gas probes installed at 5 ft bgs and 10 ft bgs. The second method will be continuous field measurement of CO_2 concentrations with sensors placed in wells screened at 5 ft bgs and 10 ft bgs. The third method will be CO_2 efflux measurements taken at ground surface with a dynamic closed chamber. At each station, 16 soil collars (receivers for the dynamic closed chamber) have been installed for these measurements.

E.I.2.1.b. Type and Number of Samples/Test Runs

CO_2 gas stream, monitoring of operational parameters, corrosion coupons, and groundwater sampling activities and frequencies are shown in Table E.2-1 of the Testing and Monitoring Plan.

E.I.2.1.c. Site/Sampling Locations

Grab samples for laboratory analysis will be taken from AN-0501, which is a sample station located immediately upstream of the injection flow meter [in conformance with the requirements of 40 CFR 98.444(b)(3)], both of which are located proximate the CSS #1 injection wellhead #1 – see Section A.II.2.2.2 of Well Construction Details for additional information.

The locations of the instruments for continuous monitoring of operational parameters are discussed in the Testing and Monitoring Plan.

Corrosion coupons will be mounted in holders located downstream of the surface equipment and upstream of the injection wellhead.

Near-surface soil gas sampling and above confining zone groundwater monitoring will be conducted at the six stations shown on Figure E.I.2-1.

Injection zone groundwater monitoring will be conducted at MW #1. The proposed location of MW #1 is shown in Figure E.I.2-1.

E.I.2.1.d. Sampling Site Contingency

The locations of the CO_2 grab sampling station, monitoring of operational parameters instruments, and the corrosion coupon monitoring station are under direct control of PCC (i.e., located on PCC owned- or leased-property and secured by fencing and locked gates), thus no problems of site accessibility are anticipated.

The project team has acquired access permissions for all above confining zone groundwater, soil gas monitoring, and injection zone groundwater locations. No problems with accessibility are anticipated.

If inclement weather (or another temporary event) makes site access difficult for any of the above sampling activities, sampling schedules will be reviewed, and alternative dates may be selected that would still meet permit-related conditions or schedule relief will be requested from the US EPA UIC Program Director. The US EPA will be notified anytime a scheduled sampling event is missed or rescheduled.

E.I.2.1.e. Activity Schedule

See the Table E.2-1 of the Testing and Monitoring Plan for frequencies of data collection.

E.I.2.1.f. Critical/Informational Data

Detailed documentary information will be collected on field forms (Attachment E.I.3) for each of the sampling activities. Site specific information regarding quality control samples is found in Section E.I.2.5, “Field Quality Control.” Additional quality control sampling information is found in the site-specific SOP in Attachment E.I.3. Critical information will include time and date of activity, people performing the activity, the location of the activity (e.g., well name), field instruments used, calibration information, and field parameter outputs from the instruments. The laboratories performing the analyses will also provide detailed documentary information including but not limited to: custody transfer of the samples, time and date of analysis, analytical methods utilized, and test method results. Much of the critical data from the laboratories is generated during analysis and provided to end users in digital and printed formats.

E.I.2.1.g. Sources of Variability

Potential sources of variability related to monitoring activities include (1) natural variation in fluid quality, formation pressure and temperature and seismic activity; (2) variation in fluid quality, formation pressure and temperature, and seismic activity due to project operations; (3) changes in recharge due to rainfall, drought, and snowfall; (4) changes in instrument calibration during sampling or analytical activity; 5) different staff collecting or analyzing samples; (6) differences in environmental conditions during field sampling activities; (7) changes in analytical data quality during life of project; and (8) data entry errors related to maintaining project database.

Activities to eliminate, reduce, or reconcile variability related to monitoring activities include (1) collecting long-term baseline data to observe and document natural variation in monitoring parameters, (2) evaluating data in timely manner after collection to observe anomalies in data that can be addressed by resampling or reanalyzing, (3) conducting statistical analysis of monitoring data to determine whether variability in a data set is the result of project activities or natural variation, (4) referencing weather data collected near project site (such as from local airports) when appropriate, (5) following instrument calibration protocols, (6) thoroughly training staff, (7) conducting laboratory quality assurance checks using third party reference materials, and/or blind and/or replicate sample checks, and (8) developing a systematic review process of data that can include sample-specific data quality checks (i.e., cation/anion balance for aqueous samples).

E.I.2.2. Sampling Methods

Logging, geophysical monitoring, and pressure/temperature monitoring do not apply to this section and are omitted.

E.I.2.2.a/b. Sampling SOPs

CO_2 Stream
Grab CO_2 stream samples will be collected using a written SOP based upon the methods presented in GPA Midstream Standard 2166, American Petroleum Institute (API) 14.1, or similar (GPA 2022, API 2017). The CO_2 grab sampling SOP is included in Attachment E.I.5.

Corrosion Coupons
The corrosion coupons will be prepared and collected using a written SOP based upon the methods presented in NACE Standard SP0775-2018-SG, ASTM G1-03, or similar (NACE 2018, ASTM 2017). The corrosion coupon sampling SOP is included in Attachment E.I.5.

Groundwater Sampling
Groundwater sampling will be collected via low-flow techniques from MS-1 through MS-6 and MS-11 following sampling methods provided in Attachment E.I.5. To ensure samples are representative of the formation water quality, groundwater will be purged from the sampling equipment and well prior to collecting the samples. Dedicated bladder pumps will be installed in each monitoring well to minimize potential cross contamination between wells. Compressed nitrogen is supplied to the bladder pump via the drive tubing with the use of a control unit. The applied pressure causes the bladder to compress and force water into sample tubing. Subsequent venting releases the pressure and allows water to re-enter the pump. This cycle is repeated to provide water flow. See Attachment E.I.5 for the site-specific groundwater sampling SOP.

Static water levels in each well will be determined by using an electronic water level meter indicator before purging begins. The water level meter will be the only piece of equipment utilized at multiple wells and will be decontaminated after each use. Proper decontamination involves a series of steps including abrasive cleaning, disinfection with Alconox™, and rinsing with distilled/deionized water.

Table E.I.2-1. Stabilization Criteria for Sampling of Fluids Above the Confining Zone

Field Parameter	Stabilization Criteria
pH	±0.1 pH units
Temperature	±3 °C
Specific conductance	±3%
Dissolved oxygen	±3%
Turbidity	±10% or < 10 NTUs
Oxidation Reduction Potential	±10 millivolts
Dissolved CO_2	Considered stabilized when above parameters are stable

Field parameters will include pH, temperature, specific conductance, dissolved oxygen, turbidity, and dissolved CO_2. Field parameters will be considered stable once three successive measurements have been made at three-minute intervals as shown in Table E.I.2-1. Sampling begins after field parameters have stabilized. For wells with low achievable extraction rates, sample timing will be based on available water volume (e.g., samples collected before well runs dry even if field parameters have not met all stabilization criteria).

Deep Monitoring Well: MW#1

MW #1 is designed as a dual zone monitoring well, with the positions of the sliding sleeve and the standing valve determining which zone is accessible. The lower zone of MW #1 is used to obtain fluid samples from the Arbuckle Group injection zone when the sliding sleeve is closed and the standing valve is pulled; the upper zone of MW #1 is used to obtain groundwater samples from the Iola Limestone member of the Kansas City Formation when the sliding sleeve is open and the standing valve is set in the profile nipple of the packer assembly. Injection zone and groundwater fluid samples will be collected from MW #1 using the following procedure:

Injection Fluid Samples from Lower Zone of MW #1

- Rig-up slickline unit and lubricator, pressure test lubricator to 4,000 psig with pump truck
- Run-in-hole(RIH) and pull standing valve out of profile in packer
- Run-in-hole (RIH) with swab cups and swab back a minimum of 1,400 gallons of fluid (10% excess of tubing volume). Upon reaching 1,400 gallons, measure and record swab fluid field parameters listed in Table E.I.2-2
- RIH with swab cups and swab back, measure and record swab fluid field parameters listed in Table E.I.2-2
- Repeat previous step until two successive field measurements meet the stabilization criteria listed in Table E.I.2-2, then go to next step
- RIH with swab cups and swab back for final time, measure and record swab fluid field parameters listed in Table E.I.2-2, then collect and prepare sample for laboratory analyses
- If not planning to take a groundwater sample from upper zone of MW #1, then RIH with standing valve to set in profile nipple of packer assembly

Groundwater Samples from Upper Zone of MW #1

- RIH with standing valve to set in profile nipple of packer assembly.
- Positive pressure test standing valve to 1,000 psig with pump truck.
- Negative pressure test standing valve.
- RIH with shifting tool and open sliding sleeve above packer.
- RIH with swab cups and swab back a minimum of 4,275 gallons of fluid (10% excess of tubing and annulus volume). Upon reaching 4,275 gallons, measure and record swab fluid field parameters listed in Table E.I.2-2.

- RIH with swab cups and swab back, measure and record swab fluid field parameters listed in Table E.I.2-2.
- Repeat previous step until two successive field measurements meet the stabilization criteria listed in Table E.I.2-2, then go to next step.
- RIH with swab cups and swab back for final time, measure and record swab fluid field parameters listed in Table E.I.2-2, then collect and prepare sample for laboratory analyses.

All swab purge waters will be handled and disposed in accordance with State and local regulation (e.g., collect into a water tank truck, transport, and inject into a nearby Class II well).

Table E.I.2-2. Stabilization Criteria for Sampling of Fluids from MW #1

Field Parameter	Stabilization Criteria	
pH	MW #1 Upper Zone Fluid Samples	±0.5 pH units
	MW #1 Lower Zone Fluid Samples	±1 pH units

Soil Gas Samples
Near-surface soil gas sampling will follow procedures described in the site-specific soil gas sampling SOP included in Attachment E.I.5. This SOP was written and informed by the USEPA Region 4 Operating Procedure for Soil Gas Sampling (LSASDPROC-307-R4). A 300 mL syringe will be attached to well tubing installed in each soil vapor well. The syringe will be used to purge three times. The syringe will be filled a fourth time with 300mL of vapor that will be pushed into the Tedlar bag. The Tedlar bag will then be attached to the LANDTEC GEM 2000 (or equivalent) to record the field parameters (CO_2, O_2 and CH_4). This process will be repeated until stabilization is reached. Stabilization is considered to be achieved when three consecutive readings of CO_2, O_2 and CH_4 are within ± 10% of each other.

Both field measurements and analytical samples collected in IsoBags or equivalent will be conducted. Field parameters will be considered stable based on three successive measurements meeting the criteria in Table E.I.2-3.

Table E.I.2-3. Stabilization Criteria for Sampling of Soil Gas

Field Parameter	Stabilization Criteria
O_2, CO_2, and CH_4 concentration	±10%

E.I.2.2.c. In-situ Monitoring

In situ monitoring will be conducted by data loggers that are described in the Continuous Monitoring section below.

E.I.2.2.d. Continuous Monitoring

Data loggers will be used to collect continuous measurements of above confining zone groundwater elevations (by water pressure), temperature, and conductivity. Both the shallower and deeper well at each of the six stations on Figure E.I.2-1 will have continuous data logging. The measurements will be taken approximately once every 12 hours. The sensors will report each measurement to a data logger that will store the information for upload as appropriate. In addition, the data logger will load the measurements to a modem that will transmit the data by antennae via a cellular signal for retrieval by the project team.

A sensor will be used to collect continuous measurements of near surface CO_2 concentrations in soil gas. The measurements will be taken from PVC wells screened at 5 and 10 ft bgs at each of the stations in Figure E.I.2-1. The sensors will measure the CO_2 concentration approximately once every 30 minutes and report an average over that timeframe, for an aggregate of approximately 12 hours. The sensors will report each measurement to a data logger that will store the information for upload as appropriate. In addition, the data logger will load the measurements to a modem that will transmit the data by antennae via a cellular signal for retrieval by the project team.

E.I.2.2.e. Sample Homogenization, Composition, Filtration

Sample homogenization, composition, and filtration will be conducted by the laboratories according to the methods for a given analysis.

E.I.2.2.f. Sample Containers and Volumes

CO_2 grab samples will be collected following a written SOP (Attachment E.I.5), using clean sample containers (e.g., gas cylinders, sample bags) provided by the laboratory conducting the analytical tests.

The corrosion coupons will be collected following a written SOP (Attachment E.I.5), wrapped in protective packaging, and then shipped to a qualified third-party for analysis. Minimum qualifications for the third-party conducting the analysis is that a licensed Professional Engineer with metallurgical experience will oversee coupon handling, analysis, and review/sign the analysis reports.

Groundwater sample containers and volumes are detailed in Table E.I.2-4 and E.I.2-5. Near surface soil gas sample containers and volumes are detailed in Table E.I.2-6.

Table E.I.2-4. Sample Containers, Preservation Treatments, and Holding Times for Sampling of Fluids Above the Confining Zone

Target Parameters	Volume/Container Material	Preservation Technique	Sample Holding Time
Cations: Al, Ba, Mn, As, Cd, Cr, Cu, Pb, Sb, Se, Tl, Ca, Fe, K, Mg, Na, and Si	250 mL polyethylene bottle	HNO_3 to a pH less than 2; cool to 4°C	6 months
Anions: Br, Cl, F, NO_3, and SO_4	250 mL polyethylene bottle	Cool to 4°C	28 days, except nitrate, which is 48 hours
$\delta^{13}C$ of DIC	250 mL polyethylene bottle	Cool to 4°C	30 days
Alkalinity	500 mL polyethylene bottle	Cool to 4°C	14 days
Total Dissolved Solids	500 mL polyethylene bottle	Cool to 4°C	7 days

Table E.I.2-5. Anticipated Sample Containers, Preservation Treatments, and Holding Times for Samples Monitoring Groundwater Quality of the Injection Zone

Target Parameters	Volume/Container Material	Preservation Technique	Sample Holding Time
Cations: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Ni, K, Se, SiO_2, Si, Ag, Na, Sr, V, Zn Sodium Adsorption Ratio (SAR) Ferric iron Mercury	250 mL polyethylene bottle	HNO_3 to a pH less than 2; cool to 6°C	6 months, except ferrous iron, which is 24 hours
NO_3 Nitrite pH Total CO_2	250 mL polyethylene bottle	Cool to 6°C	28 days, except nitrate, which is 48 hours
Alkalinity, Br, Cl, F, SO_4	500 mL polyethylene bottle	Cool to 6°C	14 days
Phenol	2 x 500 mL amber glass bottle	Cool to 6°C	7 days
Oil and grease	2 x 1 L amber glass bottle	HCl; cool to 6°C	28 days
Conductivity Total dissolved solids Ferrous iron	500 mL plastic bottle	Cool to 6°C	28 days
Total sulfide and sulfide as H_2S	250 mL plastic bottle	NaOH and zinc acetate; cool to 6°C	7 days
Cyanide	250 mL plastic bottle	NaOH to pH ≥ 12; cool to 6°C	14 days
Total organic carbon Ammonia	250 mL amber glass bottle	H_2SO_4 to pH < 2; cool to 6°C	28 days

Table E.I.2-6. Sample Containers, Preservation Treatments, and Holding Times for Sampling Soil Gas

Target Parameters	Volume/Container Material	Preservation Technique	Sample Holding Time
CO_2, O_2, CH_4, and N_2 in shallow soil gas	0.3 L IsoBag	Storage Temperature range:-4°F (-20°C) TO +122°F (+50°C)	6 months

°F = Fahrenheit
HCl = Hydrochloric acid
L = liter
mL = milliliter

E.I.2.2.g. Sample Preservation

No special preservation procedures are required for the CO_2 stream samples other than respecting the "Hold Time to Analysis" limit provided in the sampling SOP (Attachment E.I.5).

The corrosion coupons will be collected following a written SOP (Attachment E.I.5), wrapped in protective packaging, and then shipped to a qualified third-party for analysis.

Groundwater sample preservation is detailed in Table E.I.2-4 and E.I.2-5. Near surface soil gas sample preservation is detailed in Table E.I.2-6.

E.I.2.2.h. Cleaning/Decontamination of Sampling Equipment

For CO_2 grab sampling, the sample containers will be provided by the analytical laboratory in a pre-cleaned and ready-to-use state. The sampling containers will either be disposed or decontaminated by the analytical laboratory after use.

For the corrosion coupons, the initial bulk cleaning will be performed by the field operator and final cleaning will be performed by the third-party analyst. All cleaning will be performed in accordance with NACE SP-0775-2018-SG, ASTM G1-03, or similar (NACE 2018, ASTM 2017). The company performing the cleaning is responsible for disposal of all used cleaning supplies. The third-party analyst is responsible for disposal of the coupons when the monitoring program is complete. The Field Team Lead is responsible for ensuring that proper cleaning and decontamination of sampling equipment is conducted.

The soil gas sampling train is not prone to cross-contamination. The vacuum to drive the sample into the bag is achieved by a lung box or syringe, which isolates the bag from the atmosphere.

For above confining zone groundwater sampling, dedicated bladder pumps will be installed in each groundwater monitoring well to minimize potential cross contamination between wells. The procedure for obtaining fluid samples from the monitoring wells via purging, cleans the tubing and collection system by displacing old fluid in the system with new formation fluid prior to taking the sample. Due to dedicated sampling equipment, no additional cleaning or decontamination of the sampling equipment is necessary. These pumps will remain in each well throughout the project period except for maintenance. The pumps are low-flow pumps powered by a controller and inert gas, such as nitrogen, to lift the fluid to the surface. Per EPA recommendations, pump rates will be less than 0.5 liters per minute to minimize draw down.

E.I.2.2.i. Support Facilities

For CO_2 grab sampling, tubing, connectors, and valves required to sample the CO_2 gas stream will be supplied by PCC (or its subcontractor) or the analytical laboratory providing the sample containers.

For the corrosion coupons, PCC is responsible for the design, construction, and operation of the corrosion coupon station.

For near surface soil gas sampling, the following are required: lung box for sample collection and field instrument for soil gas parameters. Field activities are completed from field vehicles.

For sampling of above confining zone groundwater, the following are required: bladder pump, compressor and power source, air-water interface probe, and field instrument for water quality parameters (e.g., pH, specific conductance). Field activities are completed from field vehicles.

For fluid sampling from MW #1, PCC will arrange for a service provider to collect the samples using standard equipment for collecting swab samples from a well.

E.I.2.2.j. Corrective Action, Personnel, and Documentation

Field staff are responsible for properly testing equipment and performing corrective actions on broken or malfunctioning field equipment. If corrective action cannot be taken in the field, then equipment will be returned to the manufacturer for repair or replaced. Significant corrective actions will be documented in field notes and included in relevant reports.

E.I.2.3. Sample Handling and Custody

Logging, geophysical monitoring, and pressure/temperature monitoring do not apply to this section and are omitted.

E.I.2.3.a. Maximum Hold Time/Time Before Retrieval

Groundwater sample hold times are detailed in Table E.I.2-4 and E.I.2-5. Near surface soil gas sample hold times are detailed in Table E.I.2-6.

E.I.2.3.b. Sample Transportation

Samples collected by the field staff will be transported to the laboratory via a courier for time sensitive samples (or other means for non-time critical samples). The courier typically arrives on-site each day at 2 pm. All samples collected before 2 pm on a sampling day will be properly labelled and packed for transportation via the courier. Samples will be logged by the laboratory the morning following sample collection to ensure that all hold times are met. Samples will be placed in individual bubble bags to prevent breakage within the sample cooler. Additionally, bubble wrap will be placed on all sides of the sample cooler to further minimize breakage potential.

See Tables E.I.2-4, E.I.2-5, and E.I.2-6 for information regarding preservation techniques and sample hold times.

E.I.2.3.c. Sampling Documentation

Field notes will be recorded for all samples collected during a sampling event. The laboratory performing the analytical tests will provide test results along with chain-of-custody (CoC) documentation. The forms and reports will be retained and archived by PCC for future reference.

E.I.2.3.d. Sample Identification

All samples will be properly identified with labels provided by the laboratory. To eliminate potential analytical bias, the field staff will denote the project, sample location/identification number, sample date and time, sampling personnel’s initials, and volume collected on each sample label. The field staff will omit key information for field duplicate labels including date/time to further reduce analytical bias.

E.I.2.3.e. Sample Chain-of-Custody

A Chain of Custody (CoC) form is the written documentation of the security of a sample from the time it is collected to the time it is transferred to the laboratory that is conducting the analysis. The chain-of-custody will be documented using a standardized form provided by the laboratory (Attachment E.I.3). Field staff will complete the CoC form at the time of sample collection. The samples listed on the CoC form must match the samples provided. The minimum information required for CoC documentation includes:

- Name and location of sample collection
- Name of the sampling personnel
- Sample-identification number
- Matrix and type of sample collected

- Number of containers per sample
- Date and time of samples collected
- Parameters to be analyzed
- Identification of laboratory

CoCs will be properly relinquished upon transfer of the sample coolers to the shipping company. Field staff will ensure signature and witness the signing by the receiver. Copies of the CoC will be provided with the samples to the laboratory and recorded with the field forms where the documents will be retained.

E.I.2.4. Analytical Methods

Logging, geophysical monitoring, and pressure/temperature monitoring does not apply to this section and is omitted.

E.I.2.4.a. Analytical SOPs

Groundwater and soil gas laboratory SOPs are provided in Attachment E.I.4 and Attachment E.I.6, respectively.

E.I.2.4.b. Equipment/Instrumentation Needed

The groundwater and soil gas laboratory SOPs provided in Attachment E.I.4 and Attachment E.I.6, respectively, describe equipment and instruments specific to the given analysis.

E.I.2.4.c. Method Performance Criteria

Each laboratory conducting analysis will be responsible for appropriately addressing analytical failure according to their individual SOPs.

E.I.2.4.d. Analytical Failure

Each laboratory conducting the analyses in Tables E.I.1-4 through E.I.1-7 will be responsible for appropriately addressing analytical failure according to their individual SOPs and laboratory quality assurance manuals. Analytical samples will be retained by the laboratory for at least 21 days following completion of the project. Unused sample volumes are held in the event of analytical, instrument, or reporting errors.

E.I.2.4.e. Sample Disposal

Each laboratory conducting the analyses in in Tables E.I.1-4 through E.I.1-7 will be responsible for appropriate sample disposal according to their individual SOPs. The EPA requires that laboratory waste management practice to be conducted consistent with applicable local, state, and Federal laws and regulations. Excess reagents, samples and method process wastes will be characterized and disposed of in an acceptable manner.

E.I.2.4.f. Laboratory Turnaround

Laboratory turnaround will vary by laboratory; however, generally turnaround of verified analytical results within one month will be suitable for project needs.

E.I.2.4.g. Method Validation for Nonstandard Methods

Nonstandard methods are not anticipated for this project. If nonstandard methods are determined to be needed or proposed in the future, the US EPA will be consulted prior to use of the nonstandard method, and additional appropriate action will be taken.

E.I.2.5. Field Quality Control

Field quality control for groundwater and soil gas sampling is described below. Additional information regarding site-specific quality control sampling information is provided in Attachment E.I.3.

E.I.2.5.a. Field QC activities

Field Blanks
Field blanks are not planned for this project and will not be collected during groundwater and soil gas sampling. Contamination resulting from exposure to the atmosphere is not expected.

Field Duplicates
For each sampling event, a field duplicate will be collected and analyzed for groundwater and soil gas for the applicable analytes in Table E.I.1-3 and E.I.1-4 at a frequency of 10% or greater from wells on a rotating schedule. Field duplicates will be collected with alternating bottles and will not be homogenized/split . Field duplicate samples are distinct samples collected from the same source immediately after the original sample in different sample containers and processed in the same manner as all other samples. Field duplicate samples are used to assess sample heterogeneity and analytical precision (EPA 2020a).

Trip Blanks
Trip blanks will not be collected during groundwater sampling events because volatile organic compounds (VOCs) are not being analyzed in the analytical suite, and because VOCs are not

expected on Site. If the analytical sampling program or site conditions change, trip blanks may be utilized for quality control.

E.I.2.5.b. Exceeding Control Limits

If the sample analytical results exceed control limits (i.e., ion balances > ±10%), further examination of the analytical results will be done by evaluating the ratio of the measured total dissolved solids (TDS) to the calculated TDS (i.e., mass balance) per American Public Health Association method. The method indicates which ion analyses should be considered suspect based on the mass balance ratio. Suspect ion analyses are then reviewed in the context of historical data and interlaboratory results, if available. Suspect ion analyses are then brought to the attention of the analytical laboratory for confirmation and/or reanalysis. The ion balance is recalculated, and if the error is still not resolved, suspect data are identified and may be given less importance in data interpretations.

E.I.2.5.c. Calculating Applicable QC Statistics

Charge Balance

The analytical results are evaluated to determine correctness of analyses based on anion-cation charge balance calculations. Because all potable waters are electrically neutral, the chemical analyses should yield equally negative and positive ionic activity. The anion-cation charge balance will be calculated using the formula:

$$\% \ Difference = 100 \ \frac{\sum cations - \sum anions}{\sum cations + \sum anions}, \qquad \text{(Equation 1)}$$

where the sums of the ions are represented in milliequivalents per liter (meq/L). The cations considered on a routine basis will be Ca^{2+}, Fe^{2+}, Mg^{2+}, Mn^{2+}, and Na^{+} and the anions will be HCO_3^-, CO_3^{2-}, Cl^-, and SO_4^{2-}. It the charge balance with this set for a given sample is ±10%, this will be considered acceptable. If the charge balance outside of this range, additional ions reported for the water sample will be considered.

Mass Balance

The ratio of the measured TDS to the calculated TDS will be calculated in instances where the charge balance acceptance criteria are exceeded using the formula:

$$1.0 < measured/calculated < 1.2, \qquad \text{(Equation 2)}$$

where the anticipated values are between 1.0 and 1.2.

Outliers

A determination of one or more statistical outliers will be conducted prior to the statistical evaluation of groundwater. This project will use the US EPA's March 2009 Unified Guidance as reference for selection of statistical methods to identify outliers in groundwater chemistry data sets as appropriate. These techniques include Probability Plots, Box Plots, Dixon's test, and Rosner's test. The US EPA 1989 outlier test may also be used as another screening tool to identify potential outliers.

E.I.2.6. Instrument/Equipment Testing, Inspection, and Maintenance

For groundwater and soil gas sampling, field equipment will be maintained, factory serviced, and calibrated per manufacturer's recommendations. Spare parts that may be needed during sampling will be included in supplies on hand during field sampling or obtained when the need is identified in the field.

All laboratory equipment, testing, inspection and maintenance will be conducted by the analytical laboratory per standard practice, method-specific protocols.

E.I.2.7. Instrument/Equipment Calibration and Frequency

E.I.2.7.a. Calibration and Frequency of Calibration

For CO_2 grab analysis and corrosion coupon analysis, the calibration and frequency of calibration for instruments are the responsibility of the laboratory conducting the analysis and will be performed in accordance with their SOPs, which are based upon the requirements of the specific analytical test methods being implemented and equipment manufacturer recommendations. The Quality Assurance Manager is responsible for ensuring that the selected laboratory adheres to the relevant SOPs.

For continuous monitoring of operational parameters, each instrument will be calibrated at the frequency specified by the instrument manufacturer.

For groundwater and near surface soil gas, field meters are calibrated according to manufacturer recommendations and equipment manuals. For meters calibrated in the field, calibrations are conducted each day before sample collection begins. Recalibration is performed if any components yield atypical values or fail to stabilize during sampling.

E.I.2.7.b. Calibration Methodology

For CO_2 grab analysis and corrosion coupon analysis, the calibration methodology is the responsibility of the laboratory conducting the analysis and will be performed in accordance with their SOPs, which are based upon the requirements of the specific analytical test methods being implemented and equipment manufacturer recommendations. The Quality Assurance Manager will ensure the laboratory selected to conduct the analysis adheres to relevant SOPs.

The field groundwater quality meter will be calibrated daily or as needed with the manufacturer calibration standard (e.g. Geotech calibration solution for YSI Pro DSS or equivalent). The acceptance criteria will follow manufacturer specifications. For example, acceptance criteria for the YSI Pro DSS parameters are as follows: temperature +/- 0.20 °C, pH slope ≥85%, ORP +/- 60 mV, Conductivity cell constant 4.5-5.5, Turbidity 0 nephelometric turbidity units (NTU) +/- 0.2 NTU, 124 NTU +/- 25 NTU. All calibration standards are NIST traceable with provided lot numbers. See Attachment E.I.1 for an example calibration sheet form.

E.I.2.7.c. Calibration Resolution and Documentation

For CO_2 grab analysis and corrosion coupon analysis, the calibration resolution and documentation are the responsibility of the laboratory conducting the analysis and will be performed in accordance with their SOPs, which are based upon the requirements of the specific analytical test methods being implemented and equipment manufacturer recommendations. The Quality Assurance Manager will ultimately be responsible for ensuring that the selected laboratory adheres to relevant SOPs. The lab will provide calibration and quality control procedures conducted during the analysis. The laboratory reports will be saved as specified in Section E.I.1.6.b.

For continuous monitoring of operational and field parameters, the calibration resolution for each instrument will follow the resolution specified by the instrument manufacturer. Calibration forms will be scanned in and saved in a cloud-based repository with the field notes as specified in Section E.I.1.6.b. Field notes and calibration forms will be included in semi-annual reports to the EPA as outlined in Table A.III.3-1 in Section A.III Summary of Requirements.

E.I.2.8. Inspection/Acceptance for Supplies and Consumables

E.I.2.8.a/b. Supplies, Consumables, and Responsibilities

Field operations supplies and consumables will be inspected for any deviations from manufacturer specifications (e.g., physical damage, operability) upon receipt. If any supplies or consumables do not meet manufacturer specifications, PCC will coordinate with the vendor for replacement prior to use. Supplies and consumables procured by the laboratory for analysis will be accepted per the established standard methodology or SOP.

E.I.2.9. Nondirect Measurements

E.I.2.9.a. Data Sources

CO_2 plume location over time will be inferred from time-lapse seismic surveys.

Pressure front location over time will be inferred from tracking of micro-seismic events.

Potential CO_2 leaks to the surface will be inferred from ecosystem stress monitoring.

Potential damage to the GS project from seismic events will be inferred from monitoring of regional seismic networks and the dedicated passive seismic network for the project.

E.I.2.9.b. Relevance to Project

Use of time-lapse seismic surveys satisfies the requirement of 40 CFR 146.90(g)(2) for an indirect method to track the extent of the CO_2 plume.

Micro-seismic event tracking satisfies the requirement of 40 CFT 146.90(g)(2) for an indirect method to track the pressure front.

Monitoring of ecosystem stress is a broad area method for indicating a potential CO_2 leak to the surface.

Monitoring of seismic events is a method for indicating potential damage to the subsurface formations and GS project equipment caused by a seismic event.

E.I.2.9.c. Acceptance Criteria

Time slices will be collected from the seismic survey. The results from each new time slice will be compared with results from the previous time slices to ensure the plume progression is reasonable, and each new time slice will be compared with predictions for CO_2 plume location from the computational model. The computational model will be periodically re-calibrated via history matching to verified time slices of the seismic surveys and other data obtained by the GS project.

Computer automation will be used for initial identification of micro-seismic event candidates using the data stream generated by the dedicated passive seismic network. Any event candidate identified by the automated system will be verified by a qualified human seismologist inspection of the data stream before the event is added to the project catalog. In addition, the qualified human seismologist will periodically perform spectral scans of the data stream to identify and verify events missed by the automated system.

Ecosystem stress monitoring relies on the use of multispectral satellite imagery data to make time-lapse measurements of the land surface and vegetation cover across the GS project and at designated target areas/points of interest. Potential anomalies will be initially identified by spatial and temporal comparison of the selected vegetative indices (VIs), such as the common normalized difference vegetation index (NDVI), for each new time slice with previous measurements and their representative statistical data for their background, long-term values. Potential anomalies will be further evaluated using other multispectral vegetation indices available from the satellite imagery data, and compared with other near surface monitoring data. A field investigation will be carried out to resolve any anomalies that persist or cannot otherwise be reasonably explained.

Seismic monitoring will use a combination of reports from regional seismic networks (i.e., the US Geological Survey Advanced National Seismic System [USGS ANSS] network, and the Kansas Geologic Survey [KGS] Seismic Network) and measurements from the dedicated passive seismic network for the project. The regional networks provide verified events using acceptance methods similar to those described above for the dedicated passive seismic network.

E.I.2.9.d. Resources/Facilities Needed

PCC will subcontract all necessary resources needed to acquire and process the seismic survey data.

PCC and subcontractors will use the dedicated passive seismic network to acquire data on micro-seismic events. The resulting data will be analyzed by a qualified subcontractor, then reported to PCC for use in guiding GS project operations.

PCC and subcontractors will access satellite imagery data from the European Space Agency Sentienel-2 mission to compute spatial NDVI and other parameters for each time slice in the time-lapse ecosystem stress monitoring program.

PCC and subcontractors will access verified seismic event data from the USGS ANSS network and the KGS Seismic Network. PCC and subcontractors will combine these data with verified event data from the dedicated passive seismic network to guide GS project operations.

E.I.2.9.e. Validity Limits and Operating Conditions

PCC and subcontractors will process each new time slice of the time-lapse seismic survey data, converting the data from the time domain into the frequency domain and extract the location of the underground CO_2 plume using geophysics-based mathematical principles, supplemented with geo-statistical methods to ensure validity of results over the survey region. Each new time slice will be added to the time-lapse survey catalog to track the plume over time.

PCC and subcontractors will utilize verified micro-seismic event data obtained from the dedicated passive seismic network to guide GS operations. The passive seismic network will be monitored by an automated computer system to detect potential events, with each potential event reviewed by a qualified human seismologist. Events verified by the seismologist will be added to the event catalog and used to guide GS project operations; false-positive events will be discarded. The seismologist will also periodically review the data records for events that were not detected by the automated process.

PCC and subcontractors will compare each new set of spatial NDVI satellite imagery data obtained in the ecosystem stress monitoring program against baseline data and apply statistical methods (e.g., Student t-value) to identify data anomalies that may indicate ecosystem stress. Data anomalies will be further investigated by a human-led field investigation to determine whether the anomalous data are indicative of a leak to surface from the GS project.

PCC and subcontractors will utilize verified seismic event data obtained from the USGS ANSS network and the KGS Seismic Network. Data from these sources are verified by their respective organizations to be within validity limits and operating conditions for the regional networks.

E.I.2.10. Data Management

E.I.2.10.a. Data Management Scheme

The Quality Assurance Manager is responsible for data management and will maintain the required project data as provided elsewhere in the permit. Data will be backed up and/or held on secure cloud servers.

E.I.2.10.b. Recordkeeping and Tracking Practices

All records will be securely held and properly labeled for auditing purposes.

Field sampling data, including field logbooks and field forms, will be maintained. Field logbook entries will be numbered sequentially on the cover page by the Field Team Lead, and a copy of the field forms will be maintained in the project file.

E.I.2.10.c. Data Handling Equipment/Procedures

All equipment used to store data will be properly maintained and operated according to proper industry techniques. The PCC SCADA system and vendor data acquisition system will interface with one another and all subsequent data will be held on a secure server.

E.I.2.10.d. Responsibility

PCC is responsible for ensuring proper data management is maintained.

The Field Team Lead is responsible for documenting all sampling activities and for filling out and submitting the COC to the laboratory. The Field Team Lead will also enter field data from the COCs (e.g., date collected, sample identification, etc.) into the database. Sample locations will be logged on the field forms and the COC.

The QA Manager will be responsible for communicating with the laboratory. The laboratory project manager will submit data via e-mail, which will include sample and QC results.

E.I.2.10.e. Data Archival and Retrieval

All data, including field forms and laboratory data, will be the responsibility of PCC. Back up of work computers and servers will be performed by each company. However, back up policies will be reviewed by and approved of by PCC prior to use for this project. Detailed procedures are considered business sensitive and are not included here. Server back ups are part of a disaster recovery process and stored in an appropriate location. Data will be available to US EPA at any time during the project upon request.

E.I.2.10.f. Hardware and Software Configurations

All hardware and software configurations will be appropriately interfaced.

Hardware used by PCC and our subcontractors must have sufficient capacity and configuration to meet the needs of the project. PCC does not maintain or take responsibility for computers owned by project personnel and as such does not use of such computers as part of this project.

Software used for data management activities includes Microsoft Excel, Microsoft SQL Server, ARCGIS, Autodesk, subcontractor developed data management systems, and other common or off-the-shelf software. Software that is acquired commercially or developed by a subcontractor will be tested by PCC prior to use. Patch management and version upgrades ensure that the baseline software is kept up to date with the latest security patches and upgrades. Any specialized software purchased for the project will be evaluated to ensure it meets the intended use requirements.

E.I.2.10.g. Checklists and Forms

Field forms for the soil gas, shallow groundwater, and LiCOR samples are provided in Attachment E.I.3.

The shallow groundwater form will be utilized for the deep groundwater samples; however, stabilization will not be conducted as the sample will be a grab sample.

E.I.3. Assessment and Oversight

E.I.3.1. Assessments and Response Actions

E.I.3.1.a. Activities to be Conducted

After completion of sample analysis, results will be reviewed for QC criteria as noted in section E.I.2.5. If the data quality fails to meet criteria set in section E.I.2.5., samples will be reanalyzed, if still within holding time criteria. If outside of holding time criteria, additional samples may be collected, or sample results may be excluded from data evaluations and interpretations. Any inconsistencies with the established sampling program will be identified and discussed in all relevant reports and EPA will be notified.

E.I.3.1.b. Responsibility for Conducting Assessments

Table E.I.3-1 defines assessment types, frequencies, organizational roles for PCC and US EPA, and identifies responsible personnel within each organization.

Table E.I.3-1. Project Assessments Table

Assessment Type	Frequency	Organization Performing Assessment	Personnel Responsible for Performing Assessment	Organization Verifying Assessment	Personnel Responsible for Verifying Assessment
QASP - Internal	Annual	PCC	Plant Manager	US EPA	Program Director
QASP - External	Once every 5 years	PCC	Plant Manager	US EPA	Program Director
Data Review	Per sampling event	PCC	Quality Assurance Manager	US EPA	Program Director

E.I.3.1.c. Assessment Reporting

All assessment information will be handled by each individual organization project manager outlined in Section E.I.1.1.a/b.

E.I.3.1.d. Corrective Action

All corrective action affecting only an individual organization's data collection responsibility should be addressed, verified, and documented by the individual project managers and communicated to the other project managers as necessary. Corrective actions affecting multiple organizations should be addressed by all members of project leadership and communicated to other members on the distribution list for the QASP. Assessments may require integration of information from multiple monitoring sources across organizations to determine whether corrective actions are required and/or the most cost-efficient and effective action to implement. PCC will coordinate multiorganization assessments and corrective actions as warranted.

E.I.3.2. Reports to Management

E.I.3.2.a/b. QA Status Reports

The reports described in Section E.I.1.6.a will be provided to the US EPA and contain all required project data, including testing and monitoring information as specified by the US EPA UIC Class VI permit. These reports will include data validation summaries based on procedures described in Section E.I.4, including reasons for rejecting or qualifying data, results from any issue resolution processes, and identified issues pertaining to data limitations or representativeness. PCC is responsible for generating these data validation summaries, and is also responsible for delegating the work to team members responsible for data collection. PCC management will be cc'd on the submittals of these reports and these will serve as reports to management.

This QASP is subject to periodic review and approvals as described in Section E.I.1.1.d and Section E.I.3.1.b. PCC will provide reports on both internal- and external-QASP assessments per the discussion in Section E.I.1.6.a.

Any material changes to testing and monitoring techniques will require a review and update of the QASP, which will be conducted in consultation with US EPA with US EPA approval of the revised QASP. Revised QASPs will be distributed by PCC to all individuals on the Distribution List.

E.I.4. Data Validation and Usability

E.I.4.1. Data Review, Verification, and Validation

E.I.4.1.a. Criteria for Accepting, Rejecting, or Qualifying Data

Data review, verification, and validation of field and laboratory data for the above confining zone groundwater, injection zone groundwater, and soil vapor/gas samples will be performed by PCC or its qualified designee through review of documentation of field procedures and comparison of the field measurements to the entire sample set. Data validation will be completed to determine if any data outliers are present and if there are explanations for the outliers. Knowing the limitations of the data is critical when interpreting site data. Qualified data may be usable so long as the data limitations are considered. Professional judgment may be required during the data validation process.

A US EPA Level 2 data validation will be performed on the laboratory data according to US EPA guidelines. The objective of data validation is to identify any unreliable or invalid laboratory measurements and qualify those data for interpretive use. Laboratory data validation is reported by using data qualifiers and adjusting reporting limits as necessary (EPA 2020a, EPA 2020b, EPA 2020c, and Trihydro Data Validation Variance Documentation, March 2023).

E.I.4.2. Verification and Validation Methods

E.I.4.2.a. Data Verification and Validation Processes

Precision
Precision is the amount of scatter or variance that occurs in repeated measurements. Precision acceptance and rejection for the project will be based on the RPDs of the field and laboratory duplicates. When both values of the field/duplicate pair are greater than five times the reporting limit (RL) for a given analyte, analytical results for the duplicate samples will be evaluated using RPD. RPD is obtained by dividing the absolute value difference between the field and duplicate

samples by the average of the two measurements and multiplying by 100 to convert the value to percent. RPD will be calculated as follows:

$$RPD(\%) = \frac{100(A - B)}{C}$$

where:

A = analyte concentration determined analytically from the primary sample

B = the analyte concentration determined analytically from the duplicate sample

C = the average analyte concentration determined analytically from the primary and duplicate samples

When field duplicate analysis results for a given analyte exceed 30% RPD for aqueous samples, 50% RPD for soil samples, and 25% RPD for air samples, and the field sample and duplicate sample results are greater than five times their respective RLs, the results will be considered estimated (unless site-specific conditions indicate a high degree of heterogeneity is expected in the measured parameter).

Accuracy

Accuracy is the degree of agreement of a measurement or an average of measurements with an accepted reference or true value and is a measure of bias in the system. The accuracy of a measurement system is affected by errors introduced through the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analytical techniques.

Accuracy acceptance or rejection will be based on the percent recovery (%R) of the laboratory MS and the LCS. To determine accuracy, the %R for each MS and LCS will be compared to the acceptable range as specified in the applicable laboratory method and/or US EPA data validation guidelines. Accuracy will be evaluated using the %R calculated using the following equation:

$$\%R = \frac{100(A - B)}{C}$$

where:

A = the target analyte concentration determined analytically from the spiked sample

B = the background level determined by a separate analysis of the non-spiked sample

C = the concentration of spike added

Field sample results associated with MS %Rs and/or LCS %Rs outside of control limits will be considered as estimated or will be rejected, as appropriate, in accordance with US EPA criteria.

Although accuracy of the field program cannot be assessed quantitatively, sample handling, shipping, preservation, and holding time will be used for a qualitative accuracy assessment for this project. Laboratory accuracy will be assessed quantitatively through the analyses of

MS/MSD samples, LCS/LCSD samples, standard reference materials, and surrogate spikes (organic analyses only).

Representativeness

The objective in addressing representativeness is to assess whether measurements obtained during the investigation reflect site conditions in the sampling unit or target area. Representativeness is evaluated by review of sampling design to confirm that areas reasonably suspected to have different characteristics were sampled separately. Representativeness will be examined after sample data have undergone data validation. The systematic sampling design will help to ensure a data set that fully represents the conditions at the site. If data gaps are identified following the completion of the initial sampling, such that additional data are needed to acquire a fully representative data set, additional sampling and analysis will be planned for and completed.

Completeness

The objective in addressing completeness is to assess whether enough data have been collected and are valid to meet the project's requirements and goals. Completeness is evaluated by comparing the number of valid sample results to the number of samples collected and will be calculated as follows:

$$Percent\ Complete(\%) = \frac{100n_A}{n_I}$$

where:

n_A = the actual number of valid analytical results obtained
n_I = the theoretical number of results obtainable under ideal conditions

The completeness target goal for this project is 90% or higher.

E.I.4.2.b. Data Verification and Validation Responsibility

PCC or its designated subcontractor will verify and validate groundwater and soil gas sampling data. PCC, through the Quality Assurance Manager, is ultimately responsible for managing data verification and validation.

E.I.4.2.c. Issue Resolution Process and Responsibility

The Quality Assurance Manager will overview the data handling, management, and assessment process. Staff involved in these processes will consult with the Coordinator (designated by the Quality Assurance Manager) to determine actions required to resolve issues.

In the case of issues identified during verification and validation of groundwater and soil gas data, the data point will be notated with a flag (e.g., "J" for estimated concentration based on a reported value less than a limit of quantitation but greater than a method detection limit) when presenting in the reports described in Section E.I.1.6.a. Definitions of each flag will be included as footnotes when presenting these data.

E.I.4.2.d. Checklist, Forms, and Calculations

Checklists and forms will be developed specifically to meet permit requirements.

E.I.4.3. Reconciliation with User Requirements

E.I.4.3.a. Evaluation of Data Uncertainty

Data uncertainty will be evaluated by methods considering the US EPA 2009 Unified Guidance (EPA 2009).

E.I.4.3.b. Data Limitations Reporting

The organization-level project managers will be responsible for ensuring that data developed by their respective organizations is presented with the appropriate data-use limitations. These limitations will be included in the reports to EPA described in Section E.I.1.6.a.

E.I.5. References

API 2017, Manual of Petroleum Measurement Standards Chapter 14-Natural Gas Fluids Measurement, Section 1-Collecting and Handling of Natural Gas Samples for Custody Transfer, American Petroleum Institute, Washington, DC, Seventh Edition May 2016, Addendum August 2017, Errata August 2017.

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EPA. 2009. Statistical analysis of groundwater monitoring data at RCRA facilities, Unified Guidance. EPA 530/R-09-007. March 2009.

EPA. 2020a. Review of field duplicates were conducted according to the US EPA Region 1 – New England Environmental Data Review Supplement for Region 1 Data Review Elements and Superfund Specific Guidance/Procedures, QADR-Supplement2, September 2020.

EPA. 2020b. Data for organic analyses were evaluated according to validation criteria set forth in the USEPA CLP National Functional Guidelines for Organic Superfund Methods Data Review. EPA-540-R-20-005. November.

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EPA. 2023. Groundwater Sampling – Operating Procedure; Region 4 – LSASDPROC-301-R6, Effective Date April 22, 2023, SOP Author Doug Peters.

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NACE. 2018. Preparation, Installation, Analysis, and Interpretation of Corrosion Coupons in Oilfield Operations, NACE Standard SP0775-2018-SG, Association for Materials Protection and Performance (formerly NACE International), Houston, TX, 2018

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