

SITE-SPECIFIC WATER QUALITY MONITORING PLAN
Chico 4-65 26-25 North
Location ID TBD

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Prepared
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ATTACHMENTS

Attachment A Colorado Oil and Gas Conservation Commission Model Sampling and Analysis Plan Rules 609 and 318A.e(4) Colorado Oil and Gas Conservation Commission Version 2

Attachment B Chico 4-65 26-25 North Well Pad Area Map with One-Half and One-Mile Radius Water Wells and Surface Waters Identified

Attachment C Surface Water Identified - One -Half-Mile Radius

Attachment D DWR Water Sources Identified - One-Half-Mile Radius Water Wells

1.0 INTRODUCTION

This site-specific water quality monitoring plan was developed by Apex Companies, LLC (Apex) on behalf of Crestone Peak Resources Operating, LLC (Crestone) to address Arapahoe County's requirements for a Groundwater and Surface Water Sampling and Monitoring report/plan (Plan) to demonstrate how the development and operations of the facility will avoid adverse impacts to surface and ground waters in Arapahoe County, identify all private and community permitted water wells of public record within one half-mile (2,640 feet), and demonstrate compliance with and implementation of standards set by the county as specified in the Arapahoe County Amended Oil and Gas Regulations Groundwater and Surface Water Sampling and Monitoring Section F.9. dated November 14, 2023.

Unless specifically stated, all procedures, guidelines, and reporting requirements will be completed in accordance with the Colorado Energy and Carbon Management Commission (ECMC), formerly Colorado Oil and Gas Conservation Commission, Model Sampling and Analysis Plan (Model SAP) (**Attachment A**), and ECMC Rule 615.

2.0 ENVIRONMENTAL DUE DILIGENCE

The following describes the process Crestone used for identifying all sampling / monitoring locations within a one-half-mile radius and the frequency of sampling / monitoring prior to the Construction Phase at Chico 4-65 26-25 North (Chico North) pad.

Water sources and associated reference data for this effort were acquired from publicly available datasets, including the Colorado Division of Water Resources (DWR) and the United States Geological Survey (USGS) National Hydrography Dataset (NHD). Spatial analysis will be completed using queries in a geographic information system (GIS) desktop environment.

For purposes of the assessment, water sources included perennial surface water and water wells that are registered with DWR, including household, domestic, livestock, irrigation, municipal/public, and commercial wells, permitted or adjudicated springs, or monitoring wells installed for the purpose of complying with groundwater baseline sampling and subsequent monitoring requirements under ECMC Rule 615.

When evaluating locations as potential available water sources (AWS) for sampling / monitoring, Crestone shall consider water sources for which the water well owner, owner of a spring, or a landowner, as applicable, has given consent for sampling and testing and has consented to have the sample data obtained made available to the public, including without limitation, being posted on the ECMC website.

2.1 Surface Water Identification

Using data obtained from USGS NHD, Crestone identified all surface water features within a one-half-mile radius of Chico North. Features included in the review, but not necessarily in the findings, included naturally occurring and constructed bodies of surface water (lakes, ponds, and reservoirs), paths through which water flows (canals, ditches, streams, and rivers), and related entities such as point features (springs, wells, stream gages, and dams), see **Attachment B** for area map. In addition, Crestone reviewed ECMC designated public water system (PWS) protection areas to determine the applicability of ECMC Rule 411.a and Rule 411.b.

During the desktop assessment, the proposed Chico 4-65 26-25 North was not located in a PWS area and no further evaluation is required. No perennial streams were identified within a one-half-mile radius. The surface water identification assessment results and distances are provided in **Attachment D**, Surface Water Identification.

As required in **Arapahoe County** Amended Oil and Gas Regulations Groundwater and Surface Water Sampling and Monitoring Section F.9.(i), Crestone shall conduct flowline monitoring in accordance with the requirements of ECMC Rule 1102.

2.2 Sampling Frequency

When applicable, Crestone will sample and test, on a one-time basis, down-gradient perennial surface waters within one-half mile of the Oil and Gas Facility prior to the construction phase.

2.3 Water Source Identification

Crestone identified all AWS within a one-half-mile radius of the Chico North location and evaluated the DWR water sources using the selection, exception, and timing criteria identified in ECMC Rule 615. Those criteria include DWR permit status, proximity to the proposed oil and gas production surface location, type of water source, orientation of sampling locations, source aquifer, direction of groundwater flow, and condition of water sources, among others. All identified water sources within the one-half-mile radius are shown on the attached map (**Attachment B**). An inventory of DWR water sources is attached (**Attachment D**).

Crestone will send a notice letter to all property owners of water sources identified within the one-half-mile radius of the proposed Oil and Gas facility to inform those water source owners of the opportunity to have their water wells sampled prior to drilling.

As shown in the area map (**Attachment B**) and DWR water sources inventory (**Attachment D**), **one available water source was identified** within the one-half-mile radius. A good faith effort will be made to contact the respective water source owner(s) to request and obtain permission for site access and collect water samples, including the acknowledgment that the sample data will be accessible to the public through the ECMC website and submitted to **Arapahoe County**.

2.4 Sampling Frequency

When applicable, Crestone will perform initial baseline sampling and testing of all identified AWS prior to drilling wells on the Oil and Gas Facility. Crestone will also perform subsequent sampling and testing of the same AWS within six months of drilling the Oil and Gas Facility, again within 24-months of completion of any well on the Oil and Gas Facility, and thereafter every 24-months for the life of all oil and gas wells on the Oil and Gas Facility.

3.0 FIELD ASSESSMENT

Baseline and subsequent water quality scheduling, field assessments, sampling processes and procedures, and data evaluations will be completed using standard industry procedures consistent with the Model SAP (**Attachment A**) and as defined in the Plan.

3.1 Surface Waters

After desktop identification, each potential sampling / monitoring location will be field verified for viability for water chemistry assessments. Surface water chemistry sampling will follow the list of compounds included in ECMC Rule 615.

3.2 Water Sources

Data evaluation of all water well samples will be completed in accordance with the Model SAP, see **Attachment A**.

4.0 PROTECTION AND MITIGATION MEASURES

Crestone has implemented the following measures to protect water bodies and avoid degradation:

- Well design (integrity testing, casing depth, etc.) in accordance with applicable ECMC rules;
- Stormwater Best Management Practices (BMPs);
- Onsite materials management BMPs;
- Permanent site detention with monitoring and maintenance plan;
- Spill Prevention Control and Countermeasures Plan (SPCC); and
- Pre-Construction Downgradient Surface Water Baseline Assessment and Spill Response:
- Prior to commencing construction activities, the operator will conduct a baseline assessment of nearby downgradient surface water features.

If Crestone identifies degradation to water well quality as a result of its oil and gas development, Crestone shall be responsible for mitigating the degradation of water quality to the applicable regulatory standards as defined by Arapahoe County. An Action Plan will be developed and provided to Arapahoe County for comment and review on a case-by-case basis depending on the degradation observed and the degree of impairment. The Action Plan will identify any potential sources of leaks, spills, or releases from the pad or from the oil and gas operations that contributed to the contamination, and Crestone will implement appropriate and effective corrective measures.

If degradation is identified within any perennial surface water features located within one half-mile of the Oil and Gas Facility, or in the unlikely event there is evidence of contamination or a release occurring at the location, Crestone will implement an Action Plan that includes:

- Bi-monthly inspections of the nearest downgradient surface water features within one half-mile of the Oil and Gas Facility for a period of three months following the release.
- If a visible sheen or petroleum odor is detected during inspections, the operator will promptly collect will sample and monitor the identified surface water for any contamination in accordance with the standards set forth in ECMC Rules 615(e) and 913.b.(2) or, as such, Rules may be amended from time to time.
- Arapahoe County Planning Division will be notified of any confirmed release, and the results of subsequent water testing will be submitted to them upon receipt.

5.0 REPORTING RESULTS

Crestone will provide copies of all test results to Arapahoe County and the water source owners within two months of the sampling event and include an action plan if necessitated. Crestone will electronically submit all results to the ECMC and Arapahoe County and mail a hard copy of the results to the water source owners within two months unless otherwise requested by the owner.

6.0 REFERENCES

Arapahoe County (2023). *Amended Oil and Gas Regulations*. Retrieved November 30, 2023, from https://files.arapahoeco.gov/Public%20Works_Development/oil%20and%20gas/Oil%20and%20Gas%20Approved%20Amendments112023.pdf

Colorado Oil and Gas Conservation Commission (2020). *Model Sampling and Analysis Plan Rules 609 and 318A.e(4) Colorado Oil and Gas Conservation Commission Version 2* Retrieved May 28, 2020, from https://cogcc.state.co.us/documents/about/COGIS_Help/COGCC_Model_SAP_20200414.pdf

Colorado Energy and Carbon Management Commission (2022). *Rules*. Retrieved April 1, 2022, from https://files.arapahoeco.gov/Public%20Works_Development/oil%20and%20gas/Oil%20and%20Gas%20Approved%20Amendments112023.pdf

7.0 ACRONYMS

ECMC – Energy and Carbon Management Commission
Crestone - Crestone Peak Resources Operating, LLC
Plan - Groundwater and Surface Water Sampling and Monitoring report/plan
COGCC - Colorado Oil and Gas Conservation Commission
Model SAP - Model Sampling and Analysis Plan
ECMC Rule 615
DWR - Colorado Division of Water Resources
USGS - United States Geological Survey
NHD - National Hydrography Dataset
GIS - Geographic Information System
AWS - Available Water Sources
PWS - Public Water System

Attachment A

Colorado Oil and Gas Conservation Commission Model Sampling and Analysis Plan
Rules 609 and 318A.e(4) Colorado Oil and Gas Conservation Commission Version 2



COLORADO

**Oil & Gas Conservation
Commission**

Department of Natural Resources

Model Sampling and Analysis Plan

Rules 609 and 318A.f

Colorado Oil and Gas Conservation Commission

Version 2

April 2020



2019 Review and Revisions by
Apex Companies, LLC & COGCC staff

REVISION HISTORY

Effective Date	Reviewer/Approver	Description (Review or Nature of Revisions)
May 1, 2013	COGCC	Version 1 SAP approval and implementation
August 2019	H. Shideman (Apex) / P. Gintautas (COGCC) A. Koepsell (COGCC)	Version 2 SAP review and updates

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1.0 – INTRODUCTION

The Colorado Oil and Gas Conservation Commission (COGCC) has prepared this model sampling and analysis plan (SAP) for parties who engage in sampling and analysis activities for Rule 609 - Statewide Groundwater Sampling and Monitoring (609), and Rule 318A.f – Groundwater Baseline Sampling and Monitoring in the Greater Wattenberg Area (GWA) which originally was rule 318A.e(4) approved during rulemaking in 2013 (COGCC Order 1R-116). This SAP document will be modified as necessary based on new procedures, protocols, and other information that need to be incorporated to meet the objectives of the rules. Rule 318A.f is the present rule number applicable in the GWA area after a clean-up rulemaking in 2014 and this rule number change became effective in 2014 (COGCC Order 1R-120).

As stated in Cause No. 1R Docket No. 1211-RM-03 Order 1R-116 Statewide Water Sampling and Monitoring (new Rule 609 and amended Rule 318A.e.(4), the statement of basis and purpose for these rules are:

"The purpose of the new and amended water sampling rules is to gather baseline water quality data prior to oil and gas development occurring in a particular area, and to gather additional data after drilling and completion operations. The water quality data generated under the rules will be publicly available on the Commission's web site. Acquiring this data and making it publicly available will inform relevant stakeholders, including public officials, of baseline groundwater quality, and may aid in early detection of any adverse impacts related to oil and gas activity. Similarly, the sampling program may identify existing groundwater contaminants, which can then be properly treated."

The timing and frequency of the sampling is described in the rules themselves and will not be described in detail in this SAP.

Sampling must be conducted in a way that employs "best practice protocols" designed for the collection of samples that are representative of groundwater at the site. Methods and techniques used in the analysis of the groundwater samples must be capable of providing both accurate and precise measurements from representative aliquots of groundwater for analysis. It is important to use well documented analytical processes so that different laboratories are capable of producing comparable accurate data. The goal of any environmental sampling program is to ensure precision, accuracy, representativeness, comparability, and completeness of the data. These principals must be carried forward for sampling and analysis efforts designed to meet requirements of rule 609 and rule 318A.f. Equally important is the assurance that the methods and processes of analysis will yield reproducible results at reporting thresholds that are adequate to evaluate potential changes in water quality.

The groundwater sampling and analysis procedures outlined in the SAP are designed to provide consistency in sampling and analytical techniques. The use of the original laboratory's electronic data deliverable (EDD) files in the COGCC format is also an essential part of ensuring that the data are accurately captured for later evaluation. The upload process allows efficient data handling and transfer and can eliminate the need to check for data transcription errors that are an inevitable result of manual data entry. Documentation of sample location and condition of an available water source (AWS) and its current use, along with field observations about the water sample, such as effervescence, reported taste, and odor, are also important. The field observations acquired at each site must be recorded and submitted into the COENV database in addition to the laboratory generated analytical data.

2.0 - PRE-SAMPLING ACTIVITIES

Water sources will be selected based on the definition in the COGCC 100 Series Definitions and further refined based on criteria contained in 609 and 318A.f. Water sources within the areas where sampling is required can be identified using the COGCC GIS Online interactive map as outlined in the COGCC guidance to operators (COGCC, 2015). An oil and gas operator (Operator) must make good faith efforts to identify the owner of the water source

and obtain permission for site access, including the acknowledgement that the sample data will be accessible to the public through the COGCC website.

An Operator shall review Division of Water Resources (DWR) online permit records for water source construction, depth, casing diameter, reported static water level, and initial flow rate/yield prior to the water source sampling. During the initial sampling, the location of the water source must be surveyed in accordance with COGCC Rule 215. Confirmation of the location of the water source should be confirmed during subsequent sampling events.

Before or during the sampling, the landowner should be interviewed regarding current water source conditions and knowledge of any discrepancies between the DWR records and the current water source configuration. Data should also be collected on recent water source use(s) and water quality concerns such as observations or recent changes in appearance, taste, and odor.

3.0 - SAMPLE COLLECTION

All samples shall be collected by individuals experienced with water quality sampling and sent to a laboratory accredited by the National Environmental Laboratory Accreditation Program (NELAP) in general and, more importantly, for analytical procedures and analytes of concern in this SAP. Guidance for general sampling practices can be found in ASTM D4448-01 (Reapproved 2019) Standard Guide for Sampling Ground-Water Monitoring Wells, ASTM D5358-93 (2019) Standard Practice for Sampling with a Dipper or Pond Sampler, and/or ASTM D5088-15a (2015) Standard Practice for Decontamination of Field Equipment used at Waste Sites.

A complete set of samples should be obtained from each available water source, as specified in 60g and 318A.f, and at a minimum analyzed for the required analytes listed in Table 3-1.

The individual collecting the samples should wear new, disposable, powder free, nitrile gloves to prevent possible contamination of the samples. At a minimum, the gloves should be changed following the collection of each sample, or more frequently, as needed.

In order to prevent cross contamination of samples, disposable sampling equipment should be used whenever possible. Samples will be placed in clean laboratory-supplied, disposable polyethylene or glass bottles containing the appropriate preservative aliquot, as applicable. All non-disposable equipment (e.g., sampling pumps with non-disposable tubing, dippers, beakers, sample collection tubing, valve assemblies, etc.) and instruments that contact the samples must be decontaminated prior to use and between sample locations using the following ASTM D5088-15a procedures:

- 1) Remove gross contamination by dry brushing followed by a tap water rinse;
- 2) Wash with a laboratory grade detergent solution, such as Alconox® or equivalent;
- 3) Detergent solutions should be circulated through sampling pumps and non-disposable discharge tubing to decontaminate this equipment;
- 4) Rinse with tap water;
- 5) Rinse with distilled or deionized water;
- 6) Air dry; and
- 7) Decontaminated equipment should be stored in sealed containers such as zipper-lock plastic bags or boxes with tight lids to protect from airborne dust contamination during mobilization to the next site and prior to use.

Initial decontamination should be performed prior to arriving at a sampling location. All decontamination solutions should be collected, properly disposed, and documented in accordance with applicable federal, state, and local regulations.

Table 3-1 – Minimum Required Laboratory Analytes

Analyte	Filter, Container, and Preservative	Lab Method, Holding Time, LLO
General Water Quality Parameters		
pH	Unfiltered, Plastic, Unpreserved & 4°C	SM4500-H+ or SW846 9040C, < 15 minutes, NA
Specific Conductance (Conductivity)		SM2510B or SW846 9050A, 28 days, NA
Solids, Total Dissolved (TDS)		SM2540C, 7 days, 10 mg/L
Bicarbonate, Carbonate and Total Alkalinity (as CaCO ₃)		SM2320B, 14 days, 10 mg/L
Major Anions		
Bromide (Br)	Unfiltered, Plastic, Unpreserved & 4°C	EPA 300.0 or SW846 9056A, 28 days, 0.2 mg/L
Chloride (Cl)		EPA 300.0 or SW846 9056A, 28 days, 0.1 mg/L
Fluoride (F)		EPA 300.0 or SW846 9056A, 28 days, 0.2 mg/L
Sulfate (SO ₄ ²⁻)		EPA 300.0 or SW846 9056A, 28 days, 5 mg/L
Phosphorus (P)		EPA 365.1 or SM4500-PA, NA, 0.05 mg/L
Nitrate as N (NO ₃)		EPA 300.0 or SW846 9056A, 48 hours, 0.1 mg/L
Nitrite as N (NO ₂)		EPA 300.0 or SW846 9056A, 48 hours, 0.1 mg/L
Nitrate & Nitrite as N		By summation of results of NO ₃ and NO ₂ analyses by 300.0 or 9056A (above)
Nitrate & Nitrite as N	Unfiltered, Plastic, preserved with H ₂ SO ₄ & 4°C unless analyzed in 24 hours of collection	SM4500-NO ₃ F or EPA353.3, 28 days, 0.1 mg/L
Major Cations (dissolved)		
Calcium (Ca)	Filtered (0.45µm) at lab, Plastic, HNO ₃ Preserved to pH<2 at lab & 4°C	EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 1 mg/L
Iron (Fe)	May also be filtered in the field and then immediately preserved to pH<2	EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.1 mg/L
Magnesium (Mg)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 1 mg/L
Manganese (Mn)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.01 mg/L
Potassium (K)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 1 mg/L
Sodium (Na)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 1 mg/L
Other Elements (dissolved)		
Barium (Ba)	Filtered (0.45µm) at lab, Plastic, HNO ₃ Preserved to pH<2 at lab & 4°C	EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.001 mg/L
Boron (B)	May also be filtered in the field and then immediately preserved to pH<2	EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.1 mg/L
Selenium (Se)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.001 mg/L
Strontium (Sr)		EPA 200.7/200.8 or SW846 6010D/SW846 6020A, 180 days, 0.01 mg/L

Table 3-2 – Minimum Required Laboratory Analytes (continued)

Analyte	Filter, Container, and Preservative	Lab Method, Holding Time, LLQ
Dissolved gases		
Methane (CH ₄)	Preferred – In-line sample collection system container such as Isoflask® with bactericide present in sampling device, per laboratory specifications Alternate- Unfiltered, 40ml VOA vial, may be preserved with HCl to pH<2 & 4°C	Lab-specific SOP for analysis if in-line sample collection vessel such as IsoFlask® used. RSK175 (for use with 40ml vials); 14 days preserved, 7 days non-preserved, recommend 48 hours; 0.005mg/L
Ethane (C ₂ H ₆)		
Propane (C ₃ H ₈)		
Compositional and Isotopic Analysis (if [CH ₄ , Dissolved]>1mg/L)		
Fixed Gases C1-C6 (Gas Chromatograph Concentrations of N ₂ , O ₂ , CO ₂ , Ar, H ₂ , He, CH ₄ , C ₂ H ₆ , C ₃ H ₈ , iC ₄ H ₁₀ , nC ₄ H ₁₀ , iC ₅ H ₁₂ , nC ₅ H ₁₂ , iC ₄ , nC ₄ , iC ₅ , nC ₅ , and C ₆ +).	Preferred – In-line sample collection system container such as IsoFlask® with bactericide in sampling device, per laboratory specifications Alternate- 1000ml plastic with septa sealed lid with bactericide preservative added by lab in gel capsule	Lab Specific SOP, 6 weeks, NA
mass spectrometric determination of δ ¹³ C of CH ₄ , and δD of CH ₄ and δ ¹³ C of C ₂ H ₆ , and δ ¹³ C of C ₃ H ₈ (If present at concentrations great enough to yield accurate data)		
Organic Analytes		
Benzene, toluene, ethylbenzene, o-xylene, m-+p-xylene, total xylenes (by sum of xylene isomers)	Unfiltered, 40ml VOA vial, HCl to pH<2 & 4°C	SW846 8260D, 14 days, 1 µg/L
Total Petroleum Hydrocarbons (TPH) (volatile) as Gasoline Range Organics (GRO) using retention time window between 2-methylpentane to 1,2,4-trimethylbenzene (approx.. C ₆ to C ₁₀ range)		SW846 8015C and modifications or SW846 8260D and modifications, 14 days, 0.05 mg/L
TPH (extractable) as Diesel Range Organics (DRO) using retention time window of C ₁₀ -C ₂₈ Range	Unfiltered, 1L Amber Glass, & 4°C	SW846 8015C and modifications, 7 days, 0.5 mg/L
Bacterial Activity Reaction Tests		
Iron Related Bacteria	Unfiltered, Sterile Plastic, Unpreserved & 4°C	BART Method, days to reaction or 100cfu/100ml, test should be initiated within 24-48 hours of sample collection
Slime Forming Bacteria		
Sulfate Reducing Bacteria		

NA - Not Applicable

3.1- Sample Labeling

Sample containers should be properly labeled prior to, and/or during field work. Labels will be completed with indelible ink and will include the following minimum information:

- 1) Sample identification number (Facility ID created in the COGCC Environmental (COENV) database);
- 2) Water source name;
- 3) Sampler's initials;
- 4) Date and time of collection, and
- 5) Preservation type.

Labels can be waterproof stickers, tags, or written directly onto the container and can be covered with clear plastic tape after being filled out to keep the ink from running due to contact with water during sampling and moisture in the sample shipping cooler. Containers should be free from all other labels to prevent confusion.

3.1.1 - Facility Naming Convention

The facility name shall be generated based on the following naming convention:

- Water sources such as permitted water wells, monitoring wells or adjudicated springs will have a facility name which includes last name of the landowner followed by the permit number assigned by the DWR.
- Sources without an assigned permit number such as some livestock wells, other types of wells, or surface locations without an assigned permit number will have a facility name created by entering the landowner's last name followed by Quarter-Quarter, Section, Township, and Range.

3.2 – Water Source Sampling

Standard monitoring well sampling protocols require purging a specified number of well volumes prior to collecting water samples (ASTM D6452-18, 2018). However, most available water sources are used frequently, have longer screen intervals or open boreholes, are equipped with fixed depth high flowrate pumps, and water collection is not taken directly from the wellhead but rather through the closest practical sampling point; therefore, standard groundwater monitoring well sampling protocols may not be appropriate at all sites (Molofsky et. al, 2018). It is recommended that a withdrawal point, upstream of ancillary equipment (e.g. holding tanks, pressure tanks, water softeners, water treatment systems, conveyance piping, etc.) be identified. If no withdrawal points upstream of ancillary equipment are available, best judgement should be utilized in purging to flush the water holding capacity of piping and any equipment upstream of the withdrawal point (US EPA, 2017a). Specifically, purge calculations should include the water holding capacity of the pressure tanks to limit the potential CH₄ loss (Molofsky et. al, 2018).

An Operator must document, in detail, their procedures and provide the procedures to COGCC staff, upon request. Once the purge method has been established at specific water sources, the same procedure will be utilized for all subsequent sampling at the specific water source (Molofsky et. al, 2018).

3.2.1 - Water Source Purging

Instructions for acceptable water source purging practices can be found in ASTM D6452 - 18 Standard Guide for Purging Methods for Well Used for Groundwater Quality Investigations (2018); ASTM D6771-18 Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (2018); Purging and Other Sampling Variables Affecting Dissolved Methane Concentration in Water Supply Wells (Molofsky et. al, 2018); Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures (Puls and Barcelona, 1996); and EPA Operating Procedure Groundwater Sampling, Number SESDPROC-301-R4 (2017a).

Water sources will be purged prior to sampling to obtain a water sample representative of the aquifer. The purging methods described below are meant to be used as guidelines, but may change with site conditions, purpose of sampling, and/or landowner concerns. Two methods for purging water sources are recommended:

- 1) fixed wellbore volume purging techniques, or
- 2) purging until stabilization of water quality parameters.

Many domestic water wells in Colorado yield a few hundred gallons, or less, per day, which may still provide adequate water volume to the users. As part of the pre-sampling activities, the samplers must determine if, during normal use, the water source has been purged frequently. If the well is used frequently, a representative sample can be collected after purging <1 wellbore volume (Molofsky et al., 2018). It is recommended to use the stabilization of water quality parameters method, discussed below, with detailed notes of well use recorded on the field sampling data sheet (Attachment 1). It is always prudent to take a conservative approach, utilizing low flow and/or low volume purging techniques (Puls and Barcelona, 1996; COGCC, 2008).

Regardless of purge method, onsite collection of water quality operational and indicator parameters such as water volume purged, visual and olfactory observations such as presence or absence of odor, bubbles or effervescence, qualitative determination of color of water if any, presence or absence of sediment, quantitative measurements of pH, water temperature, and conductivity must be monitored during the purge and recorded on a field sampling data sheet. Field parameter measurements should be collected using a multi-parameter instrument, utilizing an in-line flow-through device (ASTM D4448-01, 2019; ASTM D6452-18, 2018; ASTM D6771-18, 2018; Puls and Barcelona, 1996). Parameter stabilization is defined in Table 3-3 and is achieved once three successive measurements, taken 3 to 5 minutes apart, are within recommended ranges (ASTM D6771-18; Puls and Barcelona, 1996). It is also recommended that quantitative instrumental determination of oxygen-reduction potential (ORP), dissolved oxygen (DO), and turbidity be measured and recorded at each sampling site.

Table 3-3 - Field Parameters

Field Parameters	Field Methods	Lower Limit of Quantification (LLQ)	Parameter Stabilization Criteria ¹
Volume Water Purged Prior to Sampling	Measured Volume	NA	NA
Odor	Olfactory	NA	NA
Water Color	Visual, Photo	NA	NA
Bubbles	Visual, Photo	NA	NA
Effervescence	Visual, Photo	NA	NA
Sediment	Visual, Photo	NA	NA
pH	Field Meter	NA	±0.2 SU
Specific Conductance	Field Meter	NA	±3 % µS/cm
Temperature (water)	Field Meter	NA	±0.3 % °C
Dissolved Oxygen	Field Meter	NA	±10 % or ± 2 mg/L, whichever is greater
Turbidity	Field Meter	NA	±10 % or ± 1 NTU, whichever is greater
Oxygen Reduction Potential	Field Meter	NA	±10 % or ± 10 mV, whichever is greater
%LEL and/or CH ₄	4-Gas Meter	Range (0-100%)	NA

NA - Not Applicable, Required Parameters, Recommended Parameters

If the water source is not routinely operated under normal use, volumetric purging with a minimum of three to five casing volumes should be purged prior to sampling (EPA, 2017a). After the volumetric purge, flow rates will be decreased to avoid drawdown in the water source, turbulence in the well bore, and to ensure any gas is not agitated out of solution.

Landowners frequently wish to capture the purge water in a cistern or portable tank, or to use in watering landscape features such as trees or shrubs. If purge water is not allowed to be discharged on location, it will be collected in portable tanks and stored on-site until the water can be transported and properly disposed off-site.

3.2.2- Water Source Sample Collection

Wells should be sampled immediately following purging. Samples should be collected and preserved as unfiltered, filtered, or dissolved gas samples, according to the specific sampling methods described below.

3.2.2.1 - Collection of Unfiltered Groundwater Samples

Unfiltered sample(s) containers should be filled directly from the pump discharge point (or via ¼" polyethylene tubing connected to the pump) into the laboratory-supplied sample containers. If sampling from a tap equipped with an aerator, the aerator should be removed, with landowner consent, prior to the sampling. If an in-line flow-through device was used during the purging, it should be disconnected or bypassed during sample collection (Puls and Barcelona, 1996). Preservation of unfiltered groundwater samples with acids should be done for certain analyses as listed in Table 3-1. The samples for analysis of volatile aromatic organic compounds and volatile petroleum range hydrocarbons will be collected in a manner that minimizes agitation, aeration, and overfill which would typically be done by direct fill of the 40ml vials.

3.2.2.2 - Collection of Filtered Groundwater Samples

Filtration and preservation at the laboratory are preferred; however, in some instances, field filtration is necessary.

When field filtration is necessary, samples will be filtered during collection using an in-line disposable 0.45-micron (µm) glass-fiber filter. When field filtering is performed, disposable tubing with the in-line filter will be connected directly to the pump discharge spigot, if possible. The pressure from the spigot/discharge point will be used to push water through the filter into the sample bottle. Alternatively, the in-line filter can be connected with tubing to a peristaltic pump to draw water from a pre-cleaned container through the filter. In all cases, the tubing and filter will be flushed with at least one liter of sample water before sample collection, and filtered water will be placed into laboratory provided sample containers. New filters will be used for each sample and decontamination procedures will be strictly followed. Preserve samples for metals analysis as listed in Table 3-1 if container did not have acid in the container provided by the lab.

3.2.2.3 - Collection of Groundwater Samples from Water Sources for Dissolved Gas Analysis

Groundwater samples collected for dissolved gas analysis from water sources with permanent pumps will be collected in IsoFlask® or equivalent in line sampling devices or by direct fill into non-preserved 40mL VOA vials equipped with gas-tight septa as described on Molofsky et al. (2016). Collection of samples utilizing in line sample collection devices such as outlined in Molofsky et al. (2016) is the preferred means of sampling for dissolved gas analysis. If bubbles are visible in 40ml vials then another sample will be collected. If it is not possible to get a bubble-free 40ml sample because the water is too effervescent, a vial with gas headspace is acceptable. The Operator should note this on the chain-of-custody (COC) and notify the laboratory that headspace was present in the field. In-line sampling containers may contain bactericide as preservative thus no acid should be added to the in line sample device before or after sample collection. Samplers should follow preservation guidance from the laboratory if using 40ml vials to collect samples. Many reports by and to COGCC staff indicate that acid preservation of certain types of groundwater samples (particularly those with elevated bicarbonate/carbonate alkalinity levels results in increased headspace in sealed 40ml vials which may lead to inaccurate analytical results of the dissolved gas analytes. Some laboratories have recommended use of a bactericide such as benzalkonium chloride for preservation of 40ml vial samples for dissolved gas analysis which

may be preferable to acid preservation techniques for this analysis. Field documentation provided to the COGCC must include type of container, preservative (if any) and method of sample collection for dissolved gas analyses.

3.2.2.4 - Collection of Groundwater Samples from Water Sources for Gas Composition and Isotopic Analysis

Groundwater samples collected for gas composition and isotopic analysis from water sources with permanent pumps will be collected in a closed-sample collection system container such as an IsoFlask® provided by the isotopic laboratory. Sample collection will be conducted using the manufacturer's specified tubing configuration and procedures (Isotech, 2014). The sampling device as provided by the vendor should contain a bactericide capsule and samples collected in such an in-line sampling device should be shipped and stored as recommended by the laboratory. Field documentation provided to the COGCC must include type of container, preservative (if any) and method of sample collection for gas composition and isotopic analyses.

3.3 - Spring and Seep Sampling

Collection of groundwater samples from springs or seeps will be collected as near to the source as possible. Prior to sampling, the field parameters pH, conductivity, water temperature, sediment/turbidity, DO, ORP, effervescence, bubbles, water color, and odor (if present) will be measured and recorded on a field sampling data sheet. A clean, white 5-gallon bucket should be used when monitoring for color, odor, and effervescence.

3.3.1 - Surface Water Sample Collection

Samples should be collected and preserved using the field methods for unfiltered samples, filtered samples, and dissolved gas samples according to the sampling protocol listed below.

3.3.1.1 - Collection of Unfiltered Surface Water Samples

Unfiltered samples should be collected by submerging a laboratory-supplied sample container or dipper directly into the spring and carefully transferring the sample to the sample container. If the sampling point is a seep, it may be necessary to use a pre-cleaned glass beaker to collect the water. Care should be taken to prevent the re-suspension of sediment into the water during sampling. The collected sample should be transferred from the dipper or beaker by allowing the water to run down the inside wall of the sample container to minimize sample disturbance. For those sample containers with preservative, special care should be taken not to overfill the container.

3.3.1.2 - Collection of Filtered Surface Water Samples

Filtration at the laboratory after receipt, followed by the appropriate preservation method will be the preferred method of filtering and preserving samples.

Alternatively, samples that will be field filtered must be collected using an in-line disposable 0.45 µm glass-fiber filter. The required water volume should be collected from the spring or seep using the dipper or beaker and placed in a pre-cleaned bucket. A hand vacuum pump and clean tubing should then be used to draw water from the bucket and push it through the in-line filter and into the sample container. In all cases, the tubing and filter should be flushed prior to sample collection and the filtered water should be collected directly into the pre-cleaned sample containers provided by the laboratory. New filters must be used for each sample, and decontamination procedures will be strictly followed. For those sample containers with preservative, special care should be taken not to overfill the container.

3.3.1.3 - Collection of Surface Water Samples for Dissolved Gas Analysis

Surface water samples collected for dissolved gas analysis from springs or seeps will be collected in non-preserved 40 mL VOA vials equipped with gas-tight septa. If the water is insufficiently deep to collect a sample, a depression will be made to create a pool of water, as close to the discharge point as possible, and to allow the flow of water to flush the suspended solids prior to sampling. Submerge a clean 500 mL or larger glass container and fill completely. Use the direct fill method outlined by Molofsky (2016) and decant water into the 40 mL VOA vial. If bubbles are visible, collect another sample. If it is not possible to get a gas-free sample because the water is too effervescent, a vial with gas headspace is acceptable. The Operator should note this on the chain-of-custody (COC) and notify the laboratory that headspace was present in the field. Samplers should follow preservation guidance from the laboratory if using 40ml vials to collect samples. Many reports by and to COGCC staff indicate that acid preservation of certain types of groundwater samples (particularly those with elevated bicarbonate/carbonate alkalinity levels results in increased headspace in sealed 40ml vials which may lead to inaccurate analytical results of the dissolved gas analytes. Some laboratories have recommended use of a bactericide such as benzalkonium chloride for preservation of 40ml vial samples for dissolved gas analysis which may be preferable to acid preservation techniques for this analysis. Field documentation provided to the COGCC must include type of container, preservative (if any) and method of sample collection for dissolved gas analyses.

3.3.1.4 - Collection of Surface Water Samples for Gas Composition and Isotopic Analysis

Surface water samples for gas composition and isotopic analysis should be collected in a 1 liter plastic bottle with gas tight septa cap provided by the laboratory with bactericide capsule inside. Collection may require gentle transfer of water from a smaller glass bottle depending on depth and/or flow of surface water. Otherwise fill the 1 liter bottle by the direct fill method (Molofsky et al., 2016). In line sampling containers should be utilized for this test samples can be collected using an installed pump as described in section 3.2.3.4. Field documentation provided to the COGCC must include type of container, preservative (if any) and method of sample collection for gas composition and isotopic analyses.

4.0- FIELD ANALYSES AND OBSERVATIONS

Physically or chemically unstable parameters, such as pH, DO, and water temperature must also be measured in the field, rather than solely at a laboratory. Although the conductivity of most groundwater samples should be relatively stable during and after sampling, it is required that conductivity be measured in the field both as part of the evaluation of the effectiveness and completeness of the purge and as a reportable parameter for the groundwater at the time of sampling. Other recommended field parameters are DO content of the groundwater, as well as the turbidity of the groundwater at the time of sampling. Measurement of the ORP of groundwater at the time of sampling is also recommended if an in-line flow-through device for measurements is used for analysis. Any field analyses performed must be reported on the field sampling data sheet. The required field parameters and observation data are summarized in Table 3-3 - Field Parameters. General guidance for documentation of a groundwater sampling event are found in ASTM D6089-15 (2015).

Calibration of field instrumentation should follow the manufacturer's calibration and maintenance procedures detailed in the equipment's technical manuals. Calibration solutions should be replaced on or before the manufacturer's expiration date printed on each container, and unused, expired standards should be disposed of per manufacturer's instructions. Temperature corrections of pH and conductivity measurements are typically done by multi-parameter meters equipped with temperature probes, but if the pH and conductivity meters are not capable of performing temperature corrections to 25°C, then manual corrections must be performed, based on the measured temperature of the groundwater, before data is entered in the COENV database.

5.0- SAMPLE PRESERVATION, HANDLING, AND SHIPPING

Preservation of samples prior to shipment to a laboratory is done in several ways depending on analyte and method guidance. Recommended preservation for many organic analytes may be as simple as storing and shipping at 4°C with a range of acceptable water temperatures on receipt at a laboratory of 0 to 6°C. Other samples, such as water samples for analysis of volatile organic compounds (VOCs), should follow the preservation guidance developed in SW 846 Chapter 4 (U.S. EPA, 2018) and guidance identified in Table 3-1.

Water samples will be placed in a cooler, with ice or other coolant, immediately following collection unless otherwise indicated by the laboratory. Collected samples will be stored in refrigerated conditions that prevent freezing. If shipping is required, samples will be packed in a cooler with sufficient ice to maintain water temperature until the samples reach the laboratory. The coolers should be clearly labeled in order to expedite delivery to the selected laboratory and transported or shipped in a timely manner (preferably overnight) to minimize the potential for failure to meet method-specified hold times. Laboratory-supplied trip blanks and temperature blanks will be included with each cooler. After the cooler is properly packed, a signed custody seal will be placed across the opening edge of the cooler, signed over to the laboratory or freight carrier, and a copy of the COC form retained, demonstrating transfer of custody.

Table 3-1 provides a summary for sample collection, storage, and preservation techniques by method or type of analyte. Laboratory specific requirements may supersede the procedures summarized and any deviations should be approved by the COGCC staff.

6.0- CHAIN OF CUSTODY DOCUMENTATION AND RECORDS MANAGEMENT

Guidance for general COC practices can be found in ASTM D4840-99(2018)e1, Standard Guide for Sample Chain-of-Custody Procedures.

Samples must be handled, stored, and shipped in accordance with COC procedures. COC procedures require that all samples be maintained under the control of the sampler (i.e., in sight or in a secure, locked environment controlled by the sampler) from the time of collection until delivery. The analytical laboratory will provide a COC form that includes the following:

- Operator;
- Sample identifications (facility name, facility ID, legal location);
- Sample frequency (e.g., initial, 1st subsequent, 2nd subsequent);
- Sample reason (e.g. 609 or 318A.f);
- Date and time of collection;
- Requested analysis;
- Preservatives;
- Matrix, number of bottles;
- Field parameters (optional); and
- Signatures.

The sampler must also sign the COC form releasing the samples to the laboratory at the time of delivery to the lab or at the time of release to the shipping courier. The laboratory also signs the COC form accepting custody of the samples at the time of delivery by the sampler or the shipping courier. The COC form and any other documentation (shipping receipts, bills of lading) should be sealed in a zipper lock plastic bag and taped to the inside top of the cooler to limit the potential for water damage to the form. Once the cooler is prepared to insure sample integrity, shipping tape and custody seals (adhesive labels signed and dated by the sampler) should be securely placed on the cooler such that the cooler cannot be opened without breaking the seal (ASTM D4840-99, 2018).

7.0- ANALYTICAL PROCEDURES AND QUANTITATION LIMITS FOR LABORATORY AND FIELD METHODS

Analysis of samples must be completed by laboratory(ies) accredited by the NELAP in general and more importantly for analytical procedures and analytes of concern in this SAP. NELAP accreditation extends to both matrix (such as groundwater, which has been listed as non-potable water (NPW) matrix in NELAP terminology), as well as to analytical technology (such as gas chromatography/mass spectrometry (GC/MS)), and to individual analytes (such as benzene or toluene). As an example, an acceptable laboratory would be accredited for analysis of benzene and toluene by purge and trap GC/MS techniques for the non-potable water matrix.

State or national accreditation may not be possible at this time for some analytes or analytical technology such as the specialized isotopic ratio determination of the carbon and hydrogen present in CH₄, dissolved gases and/or the use of bacterial activity reaction test (BART) biodefectors.

Analytes, appropriate methodology, and expected achievable detection limits are included in Table 3-1. There are many acceptable methods used for determination of the analytes in the anions and general water quality parameters and not all are listed in Table 3-1.

8.0- FIELD AND LABORATORY QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Data integrity will be assured and verified through:

- 1) Field sampling practices that comply with this SAP;
- 2) Sample analysis by an accredited analytical laboratory(ies);
- 3) Laboratory practices which follow approved analytical methods;
- 4) When available, collection and analysis of field quality assurance samples; and,
- 5) Data quality reviews of the laboratory and field practices.

All samples will be analyzed by laboratory(ies) that are NELAP accredited for the matrices and analytical processes that will be used for sample analysis, where such accreditation exists. Approved and accepted analytical methods, such as test methods for Evaluating Solid Waste SW846 or other methods such as Standard Methods for the Examination of Water and Wastewater, which are recognized standard industry practice, will be used for sample analysis as indicated in Table 3-1. Deviations to the analytical methods should be approved by the COGCC staff prior to sampling.

Where Standard Methods or EPA published methods are not available, standard industry practices will be followed. Laboratory quality assurance samples, such as matrix spike/matrix spike duplicates, will be prepared in the laboratory and analyzed as specified by the designated method. Laboratory quality assurance sample results must be reported along with the original sample results on the laboratory report including the COGCC EDD, and an analytical narrative shall be provided as part of the laboratory report.

8.1 - Field Control Samples

Field quality control samples shall be collected following an Operator's specified procedures. All field quality control sample results shall be submitted to the COGCC. Guidance for general protocols can be found in ASTM D7069-04(2015), Standard Guide for Field Quality Assurance in a Groundwater Sampling Event. Generally recommended practices are provided below.

8.1.1 - Field Duplicate Samples

The following protocol will be followed for field duplicate sample collection:

- one complete set of duplicate samples should be collected for every 20 groundwater samples collected, but not less than one per year.
- duplicate samples should be collected at approximately the same time as the original sample using identical sampling methods (ASTM D7069-04, 2015).
- each duplicate sample should be given a fictitious sample identification number, which is recorded on the field sampling data sheet.
- the laboratory will not be informed that the sample is a field duplicate, ensuring no analytical bias will occur; and
- duplicate samples should be analyzed for the same analytes as the original sample.

Duplicate sample results should be evaluated based on the relative percent difference (RPD) between the sample result and the duplicate. RPD is calculated as:

$$RPD = \frac{|S - D|}{0.5(S + D)} \times 100$$

Where,

RPD = Relative Percent Difference

|S-D| = Absolute value of S - D

S = Sample Result (original)

D = Duplicate Result

A data quality objective of $RPD \leq 20\%$ will be used for original and duplicate sample values that are greater than five times (5x) the practical quantitation limit (U.S. EPA 2017b). In instances when RPD is $\geq 20\%$, field and laboratory data will be reexamined to identify potential causes for the observed differences, and, if necessary, update SOPs as appropriate to minimize future variances.

8.1.2 - Field Equipment Blanks

Equipment blanks should be collected if decontaminated sampling equipment (e.g., sampling pump with dedicated discharge hose, sample dipper, beaker, etc.), is used to collect the samples to be analyzed for major cations (dissolved) and/or VOCs. One equipment blank sample shall be collected for every 10 groundwater samples taken with decontaminated sampling equipment, but no less than one per year. Equipment blanks should be collected immediately following equipment decontamination by running distilled or de-ionized water through or over the sampling equipment and collecting the rinse water in the sample container.

The use of equipment that requires decontamination will be minimized to reduce cross-contamination and reduce the cost of field equipment blanks, where possible.

8.1.3- Trip Blanks

Trip blanks should be used to assess contamination introduced during shipping and/or field handling procedures. Trip blanks should be collected at a frequency of one blank per cooler. Trip blanks should be collected at a frequency of one blank per cooler. Trip blank VOA vials are filled by the analytical laboratory staff under controlled conditions, transported to the sampling site, and transported back to the laboratory without being exposed to sampling procedures. Trip blanks will be analyzed for VOCs. Trip blank results should have concentrations less than the laboratory method detection limit (MDL). An Operator should verify negative results on all trip blanks and will adjust procedures accordingly if results above the MDL are identified.

8.1.4- Field Blanks

Field blanks will only be collected if the sampling technician believes that site conditions might cause the sample to become cross contaminated by VOCs or CH₄ (i.e., the water source is located adjacent to hydrocarbon or CH₄ storage or fueling area).

Field blanks will be collected by filling a clean glass VOA vial, equipped with a gas-tight septum, with distilled water and leaving the sample container open during the entire period of volatile sample collection. Immediately prior to capping, a few drops of distilled water should be added to the vial to create a positive meniscus. The vial should then be capped and inverted to check for air bubbles. If bubbles are present, the vial should be opened, additional water should be added, and the vial should be resealed and checked again for air bubbles. This procedure should be repeated until a bubble-free container is obtained.

Field blanks should be analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) and dissolved gasses (CH₄, ethane, and propane). BTEX and dissolved gases concentrations should be less than the MDL.

8.2 - Data Quality Reviews

Data quality reviews should be performed after all data reports have been received from the laboratory. Data quality reviews should be documented on a data quality review sheet (see Attachment 2) which should be stored in the project files with the field sampling data sheet and the laboratory analytical data reports. The objective of the data quality review sheet is to confirm that all data was properly collected and is suitable for release to COGCC. The data quality review should:

- Review all field sampling data sheets to confirm that:
 - The water source was properly purged;
 - The flow rate was reduced prior to sampling;
 - Water quality field parameters had stabilized prior to sampling, if necessary; and
 - No site conditions were noted that suggest the samples may not be representative.
- Review all laboratory data reports to confirm that:
 - Proper custody was maintained from the time of sampling to laboratory receipt;
 - All samples were analyzed for the requested analyses;
 - Proper laboratory methods were used for analyses;
 - Sample holding times were met;
 - Laboratory quality assurance samples such as matrix spikes and matrix spike duplicates were collected and analyzed according to the laboratory method, and all laboratory quality control sample results were within method acceptance limits; and
 - Field quality control samples meet the data quality objectives, listed above.
- Specify corrections needed and dates by when those actions should be completed.
- Certification by the data reviewer confirming that the data was collected in accordance with the SAP and that the data is suitable for incorporation into the COGCC database.

9.0- EVALUATION OF DATA QUALITY

An Operator is expected to review field sampling records to ensure that samples were collected in accordance with this SAP or if re-sampling may be required prior to submittal to the COENV database. COC records and the condition of samples upon receipt at the laboratory should also be evaluated to ensure the use of proper sample containers and preservatives by the samplers. A basic review of laboratory results and QC processes will also be

completed and will include the following minimum data quality checks (SM1030 Data Quality, 2017). If values are identified outside of the listed acceptance ranges, the sample should be re-analyzed.

Calculation of TDS from the concentrations of major cations and anions, sum of the following constituents (mg/L):

$$TDS = 0.6 (\text{alkalinity as } CaCO_3) + Na^+ + K^+ + Ca^{2+} + Mg^{2+} + Cl^- + SO_4^{2-} + SiO_3^{2-} + NO_3^- + F^-$$

- 1) Calculation of cation-anion balance must be done and reviewed with typical criteria acceptance as follows:

$$\% \text{ difference} = 100 \times \frac{\Sigma \text{ cations} - \Sigma \text{ anions}}{\Sigma \text{ cations} + \Sigma \text{ anions}}$$

Anion Sum (meq/L)	Acceptable Difference
0-3.0	± 0.2 meq/L
3.0-10.0	± 2%
10.0 – 800	5%

- 2) Measured TDS concentration should be larger than the calculated TDS calculation and reviewed with acceptance levels of:

$$1.0 < \frac{\text{measured TDS}}{\text{calculated TDS}} < 1.2$$

- 3) Calculated EC calculation should be larger than measured EC value, and reviewed with acceptance levels:

$$0.9 < \frac{\text{calculated EC}}{\text{measured EC}} < 1.1$$

- 4) Calculation of anion and cation sums should be approximately 1/100 of the measured EC, and reviewed with acceptance levels of:

$$100 \times \text{anion (or cation) sum, meq/L} = (0.9 - 1.1) \text{ EC}$$

- 5) Calculated TDS to EC ratio and reviewed with acceptance levels of:

$$\text{calculated TDS} / \text{conductivity} = 0.55 - 0.7$$

- 6) Measured TDS to EC Ratio should be between 0.55 and .07

10.0- HEALTH AND SAFETY

The health and safety of personnel and water source owners must be addressed by an Operator's health and safety program and include protocols to be followed at sample sites. General aspects of the safety plan need to address what personal protective equipment (PPE), such as hard hats, safety glasses, chemical resistant gloves, sturdy boots, long pants, etc. should be used and under what conditions during the collection of samples. While sampling, the field staff shall explain to the water source owner or representative what and why PPE is required.

10.1 - Materials and Waste Management

All materials and wastes, whether fluid or solid, generated during sampling and monitoring activities, must be properly handled, disposed, and documented in accordance with applicable federal, state, and local regulations.

Under special circumstances for large volume well purging, a sample will require coordination of waste water handling instructions, storage, transport, disposal resources, and any necessary manifesting or alternative tracking documents.

11.0 - DATA SUBMISSION

An Operator will upload all required data into the COENV database and submit to respective well owner(s), within 3-months of the sampling event as directed by 609 or 318A.f. Prior to upload into the COENV database or submittal to landowners all data, reports, and communications will receive a QA/QC check.

11.1 - COENV Database

An Operator will upload and submit the following electronic information into the COENV database:

- Facility ID (already in existence or newly created) in the COENV database;
- Division of Water Resources permit and receipt number for the sampling location (if permitted);
- Name and address of water source owner;
- GPS coordinates for the water source (wellhead or spring) and coordinates need to be in decimal degrees of latitude and longitude using the NAD83 reference, surveyed in accordance with COGCC Rule 215 with an accuracy of five decimals in the North American Datum 1983 (NAD 83);
- API number(s) for the associated oil and gas well(s);
- Sample type – initial or baseline, one-year post-completion or five-year post-completion;
- Date and time each sample was collected;
- Collection point (e.g. domestic, stock, irrigation, industrial, or municipal water supply well, or bradenhead);
- Laboratory name;
- Sample reason (e.g. 609 or 318A.f); and
- Results of field monitoring and observations must be submitted electronically to the COGCC. A simplified spreadsheet EDD can be utilized for this purpose, or results may be included on the COC and submitted with the laboratory provided EDD.

All samples submitted to the COGCC shall include the following information and file types:

- 1) Correctly formatted laboratory EDD (Either XML or Excel);
- 2) A portable document format (PDF) copy of the complete lab report including QA/QC data; and
- 3) A PDF copy of the field sampling data sheet that includes all the location information, purge information, and field parameters collected.

Laboratory results for each sample collected will be submitted via a Form 43 using the laboratory's XML or spreadsheet EDD, formatted appropriately for the COENV database. The EDD must include quality control data such as results of method blanks, results of matrix spike or laboratory control samples, results of duplicate samples, and surrogate or tracer recoveries. PDF copies of calibration logs, field sampling data sheets, photographs, and laboratory results must also be uploaded to the database.

Access to the portion of the database where facilities can be created and data uploaded is controlled, and credentials must be obtained prior to any attempt to use the COENV database by completing a Form 1A (Designation of Agent). Operators or their designated agents (i.e., contractors, consultants, or laboratories) can obtain necessary logon credentials in a manner similar to that used in E-Forms.

11.1.1 - Electronic Data Deliverables

There are two accepted versions of the COGCC EDD that may be uploaded to the COENV database via Form 43. One is an XML EDD that is based on the EPA Water Quality Data (WQX) XML schema. The second is a Microsoft Excel-based EDD. Both the XML and Excel-based EDD are in hierarchal format. The EDDs do not look, nor do they function, like a common flat file EDD. The EDDs are designed to transfer data to the COGCC database and should not be used as an analytical tool by themselves.

Prior to being accepted into the database the EDDs go through a rigorous automated QA/QC check. If the information provided in the EDD fails to meet the valid value requirements, the EDD will be rejected. If an EDD is rejected, it will be necessary to make corrections and resubmit the EDD. Once an EDD has been accepted by the database, COGCC staff will conduct a brief review of the information in the EDD. Once the review process has been completed, the EDD will be verified and saved into the database.

Data received by the COGCC will be posted to the COGCC website and be available for public review. Once verification has been completed by the COGCC staff, the data will be available within a couple of hours.

Help Regarding the EDD requirements can be found at:

https://cogcc.state.co.us/documents/about/COGIS_Help/EnviroDB/EnviroDB.htm

Help regarding the EDD Form 43 upload process can be found at:

https://cogcc.state.co.us/documents/reg/Forms/instructions/Form_Instructions/Form_43_Instructions_09282018.pdf

11.1.2 - Special Circumstances Reporting

In accordance with the COGCC Operator Guidance, an Operator will notify the water source owner and the COGCC immediately and will submit a Form 42 (Notice of Field Operations) if:

- 1) Methane concentration increases by more than 5 mg/L between sampling;
- 2) Methane concentration is detected at or above 10 mg/L;
- 3) Composition/isotopic data test results indicate thermogenic gas or a mixture of thermogenic and biogenic gas; and/or
- 4) BTEX compounds or TPH are detected.

Immediate notification is considered within 24 hours of receipt of analytical data from the laboratory. If analytical results are being re-analyzed, timely reporting is expected after the results have been confirmed. Delays in timely reporting due to third party consultants or additional internal data review should be avoided; the raw data can be reported immediately, with a caveat that additional review may be undertaken, and the results are therefore to be considered preliminary.

An operator may use any reasonable means to provide notifications to the water well owners. In-person or verbal notifications should be followed with written correspondence; written correspondence may be provided through e-mails or formal letters with delivery or receipt confirmation.

The report to the water source owner will include a description of the findings and an explanation if potential health risks for continued use of the water were determined to be present. A written letter to the landowner detailing the sample findings and potential health risks will also be provided and the findings will be reported to the COGCC.

12.0 - REFERENCES

- ASTM D4448-01(2019), Standard Guide for Sampling Ground-Water Monitoring Wells, ASTM International, West Conshohocken, PA, 2019, www.astm.org
- ASTM D4840-99(2018)e1, Standard Guide for Sample Chain-of-Custody Procedures, ASTM International, West Conshohocken, PA, 2018, www.astm.org
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ATTACHMENT 1 - Example Field Sampling Data Sheet

Field Sampling Data Sheet

COGCC Facility ID _____ Facility Name _____ Date of Sample _____

Site Address _____ Site Contact _____ Phone # _____

Sample Type (baseline, post-drill, etc.): _____ O&G API Number _____

Property Owner Name _____ Phone # _____

Mailing
Address _____

Individuals Present (Who was on-site during the sampling?) _____

Handed Out:

Introduction Letter? **Y N**

FAQ Sheet? **Y N**

How Well Do You Know Your Water Well Booklet? **Y N**

Water Well Information from Permit Records

Permit Number: _____ Receipt Number: _____ Total Depth (ft): _____ Static Water Level (ft): _____

Yield (GPM): _____ Well Diameter (in): _____

Water Well Information Onsite

GPS Location (field): _____

GPS Location (post-processed): _____

Legal Location (qtrqtr Section Township Range): _____

Casing height (in.): _____ Ground Elevation (ft): _____ How determined: _____

Approximate distance to the Oil & Gas well pad: _____

%LEL at wellhead (if measured): _____ %CH₄ (by volume) at wellhead (if measured): _____

Photo(s) Taken? **Y N** Weather conditions: _____

Where was the sample taken? (Outside Tap, Well House, Kitchen Tap, Spring, Seep, etc.) _____

Condition of the Well, Spring or Seep (Wellhead sealed? Does the ground slope away from the well? Visible contamination of spring/seep? etc.): _____

Field Sampling Data Sheet – Page 2

Facility Name: _____

Landowner Comments on Water Quality: _____

Purge Method _____ Fixed Wellbore Volume _____ Stabilization of Water Quality Parameters

Purge rate (gpm) _____ Purge Time (min) _____ Total Purge Volume (gal) _____

Sampling flow rate (gpm): _____

Water Quality Field Parameters

Clock Time	Elapsed Time	Water Level	Flow Rate (calc)	Temp (°C)	pH	EC (uS/cm)	ORP (mV)	DO (mg/L)	Turbidity	Odor	Color / Sediment	Bubbles / Effervescence

Additional Information:

Sampler's Name _____ Company: _____

(Print)

Sampler's Signature _____ Date: _____

ATTACHMENT 2 - Example Data Quality Review Sheet

Data Quality Review Sheet

COGCC Facility ID_____ Facility Name_____ Date of Sample_____

Site Address_____ Site Contact_____ Phone #_____

Sample Type (baseline, post-drill, etc.)_____ O&G API Number_____

Oil & Gas Well_____ Location/API# _____

Field Sheet Review

- 1) Was the well/spring properly purged?_____
 - a. Please provide purge volume if applicable_____
- 2) Was the flow rate reduced prior to sampling?_____
- 3) Were field parameters measured prior to sampling?_____
- 4) Did field parameters stabilize prior to sampling?_____
- 5) Did site conditions or other factors suggest that the samples may not be representative of groundwater? If yes, please describe_____

Laboratory Data Review

- 1) Were the samples received at the recommended water temperature of $\leq 6^{\circ}\text{C}$?_____
- 2) Were the samples properly preserved? If no, please explain_____

- 3) Was proper chain-of-custody maintained? If no, please explain_____

- 4) Were all samples analyzed for the requested analyses?_____
 - a. If no, can the remaining sample be analyzed within the recommended hold time? _____
- 5) Were the proper methods used?_____
 - a. If no, can the remaining sample be analyzed within the recommended hold time? _____
- 6) Were all sample holding time limits met? If no, please explain_____

- 7) Were the correct reporting limits used? If no, please explain_____

- 8) Were laboratory quality assurance samples collected and analyzed (*i.e., matrix spikes & matrix spike duplicates*) according to laboratory methods? If no, please explain_____

- 9) Were laboratory quality assurance sample results within acceptance limits? If no, please describe _____

Data Quality Review Sheet – Page 2

Facility Name: _____

Field Control Samples

- 10) Were **field duplicate** samples submitted? _____ *If no, proceed to trip blank questions.*
- 11) Were the original and duplicate samples $\geq 5x$ the practical quantitation limit (PQL) _____
- 12) Was the Relative Percent Difference (RPD) $\leq 20\%$? If no, please describe _____
- 13) Were **trip blanks** submitted? _____ *If no, proceed to equipment blank question.*
- 14) If trip blanks were submitted, were the VOC constituent concentration results below method detection limits? _____
- 15) If **equipment blanks** were submitted, did the results meet the equipment blank data quality objectives specified in the Sampling and Analysis Plan? _____
- 16) If **field blanks** were submitted, did the results meet the field blank data quality objectives specified in the Sampling and Analysis Plan? _____

Corrective Actions

- 17) Are corrective actions required to remedy any data quality issues? If yes, please describe _____
- 18) Date by when corrective actions must be completed _____
- 19) Summary of Corrective Actions (once completed) _____

Data Suitability Statement

Based upon this data quality review and your professional judgment, have the data been collected and analyzed in general accordance with the COGCC Model Sampling and Analysis Plan? Yes No
(Circle one)

Are the data suitable for release for incorporation into the Colorado Oil and Gas Conservation Commission environmental database? Yes No (Circle one)

Data Quality Reviewer's Name: _____ Company: _____
(Print)

Data Quality Reviewer's Signature: _____ Date: _____

Attachment B

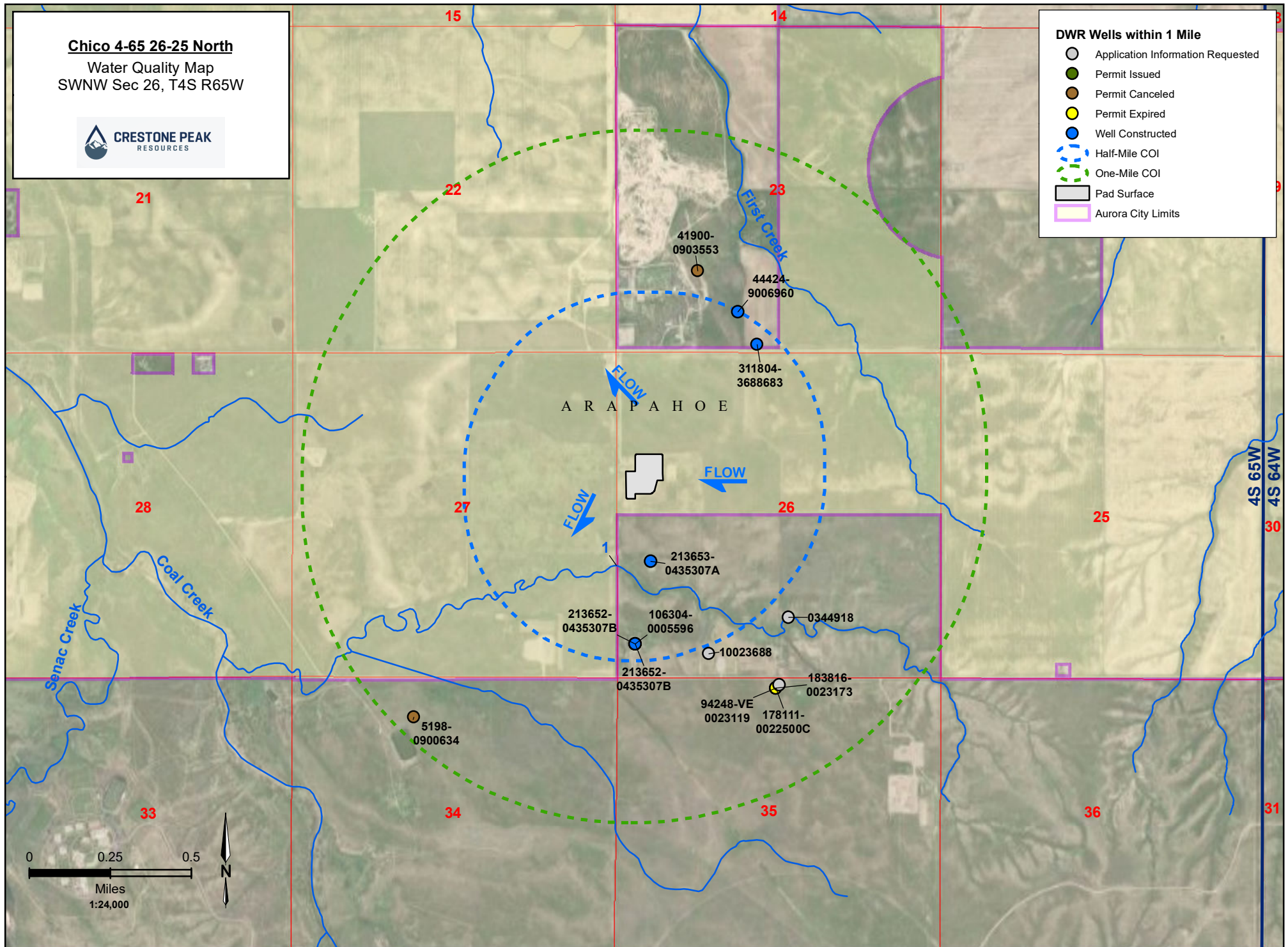
Chico 4-65 26-25 North Well Pad Area Map with One-Half and
One-Mile Radius Water Wells and Surface Waters Identified

Chico 4-65 26-25 North
 Water Quality Map
 SWNW Sec 26, T4S R65W



DWR Wells within 1 Mile

- Application Information Requested
- Permit Issued
- Permit Canceled
- Permit Expired
- Well Constructed
- Half-Mile COI
- One-Mile COI
- ▭ Pad Surface
- ▭ Aurora City Limits



Attachment C

Surface Water Identified - One -Half-Mile Radius

Chico 4-65 26-25 North**Surface Water Identification**

Surface Water Name / ID	Feature Type	NHD CODE	Distance from Site (Mile)	Evaluation Status
1	StreamRiver	Intermittent	0.208	Eliminated -- Intermittent Stream

Attachment D

DWR Water Sources Identified - One-Half-Mile Radius Water Wells

Crestone Peak Resources
DWR Water Source Inventory
Chico 4-65 26-25 North

	Status	Receipt	Permit	DWR Permit Status	Contact Name	County	Tw	Rng	Sec	Q40	Q160	Latitude	Longitude	Aquifer(s)	Use(s)	TD
1	1 - Water Source will be sampled pending well owner permission	0435307B	213652-	Well Constructed	ARABADJIEV, ROSSEN	ARAPAHOE	4S	65W	26	SW	SW	39.668867	-104.6399	DENVER	Domestic	
2	2 - Water Source will be sampled pending well owner permission	3688683	311804-	Well Constructed	HENRY, WILLIAM	ARAPAHOE	4S	65W	23	SE	SW	39.682243	-104.6328	UPPER DAWSON	Domestic	
3	3 - Water Source will be sampled pending well owner permission	0435307A	213653-	Well Constructed	MOORE, DANIEL	ARAPAHOE	4S	65W	26	NW	SW	39.672567	-104.6390	UPPER ARAPAHOE	Domestic	
4	4 - Water Source will be sampled pending well owner permission	9006960	44424-	Well Constructed	GRIMM, ALBERT	ARAPAHOE	4S	65W	23	SE	SW	39.683722	-104.6339	DENVER	Domestic	
5	Eliminated -- DWR Permit Status	5596	106304-	Permit Canceled	DELANEY, JOSEPH E	ARAPAHOE	4S	65W	26	SW	SW	39.668867	-104.6399	ALL UNNAMED AQUIFERS	Domestic	