SAMPLING AND ANALYSIS PLAN
for
ENVIRONMENTAL GROUNDWATER MONITORING

Prepared for:

GCC Rio Grande, Inc.

Pueblo, Colorado

May 2022

Effective Date: Upon approval by DRMS (TR-11)

History of Document Revisions

Revision No	Revision Date	Reason for Revision
1	2/28/2003	Initial Sampling and Analysis Plan developed for the Site after permit approval (DRMS Comments 03/17/2003)
2	03/26/2003	Revised in response to DRMS Comments received 03/17/2003 (DRMS approved April 2003)
3	10/18/2019	Revised Draft SAP submitted to DRMS for review as a Technical Revision in response to changes in Site wells and sampling protocols approved under Technical Revisions 3 and 6 (DRMS approved 07/28/2017) (Close Consulting)
4	2/19/2020	Revised SAP submitted to DRMS as Technical Revision 7 (TR-07) in response to Preliminary Adequacy Review dated October 31, 2019. (DRMS approved 04/03/2020). (Resource Hydrogeologic Services)
5	5/13/2022	Revised SAP to accommodate new monitoring wells installed under TR-08, as well as modernized methodologies to be adopted for compliance groundwater monitoring at all Site monitoring wells.

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION AND SAMPLING OBJECTIVES

This Sampling and Analysis Plan (SAP) provides a protocol for performance of groundwater monitoring at the GCC Rio Grande, Inc. facility in Pueblo, Colorado (the Site). Based on increased knowledge of the groundwater system at the Site, groundwater monitoring locations and requirements have evolved significantly since the initial SAP was prepared in 2003 (Brown and Caldwell, 2003). As a result of subsequent findings, and in accordance with Technical Revision No. 3 (TR-03) approved by the Colorado Division of Reclamation, Mining and Safety (DRMS) in April 2013, all shallow wells subject to prior monitoring were plugged and abandoned except for one (MW-005, hereinafter referred to as MW-5). The plugged wells were either dry, or were located far from the Site along the St. Charles River and proven to not be applicable for GCC monitoring. MW-5, located north of the plant, has remained dry since it was installed so no samples have been collected. Pursuant to TR-06, approved by DRMS in July 2017, new wells MW-6 and MW-7 were installed in December 2017 downgradient of the second mine panel (Figure 1). The SAP was updated under TR-07, approved by DRMS on April 3, 2020, to include and describe monitoring at all Site wells at that time, which were MW-5, MW-6, MW-7, and MW-8. TR-08, approved by DRMS on June 4, 2021, addressed Site bedrock groundwater monitoring data gaps by installing new monitoring wells at three new locations. Each location received two wells to help identify potential differences in potentiometric level and water quality between the mined Fort Hayes Limestone and the underlying Codell Sandstone. The monitoring wells installed under TR-08 are MW-9, MW-10, MW-11, MW-12, MW-13, and MW-14.

This SAP describes groundwater sampling and analysis procedures for obtaining chemical data from existing wells, and any future wells installed as mining progresses, to define the baseline groundwater conditions and track any changes in applicable water quality constituents in potentially affected groundwater. In addition to addressing new groundwater monitoring well locations for compliance monitoring, this SAP addresses a modernization of the Site groundwater monitoring protocols with respect to the sample collection and the field documentation methodologies. This SAP also updates the compliance laboratory analysis suite to include major ions. Any potential significant changes to the sampling protocol(s) made in the future will be submitted to DRMS for approval prior to implementation.

The following sections provide details of the SAP, including sample locations and frequency, sampling methods, laboratory analysis, quality assurance/quality control (QA/QC), and reporting.

2.0 GROUNDWATER SAMPLING LOCATIONS AND FREQUENCY

Figure 1 illustrates the Site features and mine plan. GCC quarries the Fort Hayes Limestone Member of the Niobrara Formation, and began extraction and processing in 2007 and 2008, respectively. GCC is permitted to quarry the Fort Hayes Limestone and approximately 5 feet into the Codell Sandstone, which has also been described as hard, brown sandy petroliferous limestone and a platy and shaly sandstone. Figure 2 shows a Site stratigraphic section. Site drilling logs indicate that the Codell also contains multiple shale or sandy shale lenses. Initially, GCC planned to remove and process Codell Sandstone, but that was eliminated near the onset of operations when further testing determined the material was not beneficial to process. GCC extracts only the Fort Hayes, leaving the bottom one foot of the limestone in place.

Regionally, the Juana Lopez Shale Member separates the Fort Hayes and Codell members, but is only about 2 feet thick. Locally, the Juana Lopez Member is largely absent due to an erosional unconformity, such that the Fort Hayes directly overlies the Codell (Collum, 2000). Underlying the Codell is approximately 400 feet of upper Cretaceous members, principally composed of dense shales, which provides an effective hydraulic barrier from the underlying regional Dakota Sandstone aquifer**.**

2.1 **Sampling Locations**

Groundwater monitoring currently occurs at ten environmental monitoring wells (Figure 1). Monitoring well MW-5 was installed between the plant Site and the Edson Arroyo in July of 2008. The well is completed in claystone (weathered shale) beneath a surficial clayey soil and screened from 9 to 25 feet. The borehole extended to 29 feet, but was terminated in the same claystone. Well MW-5 has been dry since it was installed.

The other nine Site environmental monitoring wells are installed in competent bedrock. MW-6 and MW-7, which were installed in the Fort Hayes Limestone during December 2017, (Close Consulting Group, 2018) are adjacent to each other separated by approximately 20 feet. These wells were drilled in the area of a suspected fault downgradient of the second mine panel with each apparently located on either side of the fault. Prior to drilling these wells, no free water had been encountered in the Fort Hayes or Codell Sandstone during other Site drilling and well installations. The fault/fracture system that results in water occurring in these wells transects both the Fort Hayes and Codell. MW-8 was installed approximately 25 feet distance from both MW-6 and MW-7 in February 2020 to screen the Codell Sandstone at this clustered monitoring well location.

MW-9, MW-10, MW-11, MW-12, MW-13, and MW-14 were installed in 2021 to expand the spatial distribution of the Site groundwater monitoring as mining progresses and to allow a more robust interpretation of the Site groundwater system, otherwise known as the hydrogeologic conceptual model. The TR-08-required installation report detailing the as-built information for these wells was prepared by Resource Hydrogeologic Services, Inc. (2022). MW-9 and MW-10 are located southwest of mine panel four, which is presumed upgradient from any previous or planned mining, and are paired monitoring wells separated by approximately 20 feet completed in the Codell Sandstone and underlying Blue Hills Shale, respectively. The Fort Hayes Limestone, the original completion target for MW-9, was not encountered during drilling at this location. MW-11 and MW-12 are located northeast of mine panels three and four, which is presumed downgradient from current and future mining, and are paired monitoring wells separated by approximately 20 feet surface distance completed in the Fort Hayes Limestone and the Codell Sandstone, respectively. MW-13 and MW-14 are located northeast of the quarry and plant at the permit boundary, which is presumed downgradient of all Site operations, and are paired monitoring wells separated by approximately 20 feet completed in the Fort Hayes Limestone and Codell Sandstone, respectively.

As mining progresses or compliance matters arise, additional monitoring wells may be installed. This SAP will also apply to those wells, unless specific modifications are approved by DRMS as part of future Technical Revisions.

2.2 Monitoring Frequency

Groundwater monitoring currently is performed semi-annually for dry wells (MW-5) and quarterly for wells that typically produce water (MW-6, MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, and MW-14). Quarterly monitoring is typically scheduled for February, May, August and November. Semi-annual monitoring is typically performed in May and November. Unexpected circumstances or adverse weather/Site conditions may require that a sampling date be rescheduled or modified, but GCC will strive for overall consistency in the sampling schedule.

3.0 SAMPLING METHODS

This section of the SAP presents a summary of groundwater documentation requirements, water level measurement procedures, field water quality measurement procedures, groundwater sample collection procedures, decontamination procedures, sample handling and custody requirements, and field QA/QC samples.

3.1 Documentation and Records

The intent of field documentation is to provide a complete record of the methods of sampling and consistency between sampling events. Documentation during groundwater monitoring is completed through the use of fully digital mobile field forms. GCC utilizes a custom form created for the compliance groundwater monitoring program, loaded onto a ruggedized tablet device. This technology replaced traditional paper field forms for more robust documentation system allowing for immediate cloud-based file back-up, integration of Site photos, electronic data deliverable (EDD) data export to the facility groundwater monitoring database, while decreasing potential for field documentation typos and errors through use of drop-down menus, pre-populated static data fields, internally calculated fields, and location-specific data range boundaries that act as guardrails during field data entry. The field reporting form that will be used to document each compliance sampling event is included as Appendix A.

3.2 Water Level Measurements

Static depth to groundwater will be measured with an electronic water-sensing device, typically known in the industry as a water level indicator, water level tape, or sounder. The measurement will be made at each monitoring well prior to any groundwater production/sampling that would disturb the static water level, which is critical to routine preparation of potentiometric groundwater maps to determine and track potential changes to Site groundwater flow direction and gradient. It shall be measured from inside the locking wellhead protector from the top of the dedicated wellhead pump hanger water level indicator access hole, or, for any wells that do not contain a dedicated sampling pump system, at the top of the PVC casing, and will be recorded to the nearest 0.01 foot. The known total depth of each well will also be referenced during each monitoring event. Water levels will be measured periodically during purging to track the available drawdown with the final pumping water level measured at the time of sample collection recorded on the mobile field form.

The casing stick-up height will be measured during each monitoring event. Any change in height of the casing above ground surface or concrete pad shall be noted. If the distance changes more than 0.04 feet above the wellhead concrete pad, GCC will have the measuring point resurveyed to verify accuracy of static water elevations.

3.3 Field Water Quality Measurements

Field water quality parameters (i.e., temperature, pH, and specific conductance) will be measured with a calibrated meter at each sample location (Table 1). These field measurements will be data logged by the water quality meter set to record at 20 second intervals, inserted into a compatible low-flow cell during the entire period of purging and sampling, and observed by the sampler via a hand-held device in real-time. As groundwater production for purging and sampling is accomplished with dedicated electric submersible pumps, the discharge tubing is connected to the low-flow cell, which houses the water quality meter probes. The final field water quality parameters will be recorded in the mobile field form (Appendix A). The water quality meter will be calibrated just before beginning each quarterly sampling event or otherwise in accordance with the manufacturer's specifications, which for modern multi-parameter water quality meters is on the order of every 4-6 weeks for pH/ORP and every 3-6 months for specific conductance. Calibration information will be generated by the water quality meter as a calibration file and saved to the GCC project files as well as documented in the mobile field form each time a field instrument is calibrated for use in the purging and sampling activities.

3.4 Groundwater Sample Collection Procedures

Groundwater sampling procedures, measurements and observations will be recorded in the appropriate mobile field form (Appendix A). The following typical sampling procedures will be followed to ensure that water quality can be reliably compared from well to well and from sampling event to sampling event and that the data are reproducible.

Field water quality parameters (pH, specific conductance, oxygen reduction potential and temperature) will be data logged by the water quality meter inserted into a compatible low-flow cell during the entire period of purging and sampling, and observed by the sampler via a hand-held device in real-time. The final field parameters coinciding with the sample collection will be recorded in the mobile field form.

Purging of each well will be accomplished with a dedicated environmental monitoring well pump system. This will either be a low-flow/variable speed stainless steel 12-volt electric submersible pump system or a low-flow/variable speed stainless steel bladder pump system. The 12-volt electric submersible pump system employs 3/8-inch by 1/2-inch HDPE discharge tubing from the pump to the wellhead, where the pump is suspended from the top of the 2-inch PVC casing by both the tubing and the pump motor lead from a specialized wellhead pump hanger that all fit within the locking steel wellhead protector. The 12-volt power is provided to the system by connecting the variable speed pump controller to either a portable battery placed beside the monitoring well on the cement pad, or directly to a vehicle's battery posts. This is the standard system used at the Site for monitoring wells with pumping water levels less than 170 feet below ground surface, which is all wells except MW-14. The bladder pump system employs twin-line nitrogen supply/sample discharge HDPE tubing with the nitrogen supply tubing at 1/4-inch outer diameter and the sample discharge tubing at 3/8-inch outer diameter. Each end connects to the pump at depth and connects to the specialized wellhead pump hanger at surface. Standard compressed industrial nitrogen available in steel cylinders at the Site is utilized to drive the bladder pump with a digital controller that automates low-flow/micro-purge sampling efforts.

For both types of dedicated pump systems, the wetted sample discharge connections are the same. Purge water will be discharged from the wellhead by connecting disposable 3/8-inch by 1/2-inch flexible, clear PVC tubing from the barbed tubing outlet at the wellhead to the barbed low-flow cell inlet. The sample port, a 3/8-inch PVC three-way valve, is placed in-between the wellhead and low-flow cell so that water samples are collected upstream from the low-flow cell. From the low-flow cell outlet, 3/8-inch by 1/2-inch flexible, clear PVC tubing is routed to a graduated bucket placed nearby. The graduated bucket is used to track the purge volume as well as conduct a bucket-and-stopwatch method to estimate flow rate. Total purge volume and the flow rate are recorded in the mobile field form for each sample location. At all times, wetted surfaces of purging and sampling equipment will not be allowed to come into contact with the ground or other potentially contaminated surface.

Water samples to be analyzed for dissolved metals will be filtered through a new 0.45-micron 600 cm^2 disposable filter cartridge directly into laboratory-prepared containers, using dedicated, disposable tubing connected to the sample port. The pump pressure will force the sample through the filter. The new filter cartridge shall be purged with sample water by the method described previously, allowing time to observe proper function of the filter demonstrating clear water production prior to filling the subject sample bottle(s). The dissolved metals sample containers provided by the lab contains a small amount of nitric acid preservative. In this standard case of pre-preserved (pre-acidified) bottle utilization, care must be taken at the time of sample collection to not overflow the bottle which will flush some if not all of the acid from the sample, leaving said sample less than adequately preserved. If a bottle is overflowed, the bottle shall be discarded and an appropriate replacement pre-preserved sample bottle will be substituted from spare bottle set inventory, kept on hand for such occurrences.

Utilizing the dedicated pump systems described above, low-flow sampling methodology will be utilized at all wells. Low-flow groundwater sampling is also referred to within the industry as micro-purge or, perhaps most aptly named, low-stress groundwater sampling. That is because by producing the monitoring well at a low flow rate, there is a low well bore pressure differential resulting in a relatively small distance of drawdown in the well bore. Low-stress groundwater sampling methodology has been extensively utilized and documented within the industry (U.S. EPA 2015).

Each monitoring well shall be pumped at the lowest practical rate possible, on the order of 0.03 to 0.1 gallons per minute (gpm), to purge the calculated pump discharge tubing volume. These tubing volumes for each well are shown in **Table 3**. Monitoring and recording of the field water quality parameters and depth to water shall occur as described above during the purge. Following the purging of these respective tubing volumes, stability is considered achieved and a water sample may be collected for laboratory analysis when three consecutive measurements do not vary more that 3% for conductivity and temperature, +/- 10 millivolts for ORP, and +/- 0.1 standard units for pH. This groundwater sampling methodology is based on guidance from the U.S. EPA (1996).

If a monitoring well is not capable of producing enough water utilizing the methodology described above to obtain a representative sample for field parameters and filling of the compliance groundwater lab suite bottles, then the well shall be purged until the pump can no longer produce water, effectively dewatering the well based on pump set depth, and then allowed to rest and recharge for a period of hours to 1 week. In this conventional low-yield monitoring well sampling methodology, the well shall be revisited later in the day and then daily thereafter (Monday – Friday) as needed to confirm adequate recharge based on a depth to water measurement. When there is adequate recharge, it represents formation water so the well shall be produced by low-flow methodology pumping at 0.03 to 0.1 gpm filling the compliance lab bottle suite immediately and then collecting and recording the field parameters.

Samples will be stored under ice in an ice chest while in the field pending delivery to the laboratory.

3.5 Equipment Decontamination Procedures

Dedicated and disposable equipment will be used to the extent possible to eliminate the need for equipment decontamination prior to and between uses, and the preparation and analysis of associated field rinsate blanks. Clean, new disposable nitrile gloves will be worn during purging and sampling activities, replaced each well or otherwise at any time the gloves are either obviously or suspected of being compromised for integrity or cross-contamination. Due to the use of dedicated equipment and disposable supplies, the only equipment typically requiring decontamination are the water level meter, water quality meter probes, low-flow cell, the flexible PVC discharge tubing, and the sample port valve.

Where equipment decontamination is required, the following procedures can be used:

- Spray with Alconox/Liquinox detergent followed by deionized/distilled water rinse, or
- Triple water rinse with deionized/distilled water, and
- Air dry or paper towel dry the decontaminated equipment and either use it immediately, or wrap and/or store it appropriately for later use.

Sampling equipment will be decontaminated or bagged (if disposable) between each sample location. Disposable sampling equipment and supplies (flexible PVC tubing, gloves, filters) will be disposed in Site waste containers. Purge water will be disposed on the ground near the wells.

3.6 Sample Handling and Custody Requirements

This section describes the methods used to ensure samples are managed in accordance with sampling handling and chain of custody requirements.

3.6.1 Sample Handling

Samples will be packaged and preserved in a manner prescribed by the applicable analytical method. Method-specific holding time requirements will be observed. Table 2 provides the relevant holding times by analyte/method for the GW-Compliance suite.

3.6.2 Sample Custody Documentation

The following describes the proper procedure for labeling and documenting samples once they are collected.

Sample Labeling

Individual sample bottles are labeled by the lab for each respective analytical test or group of tests and grouped into individual clear plastic bags. The bottle characteristics (size, composition, preservative) and filtering requirements are also provided in the mobile field form for reference. All sample containers shall be labeled using waterproof ink directly on the bottle or bottle label if such a label is present. Following collection, sample bottles for each sample location ID shall be placed in their respective plastic bags provided by the lab containing each bottle set for protection and grouping and sealed by either twist-tie or Ziploc-type mechanism. Information provided on each bottle set bag and the individual sample bottles and/or labels shall include:

- Site or project name;
- Sample location ID;
- Sample collection date and time;
- Sampler's name or initials.

Chain of Custody Forms

Record all samples chronologically on chain of custody forms. All entries to chain of custody documents will be made in ink. The chain of custody form requires the following information to be accurately written in ink:

- Contact information for report receipt (GCC Rio Grande)
- Contact information for report copy receipt (consultant or other relevant party)
- Contact information for laboratory invoice receipt (GCC Rio Grande)
- Samplers printed name, signature, Site information (state, zip code, time zone)
- Designation of analytical suite designation, typically assigned as quote number
- Chronological listing of sample ID, date/time of collection, matrix (groundwater), number of containers, analysis requested (analytical suite – "GW-Compliance")
- Remarks as necessary
- Relinquished by signature and date/time

No scratch-outs are permitted on the chain of custody form. If a minor correction is required, such correction shall be made in ink by a single line through the error and corrected information beside. Initials shall be placed beside the correction. If the error is deemed significant by the sampler and could cause any future question as to the validity of the sample(s), the original chain of custody shall be destroyed and replaced with a new clean, accurate version. The carbon copy shall be retained by the sampler for records. If a carbon copy is not available, a photocopy/scan of the chain of custody shall be made and filed in the sampler's records prior to packaging. The chain of custody document(s) will be placed in a Ziploc-type plastic bag and enclosed in the sample cooler or shipping container. The sample cooler will be custody-sealed as described below.

Custody Seals

Custody seals are used to assure the integrity of samples from the time the samples are collected and logged into the chain of custody system until the samples are received by analytical laboratory personnel. Samples will be shipped to the laboratory in coolers or other appropriate shipping containers. The cooler or shipping container must be custody-sealed in a manner which requires the destruction of the seal at the time of opening whenever a third-party delivery service is used. Such coolers or shipping containers will also be taped shut, with a layer of clear packaging tape placed over the custody seal, signed and dated using an indelible pen, to minimize the likelihood of accidental destruction during shipping and handling.

3.7 Field Quality Assurance/Quality Control (QA/QC) Samples

Field duplicate samples and/or field blank samples will be collected during sampling events as described below. Field duplicates are useful in documenting combined field and laboratory precision. Field blanks serve to evaluate the effectiveness of field decontamination procedures and may be collected as a QA/QC alternative to field duplicate samples. To meet a 10% QA/QC field sample requirement (one QA/QC sample per ten normal compliance samples), at least one of these QA/QC field samples shall be collected and submitted each quarter.

Duplicate Samples

One field duplicate sample will be collected per quarterly sampling event. Field duplicate samples are collected at the same location and time, placed in two different bottle sets, and labeled appropriately for separate analysis at the laboratory. Corresponding duplicate sample pair bottles are filled in alternating fashion to maximize sample homogeneity. Duplicate QA/QC samples will be identified in a manner so as to not represent the sample Site location. Designation of the sampling location and ID where the duplicate sample is taken will be recorded in the mobile field form for reference when reviewing sample results. With this single-blind methodology the laboratory may know the sample is a duplicate, but it will not know what sample has been duplicated.

Field Blanks

In cases where non-dedicated/non-disposable sampling equipment is used, one deionized or distilled field blank sample will be collected. However, use of a water level indicator decontaminated in accordance with Section 3.5 will not in and of itself trigger the requirement for a field rinsate blank. Alternatively, a field blank may be prepared in lieu of a duplicate field sample by filling the appropriate laboratory bottle set with deionized or distilled water in the same setting as one of the normal samples is collected, including the standard 0.45-micron filtration requirement for the appropriate bottles.

4.0 LABORATORY ANALYSIS AND ANALYTICAL PARAMETERS

4.1 Laboratory Analysis

Laboratory analyses will be completed within the scope of each laboratories' quality assurance manual and analytical procedures, sample handling, and preservation techniques. Analyses are conducted following standard laboratory quality assurance (QA) and quality control (QC) procedures as required by the analytical methods. Laboratory QA/QC review procedures are presented in Section 5.2.2. Laboratory analytical reports are provided in electronic format delivered by email to the GCC Environmental Engineer and designated consultant, as applicable, in both PDF and MS Excel electronic data deliverable spreadsheet format.

4.2 Laboratory Analytical Parameters

Each groundwater sample will be analyzed in the laboratory for the analytes listed in Table 1, which is based on the State of Colorado Water Quality Control Commission (WQCC) Regulation No. 41 – The Basic Standards for Ground Water, Agricultural Standards Table 3 (December 2016). Regulation No. 41 is periodically updated and the most recent Agricultural Standard values will be used during the sampling event. The contract laboratory will use analytical methods to achieve detection at or below the applicable state groundwater standard.

Initially, MW-5 was to be monitored for field pH, conductivity and temperature, and analyzed in the lab for sulfate, TDS, radium-226 and radium-228. This parameter list was developed based on results from the prior St. Charles River monitoring wells, which have since been proven to not be applicable for Site monitoring and accordingly plugged and abandoned. Potential indicator parameters for groundwater monitoring were evaluated in a report by Close Consulting Group (2016). The parameter list in Table 1 was established in TR-06, and modified by GCC in TR-07 to also analyze samples for Total Dissolved Solids (TDS) to obtain background data. This TR-11 SAP is further expanding that parameter list to require the analysis of the major ions, which are calcium, magnesium, sodium, potassium, chloride, sulfate, bicarbonate, and total alkalinity in order to properly characterize the groundwater type. Numeric Protection Levels other than Table Value Standards may be established by DRMS after a sufficient number of samples have been collected and analyzed.

If there is insufficient volume of water for the complete laboratory analytical list, the first priority will be collection of a sample for dissolved metals analysis, followed by nitrate/nitrite, then unfiltered/unpreserved sample(s) for as many remaining analytes as possible.

5.0 DATA QUALITY, VALIDATION, AND USABILITY

This section describes the data quality objectives and validation process used during review of groundwater data collected at the Site. Data validation of field and laboratory results shall be performed by a third-party contractor.

5.1 Data Quality Objectives

The following section outlines the QA/QC practices employed by sampling personnel and laboratories to ensure the data collected per this SAP are accurate, precise, representative, and comparable between labs, as applicable. QA/QC terms are described below as well as the steps that GCC will take to ensure these QA/QC practices are met.

GCC achieves QA/QC requirements by ensuring that the field meter is properly maintained and calibrated, accurate measurements and notes are recorded, field QA/QC samples are collected, proper sample collection and decontamination field procedures are performed, and a complete data review and validation (as described in Section 5.2) are performed. Analytical laboratories are contracted to follow internal SOPs, perform required QA/QC sample analysis (e.g., method blanks, control samples, matrix spikes, and associated duplicates) and include the QA/QC data in the final analytical report. The laboratory provides level II reports for general data use, as well as level IV reports for the detailed data validation process as described in Section 5.2.

The following definitions describe terms typically used for data quality.

Accuracy

Accuracy is defined as the closeness of agreement between an observed value and an accepted reference value as reported by a laboratory. When applied to a set of observed values (such as field and laboratory QA sample results), accuracy estimates will reflect a combination of random and systematic (i.e., bias) components. In practice, accuracy estimates rely on a determination of the percent recovery measured in spiked samples:

Recovery = %R = ((Cs - Cu)/Cn)*100

where:

Cs = Measured concentration of the spiked sample

Cu = Measured concentration of the unspiked sample

Cn = Nominal (theoretical) concentration increase resulting from spiking the sample, or the nominal concentration of the lab control sample.

The purpose of reviewing accuracy is to ensure that the laboratories used to analyze samples collected pursuant to this SAP are accurate and meet data quality objectives.

Precision

Precision is defined as the agreement among a set of replicate measurements without assumption or knowledge of the true value. Precision is determined by taking the difference between two measured values and dividing by the average of the two samples to get what is known as the relative percent difference (RPD). The samples used for this assessment should contain concentrations of analyte above the laboratory's reporting limit, and may involve the use of matrix spikes. A quantifiable estimate of precision is made based on the RPD:

$$RPD (\%) = ((C1 - C2)/C_{Avg})*100$$

where:

C1 = Measured concentration of the first sample

C2 = Measured concentration of the sample duplicate/replicate

C_{Avg} = Average of the two concentrations.

RPD and comparison criteria are described in Section 5.2.1.

5.2 Data Review, Validation and Verification Requirements

Field and laboratory results are reviewed and validated in accordance with the specifications presented in this section. Analytical results are electronically uploaded to the database or data tables to eliminate transcription errors. Any hand entered results are proofed, as necessary, by data validation personnel to address the potential for transcription errors.

5.2.1 Data Validation

Analytical data are validated and verified to assess how well the data satisfy data quality objectives for accuracy and precision specified by this SAP and the analytical laboratory. Conditions requiring the invalidation of analytical data are rare, as noted in the following sections. However, conditions necessitating qualifying (flagging) data in the data transmittal are more common and will be evaluated based on the following criteria. Qualified data are valid and usable in every way, but are flagged to alert the user that special care may apply to their use in interpretations.

Two types of data qualifiers are recognized for environmental samples, including: 1) flags placed on results by the laboratory to denote problems with associated blanks, spikes, etc. (i.e., laboratory flags), and 2) flags placed by data validation personnel to denote problems or issues associated with sample collection, Site conditions or documentation (i.e., validation flags).

Documentation Reviews

Samples are analyzed within the required holding time limits specified in the analytical method or the appropriate reference. Samples are preserved in accordance with applicable method specifications. Samples not analyzed within specified holding time limits, and/or not appropriately preserved, are invalidated unless professional judgment dictates that flagging would be more appropriate (e.g., consistent with historic observations).

Field QA Sample Review

The preparation of an equipment rinsate blank is required when sampling groundwater with reusable sampling equipment. However, use of a water level measuring probe decontaminated in accordance with Section 3.5 will not in and of itself trigger the requirement for a field rinsate blank. Flagging is not required when fewer field blanks than required are collected, but a QA memo will be included with the data. However, sample results associated with contaminated equipment rinsate blanks (i.e., samples collected prior to the equipment blank's preparation) are flagged if the sample blank concentration exceeds 10% of the sample concentration. Further, sample results may be invalidated if the blank concentration exceeds 50% of the sample concentration. Data are not flagged if the sample concentration is below the reporting limit, regardless of the blank concentration, because the sample is not cross-contaminated. Sample concentrations are not corrected by subtracting blank concentrations.

Field duplicates are samples intended to assess variations due to sample collection, handling or analysis. It is recognized that natural variations in the environment can cause variations in concentrations. Field duplicate concentrations should agree with one another as described below:

Relative Concentration Relationship	Criterion
Concentrations < 5 Times the Reporting Limit	± Reporting Limit
Concentrations > 5 Times the Reporting Limit	RPD (± 50% for metals, ±20% for other analytes)

The RPD (Relative Percent Difference) is calculated with the following equation:

RPD (%) = (S1-S2)/[(S1+S2)/2] * 100

where:

S1 and S2 are the two duplicated values or the highest and lowest values if more than two sample duplicates are analyzed.

Duplicated sample results that do not meet the above criteria and are not consistent with historical results are flagged. Flagging is not required when fewer field duplicates than required are collected, but a QA memo is filed with the data and the incident is noted in the data transmittal for the sampling event.

5.2.2 Laboratory Data Verification

Laboratory data reports are reviewed for appropriate QA/QC procedures and data qualifiers. Applicable U.S. Environmental Protection Agency (EPA) analytical methods encourage laboratories to develop in-house QA/QC limits, and require adherence to in-house limits for data reporting, qualifying and corrective actions. Verification of appropriate laboratory flagging is conducted during data validation.

Although it is the laboratory's responsibility to ensure that its results meet minimum internal QA/QC standards and are properly flagged, the data validation process also includes the following checks:

- Confirm that all sample locations and constituents are reported and that there is an explanation for a missing data point.
- Review the data report and confirm that titles, labels, column headings, and footnotes are accurate and complete. Confirm that constituents are reported in proper units.

- Review values reported as Non-Detected. Confirm that the analytical detection limits are low enough to accomplish project goals. Confirm that all values are either reported as values or less than the detection limit. Confirm that the detection limit is used consistently on all samples.
- Ensure that the required quality control tests (i.e., preparation and calibration blanks, laboratory control standards, matrix spikes and duplicate samples) were performed at the required frequency. If quality control results cannot be obtained from the laboratory, all associated data are qualified or invalidated.
- Ensure that initial calibration verification and reference sample test results were within laboratory specified control limits. Any data reported with associated initial calibration verification or reference standards that are outside of control limits are invalidated.
- Confirm that the laboratory properly qualified (flagged) the data.
- Review data for internal consistency. Confirm that values have a logical relationship to one another. Confirm that values are within the historical range of data for a given well and constituent. Confirm that values vary logically according to known geologic conditions.

6.0 REPORTING

For data evaluation and storage, the data collected, including recorded field parameters, will be transferred to a georeferenced database, i.e. Microsoft Access, after being validated. This will facilitate data evaluation, reporting, graphic demonstration, and statistical analysis.

After the results are reviewed internally for QA/QC, quarterly and semi-annual data will be made available to the DRMS. An annual report will be prepared and submitted to DRMS by January 31 of the following year. The annual report will summarize data and findings for the year, update the hydrogeologic conceptual model as necessary, as well as include the annual data validation report.

DRMS requires a written report with five (5) working days when there is evidence of an exceedance of applicable groundwater standards (following data validation for the subject analytes). Current groundwater standards applicable to the GCC Site are Colorado Table Value Standards (TVS) for agricultural use, some of which are specific to a particular use or application of the water. Therefore, GCC will coordinate with DRMS on whether or not levels of certain analytes constitute an exceedance requiring reporting. After a sufficient number of samples have been analyzed for a particular well, DRMS may establish Numeric Protection Levels that differ from the TVS.

7.0 REFERENCES

Brown and Caldwell, Inc., 2003. Condition #1 Groundwater Sampling Plan, GCC Rio Grande, Inc. Red Rock Plant and Limestone Mine, February 2003.

Close Consulting Group LLC, 2016. Groundwater Monitoring Evaluation for the GCC Pueblo Plant and Quarry, Letter Report to LRRC, March 17.

Close Consulting Group LLC, 2018. Groundwater Monitoring Well Installation and Baseline Sampling: MW-6 and MW-7, Letter Report to GCC, February 8.

Collom, C.J., 2000. Geologic Considerations Pertaining to the Mining of Fort Hays Limestone for the Manufacturing of Portland Cement in Pueblo County, Colorado. Prepared for Rio Grande Portland Cement, August, 14 p.

Contour Consulting Engineering LLC, 2013. Geologic Report and Submittal, Response to DRMS Letter dated 29 November 2012 regarding: Pueblo Cement Plant and Limestone Quarry, Permit No. M-2002-004, Exceedance of Groundwater Numeric Protection Levels.

Colorado Department of Public Health and Environment, Water Quality Control Commission, 2016. Regulation No. 41, The Basic Standards for Ground Water (5 CCR 1002-41), December 30.

Colorado Department of Public Health and Environment, Water Quality Control Division, Undated. Suggested Sampling Protocol for Ground Water Monitoring Wells.

Resource Hydrogeologic Services, Inc., 2022. GCC Rio Grande Pueblo Plant TR-08 Monitoring Wells Installation Report, April 1, 23 p.

U. S. EPA 1996. Low-Flow (Minimal Drawdown) Groundwater Sampling Procedures. EPA/540/S-95/504, 12 p. https://www.epa.gov/remedytech/low-flow-minimal-drawdown-ground-water-sampling-procedures

U.S. EPA 2015. Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers. EPA 542-S-02-001. 53p. http://www.epa.gov/sites/production/files/2015-06/documents/gw_sampling_guide.pdf

TABLES

Table 1. GCC Pueblo compliance groundwater analytical parameters

Parameter[1]	Applicable Standard[2]	Method Detection Limit	Analytical Method
Laboratory - Metals			
Aluminum (Al)	5 mg/l	0.05 mg/l	M200.7 ICP
Arsenic (As)	0.1 mg/l	0.0002 mg/l	M200.8 ICP-MS
Beryllium (Be)	0.1 mg/l	0.01 mg/l	M200.7 ICP
Boron (B)[3]	5.0 mg/l	0.03 mg/l	M200.7 ICP
Cadmium (Cd)	0.01 mg/l	0.00005 mg/l	M200.8 ICP-MS
Calcium (Ca)[4]	NA	0.1 mg/L	M200.7 ICP
Chromium (Cr)	0.1 mg/l	0.02 mg/l	M200.7 ICP
Cobalt (Co)	0.05 mg/l	0.02 mg/l	M200.7 ICP
Copper (Cu)	0.2 mg/l	0.01 mg/l	M200.7 ICP
Iron (Fe)	5 mg/l	0.06 mg/l	M200.7 ICP
Lead (Pb)	0.1 mg/l	0.0001 mg/l	M200.8 ICP-MS
Lithium (Li)	2.5 mg/l	0.008 mg/l	M200.7 ICP
Magnesium (Mg)[4]	NA	0.2 mg/L	M200.7 ICP
Manganese (Mn)[5]	NA	0.01 mg/l	M200.7 ICP
Mercury (Hg)	0.01 mg/l	0.0002 mg/l	M245.1 CVAA
Nickel (Ni)	0.2 mg/l	0.008 mg/l	M200.7 ICP
Potassium (P)	NA	0.2 mg/L	M200.7 ICP
Selenium (Se)	0.02 mg/l	0.0001 mg/l	M200.8 ICP-MS
Sodium (Na)	NA	0.2 mg/L	M200.7 ICP
Vanadium (V)	0.1 mg/l	0.01 mg/l	M200.7 ICP
Zinc (Zn)	2 mg/l	0.02 mg/ l	M200.7 ICP
Laboratory - Wet Chemistry			
Alkalinity as $CaCO_3$[4]	NA	2 mg/L	SM2320B
Fluoride (F)	2 mg/l	0.15 mg/l	SM4500F-C
Nitrate as N[4]	NA	Calculation	Calculation NO_3NO_2 - NO_2
Nitrate/Nitrite as N	100 mg/l as N	0.02 mg/l	M353.2
Nitrite as N	10 mg/l as N	0.01 mg/l	M353.2
pH[6]	6.5 - 8.5	--	SM4500H+B
Sulfate[4]	NA	1 mg/l	D516-02/-07/-11
Total Dissolved Solids[7]	1.25 X background	20 mg/l	SM2540C
Field			
pH	6.5 - 8.5	NA	NA
Specific Conductance	NA	NA	NA
Oxygen Reduction Potential	NA	NA	NA
Temperature	NA	NA	NA

Notes:

1. Laboratory analyses are dissolved concentrations with samples 0.45 µm field-filtered as required per analytical method specifications.

2. State of Colorado Water Quality Control Commission (WQCC) Regulation No. 41 – The Basic Standards for Ground Water, Agricultural Standards Table 3 (December 2016).

3. This is the applicable WQCC Regulation No. 41 groundwater standard for the Site as crop watering use of groundwater for specified plant species is not reasonably expected (per Table 3 footnote "g"); otherwise the stated WQCC Regulation No. 41 Table 3 groundwater standard is 0.75 mg/L

4. No applicable WQCC Regulation No. 41 Table 3 groundwater standard for this parameter.

5. This WQCC Regulation No. 41 Table 3 groundwater standard is only applicable where acidic soils exist (not at this Site), per Table 3 footnote "j"; otherwise the stated WQCC Regulation No. 41 groundwater standard is 0.2 mg/L

6. Laboratory pH analysis is only required if field pH is not measured.

7. WQCC Regulation No. 41 Table 4 groundwater standard for background TDS value 501 - 10,000 mg/L range observed at Site is 1.25 times the background value.

Table 2. GCC Pueblo compliance groundwater sample hold times by analytical method

Parameter	Analytical Method	Holding Time (days)
Aluminum (Al)	M200.7 ICP	180
Arsenic (As)	M200.8 ICP-MS	180
Beryllium (Be)	M200.7 ICP	180
Boron (B)	M200.7 ICP	180
Cadmium (Cd)	M200.8 ICP-MS	180
Calcium (Ca)	M200.7 ICP	180
Chromium (Cr)	M200.7 ICP	180
Cobalt (Co)	M200.7 ICP	180
Copper (Cu)	M200.7 ICP	180
Iron (Fe)	M200.7 ICP	180
Lead (Pb)	M200.8 ICP-MS	180
Lithium (Li)	M200.7 ICP	180
Magnesium (Mg)	M200.7 ICP	180
Manganese (Mn)	M200.7 ICP	180
Mercury (Hg)	M245.1 CVAA	180
Nickel (Ni)	M200.7 ICP	180
Potassium (P)	M200.7 ICP	180
Selenium (Se)	M200.8 ICP-MS	180
Sodium (Na)	M200.7 ICP	180
Vanadium (V)	M200.7 ICP	180
Zinc (Zn)	M200.7 ICP	180
Alkalinity as $CaCO_3$	SM2320B	14
Fluoride (F)	SM4500F-C	28
Nitrate as N	Calculation NO_3NO_2 - NO_2	2
Nitrate/Nitrite as N	M353.2	2
Nitrite as N	M353.2	2
Sulfate	D516-02/-07/-11	28
Total Dissolved Solids	SM2540C	7

Table 3. GCC Pueblo monitoring well construction and dedicated sampling pump information

Monitoring Well ID	Year Installed	CDWR Permit Number	UTM NAD 83 Zone 13N Easting (meters)	UTM NAD 83 Zone 13N Northing (meters)	Elevation - Top of PVC Casing - Water Level Measuring Point (ft)	Elevation - Ground Surface at Wellhead Cement Pad (ft)	Total Well Completion Depth (ft bgs)	Screened Interval (ft bgs)	Screened Filter Pack Interval (ft bgs)	Screened Interval Formation	Type of Dedicated Sampling Pump	Pump Make/Model	Pump Intake Set Depth (ft bgs)	Pump Discharge Tubing Inner Diameter (in)	Pump Discharge Tubing Purge Volume (gal)
MW-5	2008	278490	533304.305	4217575.554	4966.65	4964.39	25.00	9.0-24.0	8.0-25.0	Colluvium/Unconsolidated	NA - dry well	NA -dry well	NA - dry well	NA - dry well	NA - dry well
MW-6	2018	312701	533308.582	4217579.756	5064.14	5061.62	56.40	30.9-56.4	28.0-56.7	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	55.7	0.375	0.3
MW-7	2018	312702	534710.190	4219189.212	5063.75	5061.09	56.10	30.6-56.1	27.5-57.0	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	55.0	0.375	0.3
MW-8	2020	316170	534714.843	4219193.313	5062.90	5060.74	63.10	58.1-62.9	57.0-64.3	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	62.5	0.375	0.4
MW-9	2021	323005	535148.659	4221153.094	5256.09	5253.97	40.30	30.0-40.0	20.9-42.0	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	38.6	0.375	0.2
MW-10	2021	323006	535153.271	4221157.369	5255.82	5253.60	80.30	50.0-80.0	47.0-81.5	Blue Hills Shale	12-volt ESP	Proactive Environmental SS Sample Champ XL	79.0	0.375	0.5
MW-11	2021	323007	534405.485	4219710.530	5084.30	5082.09	70.00	39.6-69.6	36.6-70.6	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	68.5	0.375	0.4
MW-12	2021	323008	534407.927	4219719.209	5083.94	5081.64	86.50	76.2-86.2	73.1-86.6	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	85.4	0.375	0.5
MW-13	2021	323009	534401.520	4219714.939	4990.11	4987.93	175.33	135.0-175.0	135.0-175.0	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	167.5	0.375	1.0
MW-14	2021	323010	535242.397	4221415.851	4989.92	4987.81	205.33	190.0-205.0	187.0-206.0	Codell Sandstone	Bladder	QED Well Wizard SS T1300	203.6	0.250	0.6

Notes:
Coordinates based off state plane grid/NAD83 Colorado South. Vertical datum based on NAVD88.
All wells constructed of 2-inch schedule 40 flush-joint PVC casing and screen.
ESP = electric submersible pump.
SS = stainless steel.

FIGURES

Figure 1. GCC Pueblo Site Map

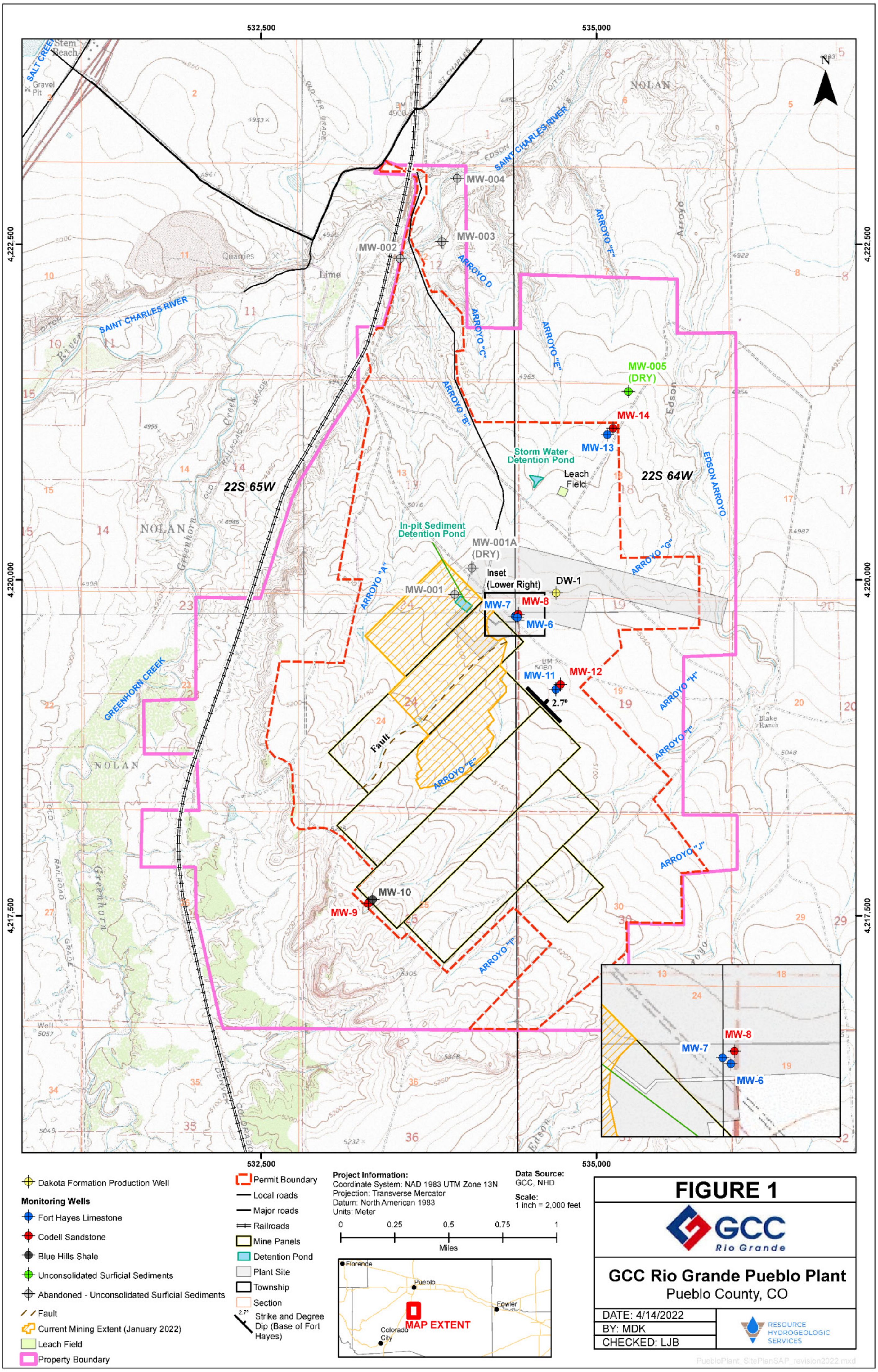

Figure 2. GCC Pueblo stratigraphic section (from Contour Consulting Engineering LLC Geologic Report and Submittal, January 25, 2013) (2013-01-28_HYDROLOGY – M2002004)

Ref: USGS Miscellaneous Geologic Investigations Map I-597

GEOLOGIC STRATIGRAPHY PUEBLO CEMENT PLANT

Formation	*Member*	*USGS Map Symbol*	*Stratigraphic Description*	*Thickness (Feet)*	*Remarks*
COLLUVIUM (Quaternary)		Qc	Yellowish-gray silt and clay containing pebbles, angular blocks of limestone, and sandstone derived from underlying bedrock and surficial deposits. Areas of lower elevations above streams are same age as and grade into Piney Creek Alluvium. Large broad upland areas range in age from Illinoian to Holocene. Along drainageways includes some alluvium.	10-20	plant site and mine site overburden material
NIOBRARA FORMATION (Late Cretaceous)	SMOKEY HILL SHALE	Ksuc	upper chalk unit: olive-black blocky ledge-forming chalk that weathers dark yellowish orange.	8	missing at Red Rock Site (removed by erosion)
		Ksus	upper chalky shale unit: olive-gray gypsiferous bentonitic calcareous shale and yellowish-gray platy chalk beds in upper part; pale-yellowish brown soft calcareous shale and platy chalky limestone beds in lower part.	263	
		Ksmc	middle chalk unit: yellowish-gray platy ledge-forming chalk containing selenite nodules.	28	
		Ksms	middle shale unit: light-olive-gray platy bentonitic gypsiferous calcareous shale containing limestone concretions 30 to 40 feet below the top; sandy shale 150 to 190 feet above base; shaly limestone at base.	283	
		Ksll	lower limestone unit: dark-gray platy hard ledge-forming limestone in about 16 beds separated by light-olive-gray platy shale containing limonite-stained gypsum lenses. Contains alternating thick shale and thin limestone beds in lower 15 feet.	38	
		Ksls	lower shale unit: yellowish-brown platy to earthy calcareous shale containing thin beds of platy limestone and limonite-stained gypsum lenses.	56	underlies Colluvium at plant site
		Kssl	shale and limestone unit: about 18 beds of gray dense ledge-forming limestone separated by soft calcareous shale.	21	underlies Colluvium in portion of mine area
	FORT HAYES LIMESTONE	Kf	about 40 beds of gray desnse ledge-forming limestone separated by thin beds of calcareous shale. Contains pseudomorphs of limonite after pyrite.	40	source of limestone for mining operation
CARLILE SHALE (Late Cretaceous)	JUANA LOPEZ MEMBER	Kc	yellowish-gray calcareous shale containing lenses of dark-brownish-gray fetid fine-grained calcarenite that has spots of light-gray glauconitic calcarenite.	2	
	CODELL SANDSTONE		yellowish-gray massive to platy cliff-forming sandstone; shaly and containing spherical concretions in lower part.	30	
	BLUE HILL SHALE		dary-gray hard to soft blocky shale; upper half sandy, and containing two prominent layers of large septarian concretions.	101	
	FAIRPORT CHALKY SHALE		gray to yellowish brown soft bentonitic platy calcareous shale	99	
GREENHORN LIMESTONE (Late Cretaceous)	BRIDGE CREEK LIMESTONE	Kgh	about 26 gray hard shaly-weathering limestone beds separated by soft calcareous shale and bentonite layers.	52	
	HARTLAND SHALE		dark-gray calcareous platy shale and thin layers of calcarenite composed of tests of Foraminifera and prisms of Inoceramus shells.	59	
	LINCOLN LIMESTONE		gray thin-bedded petroliferous limestone and calcareous shale	25-50	
GRANEROS SHALE (Late Cretaceous)		Kg	Dark-gray to black fissile gypsiferous shale; contains zone of calcereous concentrations about 40 feet below top. Alternating beds of shale and sandstone at base.	90-200	
DAKOTA SANDSTONE (Early Cretaceous)	UPPER SANDSTONE	Kd	Tan to bright gray, fine-to medium-grained massive sandstone. May be conglomeratic and moderately cemented, but may be soft and contain thin shale beds.	74-140	proposed aquifer for production well
	DRY CREEK CANYON		Dark-gray to black sandy shale, this unit may not be present.		
	LOWER SANDSTONE		Medium-grained sandstone.		

Sources:

1. Scott, Glenn R., 1969, Geologic Map of the Southwest and Southeast Pueblo Quadrangles, Colorado U.S. Geological Survey Miscellaneous Investigations Series Map I-597. Scale 1:24,000.
2. Weist, 1965, U.S. Geological Survey Water Supply Paper 1799.

APPENDICES

Wells - GCC Pueblo Compliance Water Sampling

GCC Pueblo Quarry and Cement Plant
(719) 647-6800
3372 Lime Road
Pueblo, CO 81004
www.gcc.com

Reference Number: ______________________________
Form Name: ______________________________
Submitter Name: ______________________________
Submission Date: ______________________________

SITE INFORMATION

Location

Project Site	____________________
Sample ID	____
Water present to measure/sample?	Yes/No
Is the water present within 0.25 feet of the well TD?	Yes/No
Wellhead Stick-Up from Ground Level Reference Point to Depth to Water Level Reference Point (ft)	______
Static Depth to Water (ft)	______
Well Total Depth (ft below top of casing)	______
Depth to Water below ground Surface (ft)	______
Well Diameter (In)	______

Misc

Site Photo

GCC_RGPP-Sample Date

Water Quality Meter

Water Quality Meter Make/Model/SN ______________
Calibration Date/Time: ___________________________
Calibration Parameters ___________________________
____
____
____
AquaTroll calibration log generated? Yes/No

SAMPLING DETAILS

Weather _____
Air Temperature (°F) _____
Date ____________
Time ____________

Sampling

Sample Temperature (°C) ____________
Specific Conductivity (µS/cm) ____________
pH (S.U.) ____________
Oxygen Reduction Potential (mV) ____________

Water level measured at sample time? ____________________________________

Depth to Water (ft TOC) ____________
Was flow rate measured? ____________
Flow Rate (gpm) ____________
Total Purged (gal) ____________
Geographic Sample Location ________________________________
____
____
______________________ [viewMap]
Sample(s) collected for laboratory analysis? Yes/No

Sampler

Sampler Name ___________________________________

Sampler's Signature ___________________________________

SAMPLE(S) COLLECTED FOR LABORATORY ANALYSIS

Sample Submittal Information

LAB SAMPLE 1 OF 2

Details

Method of Sample Collection ____________________

Lab Sample Name __________
Date __________
Time __________
Lab Suite __________
Number of Bottles/Containers __________
Lab Sample Type __________

LAB SAMPLE 2 OF 2

Details

Method of Sample Collection ____________________

Lab Sample Name __________
Date __________
Time __________
Lab Suite __________
Number of Bottles/Containers __________
Lab Sample Type __________

Sample Handling

SAMPLE HANDLING 1 OF 3

Bottle Details

ACZ Labs Bottle Sticker	None
Bottle Volume (mL)	500
Bottle Composition	Poly
Bottle Quantity	1
Field-Filtered to 0.45 µm (Yes/No)	No
Preservative (Type)	Raw/None
Analysis	Wet Chemistry - no preservative, no filtration

SAMPLE HANDLING 2 OF 3

Bottle Details

ACZ Labs Bottle Sticker	White
Bottle Volume (mL)	250
Bottle Composition	Poly
Bottle Quantity	1
Field-Filtered to 0.45 µm (Yes/No)	Yes
Preservative (Type)	Raw/None
Analysis	Wet Chemistry - no preservative, field-filtered

SAMPLE HANDLING 3 OF 3

Bottle Details

ACZ Labs Bottle Sticker	Green PC
Bottle Volume (mL)	125
Bottle Composition	Poly
Bottle Quantity	1
Field-Filtered to 0.45 µm (Yes/No)	Yes
Preservative (Type)	Nitric Acid
Analysis	Metals (dissolved including ICPMS) - nitric preserved, field-filtered

GCC	Creation Date: 02/18/2020	Revision Date: 5/13/2022
	Control Number: PUE.EN.P.003.02	Page: 1 of 7

Title: **GCC Rio Grande Pueblo Plant Groundwater Monitoring Well Compliance Sampling Procedure**

1.0 SCOPE

This procedure covers the process for obtaining and submitting groundwater monitoring well samples to an analytical lab as required by the DRMS approved Sampling and Analysis Plan (SAP) under TR-11.

2.0 REFERENCES AND RELATED DOCUMENTS

PUE.SA.P.015 Workplace Examination Procedure
PUE.SA.F.005 Workplace Examination
PUE.EN.D.026.05 SAP for Groundwater Monitoring

3.0 RESPONSIBILITY

N/A

4.0 TRAINING REQUIREMENTS

Read and understand these procedures. Contact the Environmental Engineer if you have questions regarding these instructions.

5.0 REPORTING AND COMMUNICATION

All groundwater sampling records (field forms) are completed and accessed through the ProntoForms app by the GCC Environmental Engineer who will store the produced PDF-format and XLSX-format electronic data deliverables generated by each form completion on the Pueblo Environmental Shared Drive. This represents the Facility Groundwater Monitoring Record.

All analytical will be stored on the Pueblo Environmental Shared Drive upon receipt from the lab.

6.0 DEFINITIONS

N/A

7.0 MATERIALS AND EQUIPMENT

- PPE
- Wellhead lock combination number
- Multiple indelible ink pens & markers
- Mobile tablet computer loaded with ProntoForms app and In-Situ VuSitu app
- Smart phone/camera/calculator/stopwatch
- Calibrated water quality meter (In-Situ AquaTroll 400 or similar) and accessories, pH, specific conductance, oxygen reduction potential calibration fluids
- In-Situ AquaTroll low-flow cell
- Water level indicator (WLI), 210-foot minimum length for the current maximum monitoring well depth
- Proactive Environmental Sample Champ XL Low Flow Power Booster Controller
- 12-volt auto/tractor battery, fully charged; alternatively use vehicle's onboard battery
- New 1/2" X 3/8" environmental grade clear PVC tubing, approximately 10-foot length
- Plastic 3/8" barbed three-way valve
- 0.45 µm 600 cm^2 inline disposable filters

- Sample cooler with "GW-Compliance" bottle sets with bagged and cubitainer ice. Minimum of 10 bottle sets per quarterly sampling event (bring spares!).
- Ziploc-type bags for ice and COC
- Clear packing tape
- COC's, custody seals
- Box or bag of disposable nitrile gloves
- Hand sprayers – (1) with Liquinox solution, (1) with distilled or deionized water
- Roll of paper towels
- Graduated 3 to 5-gallon bucket
- Graduated cylinder
- Plastic tubing cutter

8.0 PROCEDURE

1) **Prior to the day of sampling, obtain necessary equipment and materials (listed above in previous section) to sample groundwater monitoring wells per compliance requirements.**
2) **Calibrate the In-Situ AquaTroll 400 (or similar) water quality meter for pH, specific conductivity, oxygen reduction potential, and dissolved oxygen (all probes on the sonde) per manufacturer's instructions in office or lab setting prior to going to field. If all quarterly compliance sampling efforts are completed within one month, calibration is only required just prior to the first day of the sampling effort.**
3) **Complete Workplace Examination, per PUE.SA.P.015, and review with crew.**
4) **Observe and document in official record (ProntoForms mobile tablet form comments section) any unusual conditions at or near well, especially including potential signs of tampering such as unlocked wellhead, removed cap, damage, etc. Take photo(s) as needed with the ProntoForms app.**
5) **Measure and record well water level and well head stick-up.**
   a) Unlock the wellhead padlock. Remove the wellhead pump hanger PVC slip cap or j-plug, as applicable.
   b) Measure and record to the hundredth of foot the well head stick-up (SU) from ground surface to top of casing using the WLI tape. Confirm this value is the same as what is programmed into the ProntoForms app. Make a note in the ProntoForm comments section if the measured length is not within +/- 0.01 of the programmed value and report that measured length there.
   c) Measure depth to water (DTW) with a clean/decontaminated WLI to the hundredth of foot from top of casing or top of the wellhead dedicated sampling pump hanger at the WLI access hole, as applicable. Record value in the ProntoForms app.
   d) Measure and record the total depth of the well (TD) with WLI from top of casing. For wet wells that contain dedicated sampling pump systems, it is not possible for the WLI probe to pass below the pump. For these wells, the TD is already programmed into the ProntoForms app.
   e) Leave the WLI probe deployed to a depth just above the static water level for use during sampling, as applicable.
   f) Clean/decontaminate probe and tape with Liquinox detergent solution followed by distilled water rinse when done with use at this well.

g) If no water is present in the well when measured, or the water level is found to be within 0.25 feet of well TD (the distance between the lowest screen slot and well bottom cap), this monitoring event shall be designated "dry" in the Groundwater Monitoring Record, by indicating as such in the ProntoForms app. No collection of water quality field parameters or a sample for lab analysis is possible. Retrieve and decontaminate WLI, secure wellhead and rig down all monitoring equipment. Complete and submit the ProntoForm for a water level-only field record.

6) Set up sampling station.

a) Place the water level indicator (WLI), Proactive pump controller, and 12-volt battery beside well.

b) Place the graduated bucket for purge water collection, flow rate and volume measurement nearby.

c) Place the cooler containing bags of ice, "GW-Compliance" sample bottle set(s), a bag or box of disposable nitrile gloves, sealed new 0.45 µm filter(s), and clear 1/2" X 3/8" PVC tubing nearby.

d) Setup In-Situ AquaTroll 400, installed into the low-flow cell, and establish wireless connection between the AquaTroll 400 and the tablet computer via the VuSitu app. Select the appropriate site stored in the app for that well and set the datalogging frequency for 20 second intervals and start logging.

7) Purge, measure water quality parameters & collect sample for laboratory submittal.

a) With clean disposable nitrile gloves, attach clear 1/2" X 3/8" PVC tubing to wellhead sampling pump discharge elbow fitting and cut it to approximately 2 feet long.

b) Attach the barbed three-way sample valve to the tubing and then connect another piece of clear 1/2" X 3/8" PVC tubing, approximately three feet long, between the valve and the lower 3/8" hose barb on the low-flow cell. Attach a very short piece of the tubing to the last open barb on the valve; this will be the sample port and allows the disposable 0.45 µm filter to be attached.

c) Attach another piece of 1/2" X 3/8" PVC tubing to the upper 3/8" hose barb on the low-flow cell and then cut it to a length that allows it to reach the location of the graduated purge bucket.

d) Ensure the pump speed control knob on the Proactive pump controller is dialed counter-clockwise to its limit which is the "off" position. Attach the alligator clips (red for positive, black for negative) from the Proactive pump controller appropriately to the 12-volt battery positive and negative posts. This will immediately power up the controller with the cooling fan starting and the LCD screen illuminating to show 0.00 V.

e) Turn Proactive pump controller speed control knob clockwise slowly observing the increased voltage being supplied to the pump. Once a trickle of groundwater is being produced, keep this flow rate consistent. Depending on the well's DTW, this could be between 7 and 24 volts as displayed on the LCD screen. Follow the maximum voltage guidance depth table label on the controller to prevent over-powering and damaging the pump.

f) Conduct a bucket-and stopwatch flow rate test. For low-purge volume wells, use of a graduated cylinder is a more appropriate container than a graduated bucket. Record flow rate in the ProntoForm. If using a graduated cylinder for the flow rate test, dump its contents into the graduated bucket when complete to fully collect and document the total purge volume, also to be recorded in the ProntoForm. The flow rate should be on the order of 0.03 to 0.1 gpm.

g) While water is discharging during the flow rate test, measure the pumping DTW. The goal is minimal well drawdown in response to pumping to keep well bore turbulence to an absolute minimum. Decrease the flow rate as necessary to minimize drawdown.

h) Utilizing the well construction and pump information table included at the end of this procedure, continue pumping towards the given pump discharge tubing purge volume for that well.

i) While conducting steps 7(f) through 7(h) continue to observe the individual water quality parameters displayed on the VuSitu app. Once the given target tubing purge volume has been discharged, monitor the individual water quality field parameters utilizing the VuSitu app for stabilization over 3 consecutive measurements according to the following:

Temperature (3%)

Specific Conductance (3%)

Oxygen Reduction Potential (+/- 10 millivolts)

pH (± 0.1 unit)

8) If the well goes dry before field parameter stabilization, rig down, secure the well and allow well to recover for up to seven days. Monitor DTW for adequate recovery daily (Monday-Friday) until there is adequate water to collect the water sample. If the well recovers within seven days, no further purging is required before collecting the sample for lab submittal so move to step 9 below. If the well does not recover within seven days, this monitoring event shall be designated "dry following purge" in the ProntoForm comments section. No collection of a sample for lab analysis is possible, however the last set of field water quality parameters collected during the purge shall be retained in the ProntoForm for the Facility Groundwater Monitoring Record. Retrieve and decontaminate WLI, secure wellhead and rig down all monitoring equipment.

9) Collect final field parameters and sample

a) When stabilization criteria are met, utilize the "mark" feature in the VuSitu app to designate that set of field parameters as the final field parameters to represent this lab sample. Download and email the data logged AquaTroll 400 file from the VuSitu app to the GCC Environmental Engineer.

b) There are 3 individual bottles in the "GW-Compliance" bottle set to be filled. Label all sample bottles by completing lab-provided labels with indelible ink pen or marker prior to filling. Alternatively, the labeling may be made by writing directly on the bottles. Information shall include:

- Site or project name (GCC Rio Grande)
- Sample ID
- Sample collection date and time
- Sampler's initials

c) Turn the valve handle to change the flow from discharging to the low-flow cell to the sample port and allow it to flow to the ground for a moment to flush any trapped sediment. Attach the inlet side of a new disposable 600 cm^2 0.45 µm filter (observe flow arrow on filter) to the 3-way valve sample port tubing.

d) Allow the pumped well discharge water to flush air from the 0.45 µm filter and fill with sample water until the filter is producing water. Confirm there are no visible particulates flowing in the water from the filter outlet that may indicate a damaged filter. Replace the filter and repeat the flush process if necessary.

e) Fill the 125 ml poly preserved bottle to the bottleneck and cap immediately. There is acid preservative in this container. Do not over-fill or spill the preservative – if this does happen then take a replacement 125 ml poly preserved bottle from a spare bottle set and repeat the fill procedure.

f) Fill the 250 ml poly unpreserved bottle from the 0.45 µm disposable filter outlet to the bottleneck and cap immediately.

g) Remove the 0.45 µm disposable filter from the sample port.

h) Fill the 500 ml poly unpreserved bottle to the bottleneck directly from the sample port and immediately cap.

i) Label each bottle with actual the sample time, coordinated with the final logged water quality field parameters readings.

j) IF AT ANY POINT A BOTTLE CAP GETS DROPPED ON THE GROUND, RAINED ON, ETC. – simply triple rinse the cap (inside and out) with excess sample water from the pump discharge to decontaminate. Confirm no debris is on the cap and then screw it onto the bottle. If the cap is dropped into a known or suspected contaminant, then do not take a chance and simply replace the contaminated cap from a bottle from a spare bottle set.

k) Place all 3 filled and labeled sample bottles into the original lab-provided bottle set bag or otherwise a gallon-size Ziploc-type bag and place in cooler under cubed ice. It is important to use cubed ice to rapidly chill the samples in the field ahead of shipping. Label the bag with the same information on the individual bottle labeling in indelible ink.

10) Collect QA/QC field duplicate sample

a) For each quarterly compliance groundwater monitoring event (up to 10 monitoring locations to meet 10% minimum QA/QC standard), one randomly selected, blind duplicate sample shall be collected and submitted for laboratory analysis by the "GW-Compliance" suite.

b) Fill the bottles for the duplicate sample in sequence of the standard sample that is being duplicated by using the procedure in step 9. Batching each bottle type is recommended for better sample-splitting and efficiency with field-filtered samples. This is accomplished by alternating between filling the standard sample bottle of one bottle type, i.e., the filtered 125 ml poly preserved bottle, and then the duplicate sample bottle for the 125 ml poly preserved bottle, until all bottles are filled.

c) Alternatively, a field blank may be submitted for the required one QA/QC sample collection per quarter. This is accomplished by filling a GW-Compliance bottle set with deionized or distilled water at the well, utilizing a separate new 0.45 µm disposable filter for the appropriate bottles as indicated in step 9.

d) Name the sample MW-2B (to make the sample ID "blind" from the lab) and assign it a sample time of plus one hour of the duplicated or field blank sample collection time (i.e., 12:00 for standard sample, 13:00 for the duplicate/field blank), also to aid in keeping the sample identification blind from the lab.

e) Add the QA/QC sample information into the ProntoForm already in progress for the standard sample at this well. This will tie the field record of this blind QA/QC sample to the standard sample record.

f) Place all 3 filled and labeled sample bottles into the original lab-provided bottle set bag or otherwise a gallon-size Ziploc bag and place in cooler under cubed ice. It is important to use cubed ice to rapidly chill the samples ahead of shipping. Label the bag with the same information on the individual bottle labeling in indelible ink.

11) Rig down sampling equipment

a) Reel up WLI and decontaminate the probe and tape exposed to well water with Liquinox solution spray and spray-rinse with distilled water.
b) Place the used 0.45 µm filter, nitrile gloves, tubing, and other miscellaneous consumables into a trash bag for appropriate disposal.
c) Decontaminate the AquaTroll 400 water quality meter probes by spraying with Liquinox solution followed by spraying with distilled water until no suds remain. Prepare the meter probes for long-term storage, as appropriate per manufacturer's instructions.

12) Prep sample(s) for submittal to analytical lab

a) Note the laboratory analysis holding times for the "GW-Compliance" suite, specifically nitrite/nitrate analysis which requires samples to be received by lab within 48 hours of the sample collection time. **This requires each sample to be shipped by standard UPS ground service, which is overnight delivery from Pueblo, CO to ACZ Labs in Steamboat Springs, CO, by the conclusion of the day it was collected!**

b) Place all bottle set bags in a cooler with multiple cubitainer ice blocks. Package so that all bottles are secure to prevent movement during shipping. It is very important that these samples arrive to the lab between 0°C - 6°C, so it is best to error with too much ice rather than not enough. NEVER DUAL-PURPOSE THE SAMPLE COOLER FOR FOOD OR DRINKS!

c) Complete the Chain of Custody (COC) for the lab using the official sample ID, the sample date and time, the matrix "Groundwater" checked, the number of containers (3). Enter "GW-Compliance" for analysis request and check the box. Complete all header information using GCC Rio Grande site contact information with project contact person as the GCC Environmental Engineer and the designated consultant, as applicable. Sign "Relinquished By" and date/time and retain the carbon copy (yellow) for your records. If no carbon copy exists, scan and retain that file for the record. Place the COC inside a sealed 1-gallon Ziploc bag inside the cooler at the top of the contents. Complete custody seal by signing and dating and adhering across the cooler lid to cooler body. Using clear packing tape, secure lid closed, also covering and securing the custody seal.

d) Ship the cooler to the contract lab via UPS ground service, which is the most reliable overnight delivery from Pueblo, CO to ACZ Labs in Steamboat Spring, CO, utilizing tracking with email copies to the lab project manager and GCC Environmental Engineer. If the contract environmental laboratory should change, it would likely be to a Denver, CO area lab, in which UPS ground service would remain the most reliable overnight delivery option.

GCC Pueblo Well Construction & Dedicated Sampling Pump Information Table

Monitoring Well ID	Year Installed	CDWR Permit Number	UTM NAD 83 Zone 13N Easting (meters)	UTM NAD 83 Zone 13N Northing (meters)	Elevation - Top of PVC Casing - Water Level Measuring Point (ft)	Elevation - Ground Surface at Wellhead Cement Pad (ft)	Total Well Completion Depth (ft bgs)	Screened Interval (ft bgs)	Screened Filter Pack Interval (ft bgs)	Screened Interval Formation	Type of Dedicated Sampling Pump	Pump Make/Model	Pump Intake Set Depth (ft bgs)	Pump Discharge Tubing Inner Diameter (in)	Pump Discharge Tubing Purge Volume (gal)
MW-5	2008	278490	533304.305	4217575.554	4966.65	4964.39	25.00	9.0-24.0	8.0-25.0	Colluvium/Unconsolidated	NA - dry well	NA -dry well	NA - dry well	NA - dry well	NA - dry well
MW-6	2018	312701	533308.582	4217579.756	5064.14	5061.62	56.40	30.9-56.4	28.0-56.7	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	55.7	0.375	0.3
MW-7	2018	312702	534710.190	4219189.212	5063.75	5061.09	56.10	30.6-56.1	27.5-57.0	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	55.0	0.375	0.3
MW-8	2020	316170	534714.843	4219193.313	5062.90	5060.74	63.10	58.1-62.9	57.0-64.3	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	62.5	0.375	0.4
MW-9	2021	323005	535148.659	4221153.094	5256.09	5253.97	40.30	30.0-40.0	20.9-42.0	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	38.6	0.375	0.2
MW-10	2021	323006	535153.271	4221157.369	5255.82	5253.60	80.30	50.0-80.0	47.0-81.5	Blue Hills Shale	12-volt ESP	Proactive Environmental SS Sample Champ XL	79.0	0.375	0.5
MW-11	2021	323007	534405.485	4219710.530	5084.30	5082.09	70.00	39.6-69.6	36.6-70.6	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	68.5	0.375	0.4
MW-12	2021	323008	534407.927	4219719.209	5083.94	5081.64	86.50	76.2-86.2	73.1-86.6	Codell Sandstone	12-volt ESP	Proactive Environmental SS Sample Champ XL	85.4	0.375	0.5
MW-13	2021	323009	534401.520	4219714.939	4990.11	4987.93	175.33	135.0-175.0	135.0-175.0	Fort Hayes Limestone	12-volt ESP	Proactive Environmental SS Sample Champ XL	167.5	0.375	1.0
MW-14	2021	323010	535242.397	4221415.851	4989.92	4987.81	205.33	190.0-205.0	187.0-206.0	Codell Sandstone	Bladder	QED Well Wizard SS T1300	203.6	0.250	0.6

Notes:
Coordinates based off state plane grid/NAD83 Colorado South. Vertical datum based on NAVD88.
All wells constructed of 2-inch schedule 40 flush-joint PVC casing and screen.
ESP = electric submersible pump.
SS = stainless steel.