



Suggested Sampling Protocol for Ground Water Monitoring Wells

This guidance document provides suggested practices for conducting groundwater monitoring to demonstrate compliance with Colorado discharge permits. The document is not all inclusive and should be used only as a guide in meeting the Division's compliance expectations.

The following sections provide a suggested protocol for monitoring static water level and other groundwater parameters. This protocol includes three methods for groundwater sample collection (Methods A, B, and C), along with information on sampling bottles, holding times, sample quantity, and field sample collection.

I. Measurement of Static Water Level

- I.A. The facility will obtain static water level measurements at each well with either:
- I.A.1. an electronic water level indicator, such as that manufactured by Slope Indicator, Solinst, M-scope, Geotechnical Instruments, etc. with a description of the instrument and its specifications as Attachment I to this protocol; or
 - I.A.2. another acceptable methods of determining the static water level such as a "popper" or a steel tape with a weight.

The well shall not be pumped during measurement of static water level. Water level measurements shall be determined from a surveyed measuring point at the top of the protective casing, thereby eliminating the need to compensate for the "casing stick-up". The water levels will be measured with an accuracy of 0.01 feet. The measuring point is to be re-surveyed once per year to ensure accuracy of water elevation.

I.B. Instrument Decontamination Procedures.

The water level indicator cable and probe ("popper" or steel tape w/weight) shall require decontamination before each use. Procedures to decontaminate the instrument shall be as follows:

- I.B.1. Wear new and clean disposable gloves.
- I.B.2. Saturate a clean, lint free paper towel in halves with an Alconox-potable water mix on one half and distilled water on the other half.
- I.B.3. Wipe the cable as the probe ("popper" or steel tape w/weight) is rewound onto the spool with the paper towel allowing the alconox saturated half to come in contact with the cable first.
- I.B.4. Place the paper towel under the probe ("popper" or steel tape w/weight) to catch rinse fluids.
- I.B.5. Rinse probe ("popper" or steel tape w/weight) with alconox-water mix, followed by a final rinse with distilled water.
- I.B.6. Properly dispose of all used gloves and paper towels.

I.C. Collecting Water Level Data

The method by which the water level data will be acquired is as follows:

- I.C.1. New and clean disposable gloves will be worn.
- I.C.2. Water levels will be measured from the measuring point at each well. The measuring point is located on the top of the steel protective casing (surface casing). The elevation, relative to mean sea level, of the measuring point shall have been determined by utilizing local benchmarks and survey instruments.
- I.C.3. The “casing stick-up” will be measured on a quarterly basis. Any change in height of the steel casing above ground surface (stick-up) shall be noted in the operator’s logbook. If the distance changes more than 0.04 feet requires that the permittee have the measuring point re-surveyed to verify accuracy of static water elevations.
- I.C.4. The sampler’s name, the date and the time of measurement shall be recorded in a logbook or monitoring form.
- I.C.5. The depth to water to the nearest 0.01 foot shall be measured by lowering the water level probe (“popper” or steel tape w/weight) into the well.
- I.C.6. The total depth of the well shall be recorded for each well in the operator’s logbook on a quarterly basis.

II. GROUND-WATER SAMPLE COLLECTION

II.A. Ground-water sampling shall consist of ground-water sampling equipment decontamination, sample collection, sampling equipment decontamination and documentation of sample collection.

II.B. General

- II.B.1. Prior to initiating ground-water sampling activities, the monitoring person or personnel shall have calibrated all field test equipment and decontaminated all equipment used to obtain a ground-water sample. For a well with a dedicated pump, no decontamination of the pump is necessary. In those circumstances where a non-dedicated pump (and generator) are utilized, the pump and the tubing need to be thoroughly cleaned with a laboratory detergent, like Alconox, or equivalent, followed by several rinses with deionized water. If the sampling equipment has been badly contaminated, the equipment needs to be cleaned with a soft brush and hot-water detergent wash prior to the deionized water rinses. This same procedure is applicable for a bailer and its cable/rope.
- II.B.2. Purging of each well is to be accomplished by a dedicated pump, by a bailer, or by a non-dedicated pump. During the purging process, temperature, pH, conductivity and dissolved oxygen are to be determined. Most permits do not require dissolved oxygen at this time. However, in time, all permits shall require dissolved oxygen be determined during the purging, process and prior to sample collection. The measured temperature, pH and conductivity are to be entered onto a log or sampling form. After approximately three casing volumes, a ground-water sample will be collected once there is stabilization (within 10%) between the most recent sample and the previous two readings. If the meter readings for pH, temperature and conductivity do not stabilize, field personnel need only remove five casing volumes before taking a ground-water sample.
- II.B.3. Pursuant to the monitoring requirements in the ground-water discharge permit, ground water collected from the monitoring wells shall, typically, be analyzed for chloride, sulfate, nitrate and total coliform bacteria. In accordance with the “The Basic Standards for Ground Water”, the field personnel shall filter the samples for nitrate, chloride and sulfate prior to preservation. [Refer to Regulation No. 41, “The Basic Standards for Ground Water”, to determine which

parameters are required to be filtered prior to preservation.] The filter is a 45-micron filter. Some samples require preservative and some do not. The field personnel should obtain the required bottles from the laboratory that is performing the analyses. All samples are to be iced in a cooler until they are handed to the laboratory personnel.

- II.B.4. Water in the well is to be withdrawn by sampling pumps, such as Waterra inertia pumps or by using a bailer (it is preferred that the bailer be a double check valve bailer). The sampling pumps may be dedicated to the upgradient and downgradient wells. Dedicated sampling pumps eliminate the potential for cross-contamination between wells and thus need for sampling equipment decontamination. In purging and sampling wells with inertia pumps, a flow rate of approximately one gallon per minute (gpm) is recommended rate to minimize loss of any volatile compounds (This is only a concern for a volatile listed as a permit limit.) from the water to be sampled and analyzed. Provide a description and specifications of the pump(s) or bailer to be utilized.

II.C. **Method A** for Groundwater Sample Collection

This method is to be utilized for those wells that produce a sufficient volume of water and have a rapid recovery rate.

- II.C.1. Prior to purging/sampling, calibrate all test equipment used in the field according to manufacture's specifications. Enter all equipment calibration data into a field logbook. Clean all field test equipment and ground-water sampling equipment.
- II.C.2. Purge the well water into a collection container to be able to measure and record temperature, pH, conductivity [and dissolved oxygen]. Continue purging until the stagnant water in the casing has been replaced by formation water. This is best determined by logging the readings for temperature, pH, conductivity [and dissolved oxygen, where applicable] readings. After approximately three casing volumes have been removed from the well and once the most recent reading is within 10% of the previous two readings for each individual field parameter, a ground-water sample will be taken. If the field parameters do not stabilize, a minimum of five casing volumes shall be removed from the well prior to taking a ground-water sample.
- II.C.3. If a bailer is used to purge the well and to take the ground-water sample, the bailer is to be lowered into the well to what hereinafter is referred to as the "sample depth". "Sample depth" is determined by lowering the bailer to the bottom of the well. Once the bailer is gently resting on the bottom, the field person is to mark this location on the cable. The mark is to be placed directly across from the measuring point while the cable is held taut. Raise the bailer one-foot above the bottom of the well. Mark the cable or place adhesive tape on the cable to indicate the sample depth for future reference. Taking a sample at this elevation should avoid undue amounts of sediments in the sample and prevent sediment interfering with closure of the bailer valve. The well should be purged by bailing from the bottom of the well, until the water level is drawn down to the lowest possible level. Take a "throw-away" sample to determine temperature, pH and conductivity. Record the values and the volume bailed. Allow the water level to recharge to at least four feet in the bottom of the well, or to whatever depth the water recovers in well (less than four feet). Take another "throw away" sample. Continue this procedure until approximately three volumes have been removed and the parameters are within 10% of the previous two readings for each parameter. At this time, the field person will take a sample. If the field parameters do not stabilize, a minimum of five casing volumes shall be removed from the well prior to taking a ground-water sample.
- II.C.4. Prevent sampling equipment from coming into contact with the ground or a potentially contaminated surface.
- II.C.5. For those sample personnel using a bailer, they are to lower the bailer slowly through water column until the bottom of the bailer reaches the sample depth. The sample depth is indicated by a mark or adhesive tape on the cable. The bailer should be raised to the surface and the sample transferred to sample containers with minimal agitation and contact with the

atmosphere. The sample should be allowed to flow down the side of the receiving container and not allowed to cascade onto the bottom of the container.

- II.C.6. For TOC samples, the ground-water sample is to be poured into sample vials without introducing bubbles. The TOC sample vial is to be inverted and gently tapped on a gloved hand to check for air bubbles. If a headspace is detected in the sample vial, discard the sample and then refill.
- II.C.7. Store samples under ice in an ice chest pending delivery to the laboratory.

II.D. Method B for Groundwater Sample Collection

- II.D.1. This method describes procedures to be performed when the monitoring well(s) are low yielding. A low yielding well is one that is capable of recharging within three hours. This sampling procedure is applicable for both pumps and bailers and includes the following:
- II.D.2. Prior to purging/sampling, calibrate all test equipment used in the field according to manufacture’s specifications. Enter all equipment calibration data into a field logbook. Clean all field test equipment and ground-water sampling equipment.
- II.D.3. Purge the contents of the well into a container to determine the pH, temperature and conductivity of the water that has seeped into the well.
- II.D.4. Purge the well until it is dry.
- II.D.5. Because recharge takes three hours or less, take another throw away sample to determine temperature, pH and conductivity. Record these values. Once the well has recharged, collect samples in the order indicated in the permit in the paragraph for the compliance schedule addressing the sampling protocol {typically, Part IA.6. (d)(F) or I.A.7. (c)(F)}.
- II.D.6. After the last ground-water sample is taken, again take a throwaway sample to determine the pH, temperature and conductivity. Record these values and compare to the other two sets of values.

II.E. Method C for Groundwater Sample Collection

This method describes procedures to be performed when the monitoring well(s) are very low yielding. A “very low yielding” well is one whose time of recharge for sampling is greater than three hours and less than 24 hours. This sampling procedure is applicable for both pumps and bailers and includes the following:

- II.E.1. Prior to purging/sampling, calibrate all test equipment used in the field according to manufacture’s specifications. Enter all equipment calibration data into a field logbook. Clean all field test equipment and ground-water sampling equipment. HERE
- II.E.2. Pump/bail the water into sample containers. From one of the sample containers determine the temperature, pH and conductivity. As the well has recharges, collect samples in the order indicated in the permit in the paragraph for the compliance schedule addressing the sampling protocol {typically, Part I.A.6. (d)(F)}.

III. SAMPLE COLLECTION BOTTLES, HOLDING TIMES AND QUANTITY OF SAMPLE

III.A.1. The Water Quality Control Division has recommended procedures for sampling and delivery to a certified laboratory. The table below lists the proper sampling procedures, sample volumes, type of sample container, preservation and holding time foe a valid sample.

	FIELD	CONTAINER	VOL. REQ.	PRESERVATION	HOLDING
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	FILTERED		MILLILITERS (MINIMUM)		TIME
TOTAL COLIFORM	NO	POLYPROPYLENE, GLASS STERILIZED	200	COOL TO 40 C	6 HOURS
CHLORIDE	YES	PLASTIC, GLASS	50	NONE REQUIRED	28 DAYS
SULFATE	YES	PLASTIC, GLASS	100	COOL TO 40 C	28 DAYS
NITRATE + NITRITE	YES	PLASTIC, GLASS	200	COOL TO 40 C ADD H2SO4 pH <2	24 HOURS
TOTAL DISSOL. SOILIDS	NO	PLASTIC, GLASS	200	COOL TO 40 C	7 DAYS
TOTAL ORG. CARBON	NO	AMBER GLASS	4 x 15	COOL TO 40 C	7 DAYS
IRON	YES	GLASS RINSE W/1+1 HNO3	500	FIELD ACIDIFY W/HNO3 TO pH <2 COOL TO 40 C	6 MONTHS
TOTAL PHOSPHORUS	NO	GLASS RINSE W/1+1 HNO3	100	COOL TO 40 C	48 HOURS
BOD5	NO	PLASTIC, GLASS	1000	COOL TO 40 C	6 HOURS

- III.A.2. Plastic bottles are to be made out of polyethylene. Both the plastic bottles and the glass bottles need to have screw caps. All bottles are to be thoroughly cleaned before the sample is placed in them. Those sample bottles for parameters for acidification is needed may already have the acid in them. Do not throw the acid out of the bottles.
- III.A.3. For the benefit of some permittees who are new to discharge permits, the Division has added this paragraph of discussion of BOD5 sampling. The sample for BOD5 at the influent to the treatment facility is a composite sample. A "composite sample" is defined as a minimum of four (4) grab samples collected at equally spaced two (2) hour intervals and proportioned according to flow.
- III.A.4. Sample bottles are to be labeled. The label is to affixed to each sample with the following information:
- III.A.4.a. Location or identification of the sample site, i.e., 300I or 050A, 050B, etc
 - III.A.4.b. Date and time of collection;
 - III.A.4.c. Name of sampler;
 - III.A.4.d. Type of analysis to be performed on the sample;
 - III.A.4.e. Indicate whether sample was filtered and/or whether acid was added.
- III.A.5. The permittee is requested to maintain a logbook or a log form to record the sampling procedure. The logbook/form should allow space to log readings for the field parameters of temperature, pH and conductivity. In addition the field testing procedure should include the time the sample was taken, the volume of water pumped or the number of bails since the last sample plus the cumulative number of bails (or volume). Allow space for a physical description of the sample, whether the sample was clear/turbid, what color (if any) was noted

in the sample(s). In addition to the above information, the logbook/form is to allow space for the following information:

- III.A.5.a. Location/Identification of sample site (050A, 300I, etc);
- III.A.5.b. Date and time of sample collection;
- III.A.5.c. Name of sampler;
- III.A.5.d. Size of bailer used or the gpm of the pump used for sampling;
- III.A.5.e. Depth to static water level measured from the "measuring point";
- III.A.5.f. Total measured depth of the well;
- III.A.5.g. Unusual characteristics of the sample or the purging process, such as sediment in the water, or an odor was noted in the sample;
- III.A.5.h. Time for the well to recover to allow for purging and/or sampling.

IV. FIELD SAMPLE COLLECTION AND TESTING

Prior to obtaining a ground-water sample for analysis, the ground water is to be sampled for temperature, pH and conductivity. This is typically done with probes and field testing equipment. As a consequence of using this equipment, the manufacturer's instructions for use and calibration must be followed.

- IV.A.1. **pH Measurement.** The sample is not required to be filtered. The pH in ground water is controlled by the carbonate system including gaseous and dissolved carbon dioxide, bicarbonate and carbonate ions. Other dissolved gases, such as hydrogen sulfide and ammonia, can also affect the pH of the ground water. A high sodium concentration will give an anomalous pH reading, which must be corrected according to the recommendation of the manufacturer of the pH electrode. This correction is usually necessary only if pH is greater than 11 and sodium concentration is more than 10 moles per liter. Measurement of pH is temperature sensitive, so the standard buffers should be within +/- 10C of the sample solution for precise determinations. Calibrate the equipment in strict accordance with the manufacturer's instructions. If the sampling continues from one day to the next, the pH field-testing equipment is to be calibrated each day of its use. The correct buffer solution is to be determined based upon knowledge of the ground water in the area. Typically, the ground water is going to be around 7.0 s.u. The buffer solutions of 7.00 and 10.0 are to be used to calibrate the pH equipment. The pH is to be recorded to the nearest hundredth. Ensure that the buffer solutions are stored properly and approximately at the temperature of the ground water. If the temperature of the ground water were not known, then a temperature near 45 OF would suffice. It is suggested that two probes be available for use. The probe in use should be kept wet in deionized water or according to the manufacturer's instructions.
- IV.A.2. **Specific Conductance.** Specific conductance is to be measured for each monitoring well during the purging process. The meter is to be calibrated in strict adherence to the manufacturer's instructions. The meter is to be calibrated on each day that sampling is to occur. Calibration is made by using the 0.00702 N standard solution at the ambient temperature. The temperature control is set at 250C, and the ambient temperature of the standard KCl solution is recorded. A value of specific conductance is obtained and compared with values given in a graph of Specific conductance at 250C and specific conductance of a 0.00702 N KCl solution at various temperatures. The meter is to be within five (5) percent of the graph. Specific conductance meters used in the field should be battery operated, equipped with temperature compensator and read directly in micromhos/cm at 25 0C. The direct reading meter is recommended to save time in converting resistance values to specific conductance and to insure that the value is read in the field.

IV.A.3. **Temperature.** Measurement of ground-water temperature is most accurate when the ambient temperature is within 200C of the ground-water temperature. New or little-used wells may develop new producing zones during pumping, thereby varying the proportion of water entering the well from different depths and causing either an instantaneous change or continual drift in the temperature measurements. Drawdown may cause dewatering of certain beds and may cause a change in temperature. Pumping time insufficient to allow equilibration of water temperature in the casing and pump column will also cause drift of the temperature. Samples should be collected as close to the wellhead as possible. If a container is used to hold the sample, the first sample should sit in the container for one to two minutes in order to allow container to equilibrate. The sample is to be thrown out after the one to two minutes and a second sample is to be collected into the container and the temperature should be recorded immediately.