UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of CROW BUTTE RESOURCES, INC. (Marsland Expansion Area)	Docket No. 40-8943-MLA-2 ASLBP No. 13-926-01-MLA-BD01

Hearing Exhibit

Exhibit Number: CBR026

Exhibit Title: CBR-EMP-003, Water Monitoring

CBR-EMP-003

WATER MONITORING

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1 WATER MONITORING

1.1 Introduction and Purpose

Environmental water monitoring includes the routine monitoring and analysis of water samples within the permitted areas and surrounding environs to ensure compliance with federal and State rules and regulations and company policies. Water monitoring is designed to provide maximum surveillance for environmental control and is based on many years of monitoring experience in conjunction with guidance and suggested practices from numerous regulatory agencies. This document presents a discussion of water monitoring, methodology, and types of sampling to be performed.

There are three distinct phases of the groundwater and surface water monitoring.

1.1.1 Preoperational Water Monitoring

Preoperational water monitoring is performed as a part of the site characterization process. Preoperational sampling establishes baseline water quality in overlying, production, and underlying aquifers and local surface water features, which provides a basis for comparing operational monitoring data. Preoperational monitoring is also performed to determine groundwater and surface water quality in the area surrounding the active mining areas to allow monitoring impacts during operations.

1.1.2 Operational Water Monitoring

Operational monitoring is performed to ensure that the mine is constructed and operated correctly. This is accomplished by comparing the operational monitoring data with preoperational data to determine whether mining solutions are properly contained within the production zone. Operational data is analyzed from underlying, overlying, and production aquifers and surface waters then compared with preoperational data to determine whether mining activities are having an affect on water quality. Operational data from wells and surface water features located in the surrounding areas allows determination of impacts to these resources from operations.

1.1.3 Post Operational Wellfield Groundwater Monitoring

Restoration water monitoring is performed during groundwater restoration activities and is used to determine the effectiveness of restoration processes. The restoration monitoring provides data for comparison with the approved groundwater restoration goals.

1.1.4 Water Monitoring Elements

In order to ensure reliable data, from water monitoring, the following procedures must be followed:

- Baseline sampling (Section 1.2) methods ensure that sampling is performed following well development using acceptable procedures to accurately determine the preoperational groundwater characteristics. This preoperational data is used to determine the upper control limits for excursion monitoring and the groundwater restoration standards.

- Operational wellfield monitoring (Section 1.3) methods ensure that operating data accurately reflects groundwater characteristics during mining to allow excursion monitoring.

- Sampling of private water supply wells (Section 1.4) in the vicinity of the project provides data to ensure that mining activities are not adversely affecting the quality of water used as a source of drinking water or for agricultural or livestock use.

- General well sampling methods (Section 1.5) have been established that meet accepted standards for collection of environmental water samples. These methods include well water level monitoring, field determination of indicator parameters (i.e., pH and specific conductance), proper well purging techniques, sample documentation and custody control, and QA/QC requirements.

- Surface water sampling (Section 1.6) methods ensure that samples obtained from surface water features upstream and downstream of mining areas accurately reflect surface water quality to allow determination of impacts from mining operations.

- Sampling of wastewater sent to the disposal wells (Section 1.7) is necessary to properly characterize the waste stream and to ensure that monitored parameters are within permit limits.

- Evaporation pond and storage reservoir water monitoring (Section 1.8) determines the water quality of the contents. Monitoring is also performed for any water in the installed leak detection systems to ensure the integrity of wastewater containment systems associated with these facilities. Monitor wells may be installed in the first overlying aquifer down gradient of these systems to provide additional assurance of the performance of containment systems.

- NPDES discharge sampling (Section 1.9) and NPDES Storm water sampling (Section 1.10) are performed to meet specific NPDES permit requirements. NPDES discharge sampling is required for land irrigation systems that allow discharge of treated wastewater to the land surface. NPDES storm water monitoring (if any) is specified in the general or specific storm water permit(s) issued by the State.

- Drinking water supplies are monitored (Section 1.11) to ensure that potable water supplies on site meet the drinking water standards for non-transient, non-community public water supply systems.

1.1.5 Quality of Measurements

The accuracy of monitoring data is critical to ensure that the water monitoring program precisely reflects the water quality. In order to ensure consistent and accurate analytical results, State permitting requirements specify acceptable analytical procedures.

For the Crow Butte Operation, the Nebraska Department of Environmental Quality (NDEQ) requirements are contained in the Crow Butte Class III UIC permit and more narrowly specify acceptable methods as those contained in the latest edition of the following references:

- American Society for Testing and Materials, *Part 11*.

- American Public Health Association, *Standard Methods for the Examination of Water and Wastewaters*, 18th Edition, 1992.

- U.S. Environmental Protection Agency, *Methods for Chemical Analysis of Water and Wastes*, March 1979.

In addition to approved analytical methods for water quality measurements, the NRC specifies analytical quality requirements for the measurement of radionuclides in various environmental media. These requirements are contained in Regulatory Guide 4.14, which specifies the following lower limits of detection (LLD) in water:

Radionuclides	LLD (µCi/ml)
Natural Uranium	2×10^{-10}
Thorium-230	2×10^{-10}
Radium-226	2×10^{-10}
Polonium-210	1×10^{-9}
Lead-210	1×10^{-9}

The SHEQ Department will be responsible for ensuring that proper analytical techniques are used in accordance with permit requirements and regulatory guidance.

1.2 Wellfield Baseline Sampling

Baseline sampling is required to determine the water quality of the overlying and production aquifers in a wellfield before mining operations in accordance with NRC license and State permit requirements. Multiple samples are taken from each monitor well with an adequate delay between sample intervals to allow for temporal fluctuation. The samples are analyzed for the parameters listed in the appropriate NRC License and/or State permits.

Baseline sampling serves two purposes. First, it determines pre-mining water quality that is used to provide a class of use goal to which the groundwater should be restored upon completion of mining. Second, baseline values are used to calculate upper control limits (UCLs) for the approved excursion monitoring parameters. During the life of the mine unit, these UCL values are used to determine when a monitor well is placed on excursion status.

1.2.1 Prerequisites

- Baseline samples are taken after a well has been mechanically stimulated, developed, and stabilized as required in CBR-EMP-009.

- All pre-mining baseline sampling must be done at least 300 feet from any active mining unit.

- Appropriate conductivity and pH instruments must be available for field monitoring during sampling. These instruments must be properly calibrated in accordance with the instructions contained in Section 1.5.2.

When the prerequisites have been met, baseline sampling may be performed using the general well sampling instructions contained in Section 1.5. Before baseline sampling is begun, the data from initial and final well development should be reviewed and approved by Restoration Manager and/or the SHEQ Coordinator. The monitoring schedule and baseline parameters for each well will be determined by the SHEQ Coordinator in accordance with NRC license and State permit requirements.

1.2.2 Baseline Sampling Results

The SHEQ Coordinator, or designated qualified individual, will review the water quality data as it is received from the commercial laboratory to determine whether the data exhibits any abnormal results which could be attributed to sampling or analytical errors. If any abnormalities are identified, the cause will be determined (if possible), and if necessary, sample analysis will be repeated, or additional samples will be collected. If appropriate, sampling procedures may be revised.

Baseline water quality is determined in accordance with NRC License and State Permit requirements. In general, baseline water quality is determined by averaging the data for each parameter for each well or zone that has been monitored. When determining the average for a zone and depending on site-specific conditions, the average water quality may be determined by weighting the data according to the fraction of area represented by the data, or it may be determined by establishing sub zones of data represented by water of different quality.

Outlier data are determined using accepted methods. In the event that outlier data are determined, the data should be considered for exclusion from the statistical assessment of the baseline data (i.e. average concentration of a particular parameter). The cause(s) for the outlier data shall be determined in order that sampling and/or analytical errors can be corrected, if it is determined that such errors are responsible for the particular outlier data.

1.3 Operational Wellfield Monitoring

Once a wellfield is placed into production, each of the monitor wells must be sampled in accordance with the approved sampling schedule during the life of the mine unit. Perimeter (production zone) monitor wells are placed around the wellfield perimeter to ensure horizontal confinement of mining solutions. An exceedance of the upper control limits (UCLs) in these wells indicates the possibility of a horizontal excursion. Overlying monitor wells are placed in the first continuous aquifer above the production zone. These wells are sampled to ensure vertical confinement of mining solutions. An exceedance of the UCLs in these wells indicates the possibility of a vertical excursion. If a vertical excursion is suspected, form CBR-EMP-FORM-018: *SM Well Excursion Investigation Checklist*, should be completed to help identify the source of the excursion.

Monitor wells are sampled on the approved schedule (biweekly for routine sampling and weekly for wells on excursion status) for parameters that, if present over the UCLs, would potentially establish the presence of a leachate excursion and signal corrective action or reporting requirements. The excursion indicator parameters vary from site to site depending on local groundwater characteristics and lixiviant compositions. Typical excursion indicators are chloride, sodium, sulfate, conductivity, alkalinity, and bicarbonate. The CBO excursion indicators are chloride, conductivity, and alkalinity. The monitored parameters are generally very stable so any trending should be monitored closely as it may be a precursor to an excursion.

Operational wellfield sampling is performed using the general well sampling instructions contained in Section 1.5. Training of operational monitor well sampling is documented on form CBR-TRG-FORM-009.

1.3.1 Operational Sampling Results

The laboratory forwards the monitoring well data to the designated reviewer as soon as possible after completion of the analyses. In order to meet excursion reporting requirements, the data must be reviewed the first regular work day that the data is made available from the laboratory. The reviewer will process the data to:

- Determine if any wells exceed excursion criteria.
- Determine any trends in the water quality or water level data that could potentially lead to excursion conditions.

- Determine if any data appears abnormal and determine if reanalysis of a sample or resampling of a well, or wells, is necessary.

To maintain the integrity of the environmental database, access and authorization to append the data should be limited to designated, trained personnel.

NOTE: In the event that the reviewer is absent, the SHEQ Coordinator or a trained designee reviews the hard copy from the laboratory with a list of Upper Control Limits for each monitor well.

In the event that a review of the data shows that excursion conditions exist, or there is a significant change in one or more parameters, the conditions are brought to the attention of the Restoration Manager, the SHEQ Coordinator, and other appropriate supervisors to determine if additional sampling is necessary or operational changes are needed.

1.4 Private Water Supply Well Sampling

NRC licensing requirements provide that private wells near active wellfields must be monitored. This monitoring is typically required for radionuclides on a quarterly basis. The purpose of this sampling is to ensure that there is no radiological impact on water resources in the region around the mine. This requirement for sampling local wells includes all wells that are within 1 kilometer of an active wellfield and are currently in use for domestic, agricultural and livestock purposes. Samples are analyzed for radium-226 and natural uranium.

1.4.1 Sampling Procedure

Turn on the well and allow it to flow for at least five minutes to evacuate any lines or existing pressure tanks of stagnant water. If any particulate matter is identified in the water, the well should be allowed to flow until it no longer contains any particulate.

Fill out the well name and pertinent data in the sampling records.

After the well has been allowed to flow, pH and conductivity measurements are performed in accordance with Section 1.5.2.

The samples must be filtered through a 0.45-micron filter. The filtration system requires that pressure be applied to the water to force it through the filter membrane. The filtration system can be pressurized using either the existing water pressure from the well if the well is equipped with the proper fittings or compressed air. Alternatively, the sample may be filtered and preserved in the site laboratory before shipment to the contract laboratory.

Note: Always use "clean sample" filter unit for the private water supply wells to avoid potential sample contamination. Sample units used for preoperational baseline or stabilization sampling of production zone wells, which potentially contain naturally occurring elevated concentrations of natural uranium and radium-226, should never be used when sampling private water supply wells due to the potential for cross contamination.

Before taking the sample, rinse out the sample bottles thoroughly with a portion of the filtered water. Record the time of sample collection and include any remarks as to unusual conditions of the water quality on the data sheet.

After each sample is collected, empty any residual water from the filter, dispose of the used filter paper, and thoroughly clean the filter housing with deionized water.

All samples must be filtered and preserved according to the Bottle List at the site lab before the end of the day. After all of the samples are collected and preserved, the Chain of Custody form is completed and the samples are sent to the contract laboratory for analysis. Ensure that the *Quarterly Environmental Water Sampling Checklist* is completed as samples are collected and shipped (CBR-EMP-FORM-015).

1.5 General Well Sampling Method

Groundwater samples obtained for preoperational, operational, and restoration purposes are critical to meeting environmental protection goals at solution uranium mines. The results of these samples are used to determine pre-mining conditions, to monitor operational environmental protection efforts, and to determine whether restoration activities are successful. In order to ensure the accuracy of these monitoring efforts, strict compliance with groundwater sampling procedures is necessary. This section provides instructions on water level determination, proper well purging and sampling techniques, sample preservation and documentation, and QA/QC requirements. These instructions apply to all groundwater sampling conducted for baseline, operational monitoring, and restoration monitoring purposes.

1.5.1 Water Level Determination

The accurate determination of the static water level in wells provides important information concerning aquifer conditions. Significant changes in the water level in overlying aquifers may indicate a vertical excursion of mining solutions. Similarly, changes in the production zone water levels may provide an early indication of the migration of mining solutions from the active wellfield. Water level measurements are also used to determine groundwater gradients in the mining zone to assist operating personnel in managing wellfield balancing.

Well static water levels are monitored using an electrical measuring line (an "e-line"). An e-line is a device that measures electrical conductance with two electrodes contained in a shielded probe. The probe is mounted to a graduated strip to allow measurement of water levels. The probe is slowly lowered into the well. When the probe contacts the water surface in the well, the circuit is completed and an audible device is actuated. The e-line uses batteries to provide the electrical current for the signaling device.

The Environmental Sampler takes e-line readings of all monitor wells before sampling. This data may be used by the Wellfield Operations Department to determine if a sufficient hydrologic sink is being maintained in the wellfield.

Radiological Precaution: There may be a potential for contamination from radioactive materials when using this equipment in production zone wells. The following precautions are required in these situations:

- *Wash hands before eating, drinking or using tobacco products; and*
- *Perform an alpha/beta survey before entering a designated clean area and at the end of shift before leaving the site.*

Before lowering the probe in the well, the e-line circuitry should be checked by dipping the probe in water or pressing the test button (if equipped) and observing the indicator. The probe is then lowered slowly into the well until contact with the water surface is indicated. Slowly move the e-line up and down until point of contact with water has been established. Using a tape measure, measure from top of casing to nearest footage mark on e-line, add or subtract as appropriate and record the measurement on the well sample form.

It is a good practice to take a second or third check on the water level before the probe is withdrawn from the well. When possible, the person taking an e-line reading should drop the e-line probe down the pump tubing as opposed to the annulus between the tubing and casing. This procedure will prevent the entanglement of the e-line with the down hole electrical cable. However, this method will only work if the check valve in the pump has been removed so the water level in the tubing can reach equilibrium with the water level in the well bore.

During wellfield production, all e-line readings should be taken to within at least a tenth of a foot. An e-line is precise to within a hundredth of a foot, but this precision is irrelevant when compared to the induced fluctuations in the water table. The only time that level readings are recorded to the nearest hundredth of an inch is during pump tests when a dedicated e-line is used to monitor the drawdown in a particular well.

It is important to check the e-line length by measuring with a steel tape after the line has been used for a long time, when the length has been altered due to repairs, or after it has been pulled hard in an attempt to free the line. If an e-line's length is altered by these causes, a correction factor should be written on the side of the e-line so readings may be properly adjusted. Numerous e-lines are maintained with some identified for exclusive use in non-production (i.e., non-contaminated) wells. Contaminated e-lines should not be used in non-production monitor wells. The SHEQ Coordinator or designee reviews all e-line readings before issuing the Quarterly Report.

1.5.2 Field pH and Specific Conductivity Measurements

Field meters are used to measure pH and specific conductance of water samples. The use, calibration, and care of these meters are discussed in the owner's manual. The following sections discuss general instructions for obtaining accurate field pH and conductivity measurements.

1.5.2.1 Field pH Measurements

The pH of a solution is a measure of the effective hydrogen-ion concentration. In aqueous solution, pH is controlled primarily by the hydrolysis of salts of strong bases and weak acids or vice versa. The concentration of hydrogen ions can be most conveniently expressed in logarithmic units, and the abbreviation "pH" is now generally taken to mean the negative log of the hydrogen-ion concentration (H+). At pH 7, only $1x10^{-7}$ moles per liter of hydrogen ion is present, and the hydrogen-ion content does not begin to approach the status of a major component of the solution until the pH is below 4.0.

Field measurement of pH is used in conjunction with conductivity as an indication that well purging has successfully removed stagnant water from the well casing and formation water is being sampled.

Degasification (such as loss of carbon dioxide), precipitation (such as calcium carbonate), and other chemical and physical reactions may cause the pH of a water sample to change significantly within several hours after the sample is collected. Immediate analysis of a sample in the field is required if dependable results are to be obtained. Field measurement of pH is carried out with a calibrated pH meter using a suitable glass and reference electrode. A combination electrode (glass and reference contained in a single unit) is preferred for this application. It is important to remember that the expensive pH bulb is fragile and that it should not be allowed to dry out. The manufacturer recommends that the probe be cleaned occasionally and stored in pH buffer solution.

Standardization should be checked before initial use and should be checked daily during regular use. For the range of water quality encountered in well sampling activities, standardization should be performed using a pH 7.00 buffer and a pH 10.00 buffer. Calibration results will be recorded. Instrument calibration will be performed in accordance with the manufacturer's recommendations.

The operator should be on the alert for erratic meter response. In the event of erratic meter response, the operator should check for weak batteries, cracked electrodes, fouled electrodes, etc. The meter probe should be rinsed after every sample measurement. At the end of the day, the probe should be stored in accordance with manufacturer's recommendation. Normally, probes must be stored in a buffer solution.

At any time that the meter cannot be adjusted to the manufacturer's specifications, the meter will be returned to the manufacturer or a qualified instrument repair service for repair and calibration.

pH measurements will be performed in accordance with manufacturer's recommendations. The probe should be swirled in the sample to remove any air bubbles adhering to the surface of the probe. A reading is not valid until the reading on the panel is stable for at least ten (10) seconds or bounces around a point for at least ten (10) seconds.

1.5.2.2 Field Conductivity Measurements

Conductivity is a measurement of the ability of a solution to conduct an electrical current. Conductivity is used as a convenient indication of the general water quality of a sample that can be measured in the field. Field measurement of conductivity is used to indicate when well purging has successfully removed stagnant water from the well casing and formation water is being sampled. Specific conductance meters used in the field are battery operated, and read directly in micromhos (µmhos) or microsiemens (µS) per cm.

Field measurement of conductivity is used in conjunction with pH as an indication that well purging has successfully removed stagnant water from the well casing and formation water is being sampled.

The conductivity cell is checked before initial use and should be checked daily during regular use. A standard solution of known electrical conductance that falls in the range of samples to be measured is used to check the cell. For the range of water quality typically encountered, a standard solution of from 500 to 1500 micromhos/cm at 25ºC is used. Routine checks are made by using the standard solution at the ambient temperature. Calibration results will be recorded. Instrument calibration will be performed in accordance with the manufacturer's recommendations.

The operator should be on the alert for erratic meter response. In the event of erratic meter response, the operator should check for weak batteries, cracked electrodes, fouled electrodes, etc. The meter probe should be rinsed with distilled water at the end of the shift. At the end of the day, the probe should be stored in accordance with manufacturer's recommendation.

At any time that the meter cannot be adjusted to the manufacturer's specifications, the meter will be returned to the manufacturer or a qualified instrument repair service for repair and calibration.

Measurements will be performed in accordance with manufacturer's recommendations. The probe should be swirled in the sample to remove any air bubbles adhering to the surface of the probe. Conductivity readings stabilize much more quickly than pH readings. The operator should ensure that the reading is stable before recording the results.

1.5.3 Well Purging

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

Purging should be accomplished at a flowrate that is lower than the well development rate. The purge rate should approximate the natural groundwater flow rate (i.e., little change in the well water level during purging) while satisfying time constraints. Purging at too high of a flow rate can result in redevelopment of the well and increased turbidity. In no case should a well be purged at a flowrate high enough to cause the well to pump dry.

The well must have a sufficient volume of water removed to induce the flow of formation water through the well screen. Two approaches to purging are provided in ASTM Guide D 4448.

- The first approach requires purging a large volume of water. A smaller volume of water may be removed if purging is performed at the recharge rate. ASTM Guide D 4448 recommends that three to five casing volumes be purged for the high volume method, while one casing volume may be acceptable at lower purge rates. For high and medium yield wells, a minimum purge volume of three casing volumes is recommended by EPA. For low yield wells, EPA allows a smaller minimum purge volume of one casing volume if the flow is near the recharge rate of the aquifer.

- The second approach requires the removal of stagnant casing water until one or more indicator parameters are stable. Stabilization is considered achieved when the measurements of all parameters are stable within a predetermined range. Parameters that may be monitored include pH, temperature, specific conductivity, turbidity, redox potential, and dissolved oxygen.

Reliance exclusively on purging a set number of casing volumes may not ensure that all wells are adequately purged before sampling. CBO has adopted a combined approach to purging that minimizes the purge volume removed from the well while ensuring that stagnant water in the casing has been removed. Minimum purge volumes are used in conjunction with stability monitoring for field parameters before sampling may be performed. For sampling baseline wells during preoperational monitoring, a minimum of two casing volumes must be removed. For routine monitor well sampling, a minimum of one casing volume must be removed. In either situation, purging is deemed complete only when it is determined through field monitoring of pH and conductivity that the water quality is stable.

Accurate records of well purging must be maintained to document that the minimum number of casing volumes are purged from the well before sampling. These records include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times.

The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a 5-gallon bucket or other container of a known volume.

The following formula shall be used to calculate the number of gallons contained in one casing volume:

Casing Volume (Gals) =

(Height of water in well in ft) x (Radius of the well^2 in inches) x (π) x (0.052)

Where: π = 3.1416
The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Using the preceding formula, conversion factors may be determined for standard casing diameters. This conversion factor (i.e., gallons per foot of pipe), when multiplied by the height of water in the casing, will yield the casing volume.

Casing Inside Diameter (in)	Conversion (gal/ft)
2	0.163
4.33	0.765

To determine how long the well needs to be pumped to remove a casing volume, divide the casing volume in gallons by the pumping rate in gpm. This will result in the number of minutes required to pump one casing volume.

For monitor wells, the pH and conductivity are measured immediately after starting the well. These readings are then repeated no more frequently than each ½ casing volume of water that is pumped from the well. All readings are recorded on the well sampling sheet. When a minimum of three field parameter readings indicate that the well is stable, the monitoring results are compared to determine the effectiveness of well purging. The acceptance criteria to determine whether the well is stable are:

Conductivity: All values within ± 10 percent of the average with no discernable trends.

pH: All values within ± 0.2 S.U. of the average with no discernable trends.

An alternative method for ensuring that representative formation water is sampled during routine excursion monitoring allows one field reading to be taken immediately before sampling. Depending on the individual flow rate of each well, the well is purged until at least one casing volume is removed. The field parameters are then monitored and compared with the normal baseline water quality for the individual well or group of wells. If normal formation water quality is not indicated, additional purging is performed until the well has stabilized at the formation average values. The formation averages for conductivity and pH for these wells are determined during baseline sampling and during routine excursion monitoring sampling. Due to the extensive, long-term sampling program implemented for the monitor wells at in-situ solution mines, the average conductivity and pH values for each monitor well can be determined with acceptable accuracy and certainty. These values are provided to the environmental sampler for comparison during sampling.

1.5.4 Well Sampling

The sample should be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample should be obtained as soon as adequate formation water is present in the casing.

Before collecting the sample, make sure that the sample container is clean. For containers that are reused on site for routine sampling, wash out the collection container(s) with the water to be sampled. Containers provided by contract laboratories for analysis are presumed clean and do not need to be rinsed. Make sure that the water being sampled is very low in visible solids and any contamination that may show up in the analysis. Fill the sampling container(s) completely, so all air is excluded from the container.

NOTE: Do not touch the sampled water with your hands as this could result in contamination of the sample.

Record the time of sample collection and include any remarks as to unusual conditions of the water quality (e.g., odor, color) on the data sheet.

Keep the sample cool and transport it to the Environmental Laboratory as soon as possible for analysis or filtering, preservation and shipment to a commercial laboratory.

1.5.5 Sample Filtering and Preservation

Once a water sample has been taken, the quality of the sample begins to degrade with time. Because of this, all samples must be kept cool and some must be preserved in order to lengthen the acceptable holding time. The Lab Foreman and the contract laboratory (if used) should be consulted when determining proper preservation techniques. The SHEQ Coordinator and the Lab Foreman maintain a complete listing describing preservation techniques. Preservation techniques must be coordinated with the contract laboratory. Samples to be analyzed for dissolved metals should be filtered to < 0.45 microns to remove suspended solids that may affect the results.

NOTE: The sample should be filtered, if required, before preservation.

1.5.5.1 Sample Filtration

Place a disposable 0.45-micron pore size filter membrane in the filtering device. Flush the filter membrane and filtering device with sample water before use. Discard the portion of the sample used to flush the filter membrane, filtering device, and sample container (approximately the first 150 ml of filtered sample). If the sample is very turbid, it may be necessary to use a filter membrane with a larger pore size or surface area to pre-filter the sample. Collect the remaining filtered sample into the appropriate sample containers.

After filtering, the used filter membrane must be properly disposed. If the sample is from the mining zone, the filter will be potentially contaminated with radioactive material and must be disposed as radioactive material or surveyed for release as discussed in CBR-RPP-005. Decontaminate the filtering device and any transfer vessels used by flushing or rinsing with distilled water.

1.5.5.2 Sample Preservation

Preservative (acid) shall be added to sample containers either before or immediately after collection and filtration, if required, of samples. If the acid is added to the container before adding the sample, do not overflow the container with the water sample. This can dilute the preservative. In addition, do not cause undue splashing out of the container opening. This can expose the sampler to acid.

The following Table provides a summary of the sampling and preservation recommendations for analytes typically of concern in groundwater. Consult the bottle and preservation list provided by the contract laboratory to ensure that the appropriate sample preservation method is used.

Parameter	Volume Required (mls)	Preservative	Holding Time
Dissolved Metals	250	Filter (0.45 µm), then add HNO_3 to ph<2	6 months
Total Metals	250	HNO_3 to ph<2	6 months
Alkalinity	100	Cool, 4°C	14 days
Chloride	50	None Required	28 days
Conductance	100	Cool, 4°C	28 days
Fluoride	50	None Required	28 days
Ammonia as N	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate + Nitrite	50	H_2SO_4 to pH<2, Cool, 4°C	28 days
Nitrate	50	Cool, 4°C	48 hours
Nitrite	50	Cool, 4°C	48 hours
pH	25	None Required	Analyze immediately
TDS	500	Cool, 4°C	7 days
TSS	500	Cool, 4°C	7 days
Sulfate	100	Cool, 4°C	28 days
Lead-210	1000	HNO_3 to ph<2	6 months
Polonium-210	1000	HNO_3 to ph<2	6 months
Radium-226	1000	HNO_3 to ph<2	6 months
Uranium	1000	HNO_3 to ph<2	6 months

1.5.6 Chain of Custody Forms

Chain of Custody (COC) forms should accompany every sample sent to off-site laboratories. The chain of custody should contain at a minimum the type of sample, the sample identification number, the preservation techniques (if any), the name of the sampler, the date and time the sample was taken, the name(s) of individuals who handled the sample and when they passed it on to another person, and the required analysis. Once the laboratory is finished with the chain of custody, it is sent back to the SHEQ Department with the analytical package so it can be filed for future reference.

1.5.7 Wellfield Sampling QA/QC

A strong QA/QC program is vital to ensure that water sampling results are valid and representative of the ambient water conditions. The bulleted items below are minimum standards implemented as part of the water sampling QA/QC program:

- The pH meter is calibrated before each day's use as discussed in Section 1.5.2.1.
- The conductivity meter is calibrated before each day's use in a calibration solution that has a similar conductivity to the groundwater being tested as discussed in Section 1.5.2.2.
- The well is properly purged before sampling in accordance with the instructions in Section 1.5.3. This ensures that any stagnant water is removed and representative groundwater is drawn into the well bore for sampling;
- Sample containers are flushed with the sample water in order to remove potential contaminants from the container;
- The pH and conductivity probes are stored in deionized water between wells. The probe is rinsed with deionized water after each field sample analysis.
- All samples analyzed by a contract laboratory are accompanied by a chain of custody to ensure proper analysis is performed and the sample is tracked;
- The on-site laboratory maintains a stringent QA/QC program that includes daily or weekly analysis of replicate samples, daily or weekly spiked replicate analysis, and a comparison of results against historic values. The laboratory maintains records of all replicate and spiked replicate quality assurance tests;
- For wellfield water samples analyzed by the on-site laboratory, all results are reviewed for errors and trends by the Lab Foreman (or designee);
- Once the data is entered into the computer database and printed, at least one individual reviews the data once again to check for data entry errors and signs the page once satisfied the entries are correct;
- Each quarter the results from monitor well sampling are compiled for the Quarterly Report required by the State Permits. The SHEQ Coordinator or designee reviews the data for errors and trends before submitting the data to government agencies; and

- Wellfield samples that are sent off-site for analysis will only be sent to laboratories that maintain a stringent QA/QC program and have obtained the required lab certifications and licenses. All analysis must be performed using the analytical procedure requirements from the appropriate federal and State license(s) and permit(s).

1.6 Surface Water Sampling

The NRC recommends that all surface water features that lie within the license boundary be sampled at upstream and downstream locations and analyzed for radionuclides to determine the impact of operations on water quality. Specific sampling locations are specified through Crow Butte Operations NRC License. In general, preoperational monitoring is required at selected locations for at least one year before mining operations to determine seasonal variation. If site characterization determines that there is no significant flow of groundwater to surface water (i.e., surface water bodies are perched and ephemeral), sampling of surface water features may not be required by NRC.

Surface water samples are collected using methods similar to those in Section 1.5.4. Samples are collected in the appropriate container(s) and field measurements for pH and conductivity are performed and documented using the techniques described in Section 1.5.2.

The sample bottle must be rinsed with the sample water. The bottle is then filled with the mouth of the sample bottle pointed downstream to prevent collecting debris. If samples involve analysis that requires filtration, collect water in a clean bucket for transfer to the filter apparatus. Treatment of sample containers, preservation techniques, holding times, and shipping techniques are identical to those used for groundwater and contained in Section 1.5.5.

1.7 Disposal Well Sampling

The Crow Butte Operation operates disposal wells for permanent disposal of aqueous wastes. These wells are permitted under the Class I Underground Injection Control (UIC) program administered by the NDEQ. The Class I UIC Permits issued under these regulations contains specific monitoring requirements during well operation to characterize the wastewater and to ensure that permit discharge limits are not exceeded.

1.7.1 Crow Butte Deep Disposal Well Sampling

The Deep Disposal Wells (DDW's) are used to dispose of wastewater that is generated at the Main Plant and from the groundwater restoration system located in the Reverse Osmosis (RO) Building. Samples of this wastewater are obtained automatically at the transfer line in the Main Plant by an auto-sampler. Sampling occurs when the wells are in service by the auto-sampler, which obtains a metered quantity of wastewater at a preprogrammed time interval. The sample volume and programmed interval may be adjusted at the direction of the Plant Supervisor to ensure that an adequate volume of wastewater is obtained each day.

A single sample is taken daily from the sample obtained by the auto-sampler. These daily samples are composited in the Environmental Laboratory to prepare monthly composite sample. The composite sample is prepared for shipment to the commercial laboratory for the following analyses:

Calcium	Chloride	Sulfate	Sodium
Alkalinity	pH	Radium 226	Uranium
Vanadium	Arsenic	Barium	Cadmium
Chromium	Lead	Mercury	Selenium
Silver			

Standard Chain of Custody procedures are used when forwarding the sample to the contract laboratory. The contract laboratory forwards the analytical results to the SHEQ Department for review and filing. The results of the monthly sampling must be reported in the Monthly Monitoring Report submitted to the NDEQ. The SHEQ Coordinator will compare the analytical results with the injection limitations specified in the Class I UIC Permit.

1.8 Evaporation Pond and Storage Reservoir Sampling

The Crow Butte Operation is designed with a number of surface reservoirs that are used to contain wastewater from various sources in the mining process. Evaporation ponds are used to store wastewaters and encourage evaporation to reduce the volume of water that must ultimately be disposed.

1.8.1 Evaporation Pond Sampling

Evaporation ponds may be sampled for determination of the water quality of the contents. A grab sample will generally be obtained in any area except near inlet pipes. Samples should be collected and preserved in accordance with the bottle list provided by the laboratory. Decontaminate the outside of the sample bottles after the sample has been collected.

Caution: Pond liners can be extremely slick with moisture or frost. Do not walk on the top edge liners at any time as a fall may result in falling in the pond. Any time that it is necessary to walk on the liners, personnel will use life preservers or a properly secured lifeline. Personnel will ensure that they have notified their supervisor or the lead operator that they will be performing work at the ponds requiring the use of a life preserver and when they expect to return.

1.8.2 Crow Butte Evaporation Pond Monitor Well Sampling

The Crow Butte Commercial and R&D evaporation ponds are monitored using a system of monitor wells installed down gradient of the ponds in the shallow aquifer. The purpose of these wells is to monitor for any pond leakage from the primary liner system. These monitor wells are sampled quarterly for sodium, chloride, sulfate, conductivity, and alkalinity using the sampling methods described in Section 1.5. The monitor wells may be sampled more frequently, such as during periods when the pond underdrain system has indicated a potential leak in the secondary liner.

1.9 NPDES Permit Sampling

Discharges of wastewater may be authorized under the federal Water Pollution Control Act (33 USC 466 *et seq*.) through permits issued by the EPA (or authorized States) under the National Pollutant Discharge Elimination System (NPDES). For the Crow Butte Operation, these programs are implemented by the Nebraska Department of Environmental Quality (NDEQ).

For solution mines, permits may be issued for point source discharges to surface waters or for discharge by land irrigation. In order to discharge water to the surface from the Crow Butte Operation, a Permit from the State is required. Although it is not currently used to discharge water, CBO maintains an NPDES land application permit issued by the NDEQ.

As part of maintaining the permit, quarterly reports are submitted by the SHEQ Coordinator or designee to the issuing agency. Additional information regarding these requirements can be found in the permit maintained by the SHEQ Coordinator.

Regardless of the discharge method, permits contain monitoring requirements and discharge limits for specified parameters. In general, discharge permits require monthly monitoring by obtaining a grab sample from designated discharge points ("outfalls"). Grab samples are obtained at the designated sample point by ensuring that the system piping is purged of stagnant water and obtaining a sample in the specified container(s). Sampling is accomplished using steps similar to those used for private well sampling described in Section 1.4.1.

Some permits may require that composite samples be obtained to determine permit compliance. Composite samples may represent a continuous discharge sample of a 24-hour sample. In most cases, discrete aliquots are obtained on a specified schedule and combined to obtain a composite sample. This composite sample is then analyzed for the required analytical parameters.

Composite samples may be obtained in several manners as provided in the specific permit:

- The volume of each aliquot is proportional to the waste stream flow at the time that the aliquot is obtained or to the total waste stream flow since the last aliquot.
- A number of equal volume aliquots are taken at varying time intervals in proportion to the waste flow.
- A sample is obtained continuously in proportion to flow. This method usually involves the use of an auto-sampler.
- If flow proportional sampling is infeasible or non-representative, permits may specify time composite samples.

Samples obtained for discharge permit compliance will generally be submitted to a commercial laboratory for analysis. Each sample must be accompanied by a Chain of Custody as discussed in Section 1.5.6. Results must be reported to the SHEQ Department for review and inclusion in the required discharge monitoring reports.

1.10 NPDES Storm Water Permit Sampling

The NPDES Storm Water permit system is intended to control the discharge of pollutants in storm water from industrial facilities. The basic requirements for the storm water NPDES program are promulgated by the EPA in 40 CFR Part 122. For the Crow Butte Operation, this program is implemented by the NDEQ.

For solution mines, specific or general permits may be issued for discharges from the process facility or from construction areas, depending on the permit program developed by the State. Regardless of the permit type, NPDES storm water permits may contain monitoring requirements and discharge limits for specified parameters. Monitoring may be required at specified outfalls during storm activity. In these cases, sampling methods are similar to those discussed for surface water samples in Section 1.6.

1.11 Drinking Water Supply Sampling

The EPA regulates the supply of drinking water under the Safe Drinking Water Act. The implementing regulations are principally contained in the National Primary Drinking Water Regulations (40 CFR Part 141). Under the definitions contained in 40 CFR § 141.2, any drinking water supply system at Crow Butte is classified as a non-transient non-community water system (i.e., non-community systems that serve at least 25 people for at least six months per year). The system is supplied by a well drilled on site that provides water to a distribution system.

In the State of Nebraska, the Nebraska Department of Health and Human Services (NDHHS) is authorized by EPA to implement State regulations concerning public drinking water supplies. EPA regulations allow States to adopt more stringent standards than those required in 40 CFR. In the case of the NDHHS public drinking water supply regulations, there are significant differences between the federal and State programs. Crow Butte is required to meet the NDHHS monitoring requirements under the Public Drinking Water Supply Permit.

1.11.1 Crow Butte Drinking Water Supply Sampling

In Title 179 of the NDHHS regulations, monitoring is required on a nine-year compliance cycle. The compliance cycle is divided into three-year compliance periods. The following minimum monitoring schedule is required for non-community non-transient water systems the size of the Crow Butte system with groundwater as the sole source of water. These sampling requirements are subject to change depending on the analytical results for each suite of analytes. In addition, systems may also apply for waivers based on initial results.

- *Coliform* monitoring is required quarterly;
- *Nitrate* monitoring must be performed annually;

- *Nitrite* monitoring must be performed quarterly, but may be reduced to annually if four quarterly samples are below the maximum contaminant level (MCL);
- *Asbestos* monitoring must be performed once during the first three-year compliance period in a compliance cycle, although this monitoring may be waived if the system can show that no asbestos is potentially present in the water supply system;

- *Inorganics* other than nitrate, nitrite and asbestos must be sampled once at each sample point during each three-year compliance period;

- *Volatile organic compound* sampling must be performed for four consecutive quarters during each three-year compliance period, although this monitoring may be reduced to a single sample each compliance period after three years of sampling show no contamination.

Sample analysis must be performed at the NDHHS laboratory or an NDHHS-approved laboratory. Crow Butte submits all samples directly to the NDHHS laboratory in Lincoln. The NDHHS schedules all sampling to meet the requirements of Title 179 and to control the analytical workload in their laboratory. Under this system, Crow Butte receives the required sample containers directly from the NDHHS Laboratory with sampling schedule instructions. Crow Butte is required to sample the system and submit the samples on the schedule provided by NDHHS. The sample kits provided by NDHHS have complete instructions concerning collection of the samples.

1.12 Operational Monitor Well Sampling Instructions

The Operational Monitor Well Sampling instructions are used as a training tool and work instruction for all employees who collect water samples from an operational monitor well.

1.13 Pre-Start Inspection

- Perform daily walk around inspection on the sampling vehicle and complete the Pre-Use Equipment Inspection – Pickup (CBR-SHMP-FORM-003a).

- Check that the crane winch is secure and the winch cable and hook are not worn prior to beginning each sampling day.

- Check the oil level on all generators and pump jack motors before operation.

1.14 Sampling instructions

Both commercial (ore zone) monitor wells (CM) and shallow (drinking water) monitor wells (SM) must be sampled biweekly. The samples are analyzed for chloride, conductivity, and alkalinity to detect potential excursions of mining solutions. A laminated map has been prepared for each daily sampling queue. The maps not only show the location of the monitor wells, but also contain pertinent information that will be useful for the sampler. Inexperienced samplers should take these maps to the field with them as a reference. The SHEQ Coordinator or designee will inspect the wellfield following completion of the daily sampling queue when inexperienced or substitute samplers are used.

1.15 Measuring Water Levels

Prior to sampling a well, the water level must be determined. This data is used to calculate the casing volume of the well. This measurement is taken with an electronic measuring tape (e-line). Prior to measuring a water level, ensure the e-line is functioning properly by turning the tape on. A short, audible signal will indicate that tape is functional. Lower the tape into the well until the probe end contacts water, as indicated by an audible signal. Slowly move the tape up and down to determine the precise level of the water in the well. Determine the sampler water level by reading the tape at the top of the well casing or riser pipe as appropriate. Record the water level in the water level book and in the electronic tablet used for recording sampling data. The tablet will automatically adjust the water level for casing height and calculate the casing volume for that well. Water levels can be taken within a maximum of 24 hours of a pending sampling event.

1.16 Starting a Monitor Well

Before the well is started, the water level must be measured and recorded. The well start time must also be recorded into the electronic tablet. For all shallow monitor wells the start time must also be recorded on the Shallow Well Shut-off Confirmation Sheet (CBR-EMP-FORM-017.

1.17 Configuration of Monitor Wells

Cameco Resources, Crow Butte Operation, uses a number of well configurations to pump monitor wells, and each configuration requires a slightly different procedure to start the well and obtain a sample.

1.18 Shallow Monitor Well Pumping Configurations

Electric Pump Jack

- Plug the cord into a 110 volt outlet at the nearest well house.
- Ensure that the cord is rolled up and stored once the sample has been collected.

Gas Powered Pump Jack

- Check the oil level.
- Turn the gas switch to the “on” position.
- Place choke in full position.
- Pull the starter rope until the motor starts.
- Allow the motor to warm-up (this may take several minutes in cold conditions).
- Reduce the choke until the choke is off and motor is running smoothly.

SQ Pump Plugged into a Wellhouse

- Plug the cord into the 110 volt outlet located in the nearby wellhouse.
- Check to ensure the well started pumping.

Portable Generator

- Remove the generator from the vehicle and place it near the well.
- Check the generator oil level.
- Switch the fuel switch to the “on” position.
- Start the generator with the key for electric start or by pulling the pull rope for manual starts.
- Attach the sampling well head to the well.
- Plug the well into the 110 volt outlet on the generator.
- Flip the breaker into the “on” position.

MCC Panel in Wellhouse

- Turn on the SM well breaker at the MCC and switch the control switch to hand.
- Go to the SM well switch panel and turn on the wells to be sampled (each well has its own switch).
- Check to ensure that the well started pumping.

Generator/Frequency Box Combination

- The two inch SM wells are pumped with a generator/frequency box combination.
- Remove the generator from the vehicle and place it near the well.
- Check the generator oil level.
- Switch the fuel switch to the "on" position.
- Start the generator with the key for electric start or by pulling the pull rope for manual starts.
- Plug the frequency box into the 110 volt outlet on the generator.
- Plug the well into the frequency box.
- Flip the breaker into the "on" position.
- Push the start button on the frequency box.
- Increase the output on the frequency box to 265 hz.
- The well should produce water within several minutes.

1.19 Commercial Monitor (CM) Well Pumping Configurations

3 Phase Pump

- Remove the generator from the vehicle and place it near the well.
- Check the generator oil level.
- Switch the fuel switch to the "on" position.
- Start the generator with the key for electric start or by pulling the pull rope for manual starts.
- Attach the sampling well head to the well.
- Plug the well into a starter box.
- Plug the starter box into the generator (minimum 6000 watt).
- Flip the breaker into the "on" position.
- Flip the starter box to "on". (You should be able to feel air being discharged from the wellhead.)
- The well should produce water within several minutes.

SQ Pump

- Remove the generator from the vehicle and place it near the well.
- Check the generator oil level.
- Switch the fuel switch to the "on" position.
- Start the generator with the key for electric start or by pulling the pull rope for manual starts.
- Attach the sampling well head to the well.

- Plug the well into the 110 volt outlet on the generator.
- Flip the breaker into the "on" position.

MCC Panel in Wellhouse (5 hp motor)

- Ensure that the CM circuit breaker is in the "on" position in the nearby wellhouse.
- Place a sampling wellhead on the well.
- Flip the breaker next to the well to the "on" position.
- Push the start button. (You should be able to feel air being discharged from the wellhead.)
- The well should produce water within several minutes.

Trailer Mounted 18,000 watt Generator

- Start the generator and ensure the main breaker panel is plugged in.
- Verify main breaker switch should be in the "on" position.
- Go to the well and place the monitor well sampling wellhead on the well.
- Switch the breaker at the well to the "on" position.
- Push the start button. (You should be able to feel air being discharged from the wellhead.)
- The well should produce water within several minutes.

Note: Only three wells can be pumped at one time.

1.20 Purging Wells

Water that remains in the well casing between samples may not be representative of the formation water quality. The quality of water left in the casing between samples may be changed by sorption or desorption from casing materials, oxidation, or biological activity. Purging is required to remove this stagnant water and allow formation water into the well screen.

Purging should be accomplished at a flowrate that is lower than the well development rate. The purge rate should approximate the natural groundwater flow rate (i.e., little change in the well water level during purging) while satisfying time constraints. Purging at too high of a flow rate can result in redevelopment of the well and increased turbidity. In no case should a well be purged at a flowrate high enough to cause the well to pump dry.

The well must have a sufficient volume of water removed to induce the flow of formation water through the well screen. Two approaches to purging are provided in ASTM Guide D 4448.

- The first approach requires purging a large volume of water. A smaller volume of water may be removed if purging is performed at the recharge rate. ASTM Guide D 4448 recommends that three to five casing volumes be purged for the high volume method, while one casing volume may be acceptable at lower purge rates. For high and medium yield wells, a minimum purge volume of three casing volumes is recommended by EPA. For low yield wells, EPA allows a smaller minimum purge volume of one casing volume if the flow is near the recharge rate of the aquifer.

- The second approach requires the removal of stagnant casing water until one or more indicator parameters are stable. Stabilization is considered achieved when the measurements of all parameters are stable within a predetermined range. Parameters that may be monitored include pH, temperature, specific conductivity, turbidity, redox potential, and dissolved oxygen.

Reliance exclusively on purging a set number of casing volumes may not ensure that all wells are adequately purged before sampling. CBO has adopted a combined approach to purging that minimizes the purge volume removed from the well while ensuring that stagnant water in the casing has been removed. Minimum purge volumes are used in conjunction with stability monitoring for field parameters before sampling may be performed. For sampling baseline wells during preoperational monitoring, a minimum of two casing volumes must be removed. For routine monitor well sampling, a minimum of one casing volume must be removed. In either situation, purging is deemed complete only when it is determined through field monitoring of pH and conductivity that the water quality is stable.

Accurate records of well purging must be maintained to document that the minimum number of casing volumes are purged from the well before sampling. These records include the casing volume (gallons), the pumping rate (gpm), and pumping start and stop times. The pumping rate can be determined with a flowmeter or by timing how long it takes to fill a 5-gallon bucket or other container of a known volume.

The following formula shall be used to calculate the number of gallons contained in one casing volume:

Casing Volume (Gals) =

(Height of water in well in ft) x (Radius of the well^2 in inches) x (π) x (0.052)

Where:	π = 3.1416 The height of the water in the well = the total depth (TD) of the well in feet minus the depth to water in feet.

Using the preceding formula, conversion factors may be determined for standard casing diameters. This conversion factor (i.e., gallons per foot of pipe), when multiplied by the height of water in the casing, will yield the casing volume.

Casing Inside Diameter (in)	Conversion (gal/ft)
3	0.163
4.33	0.765

To determine how long the well needs to be pumped to remove a casing volume, divide the casing volume in gallons by the pumping rate in gpm. This will result in the number of minutes required to pump one casing volume.

For monitor wells, the pH and conductivity are measured immediately after starting the well. These readings are then repeated no more frequently than each ½ casing volume of water that is pumped from the well. All readings are recorded on the well sampling sheet. When a minimum of three field parameter readings indicate that the well is stable, the monitoring results are compared to determine the effectiveness of well purging. The acceptance criteria to determine whether the well is stable are:

Conductivity:	All values within ± 10 percent of the average with no discernable trends.
pH:	All values within ± 0.2 S.U. of the average with no discernable trends.

An alternative method for ensuring that representative formation water is sampled during routine excursion monitoring allows one field reading to be taken immediately before sampling. Depending on the individual flow rate of each well, the well is purged until at least one casing volume is removed. The field parameters are then monitored and compared with the normal baseline water quality for the individual well or group of wells. If normal formation water quality is not indicated, additional purging is performed until the well has stabilized at the formation average values. The formation averages for conductivity and pH for these wells are determined during baseline sampling and during routine excursion monitoring sampling. Due to the extensive, long-term sampling program implemented for the monitor wells at in-situ solution mines, the average conductivity and pH values for each monitor well can be determined with acceptable accuracy and certainty. These values are provided to the environmental sampler for comparison during sampling.

1.21 Well Sampling

The sample should be taken as soon as the well is adequately purged. If the well was pumped dry during purging, the sample should be obtained as soon as adequate formation water is present in the casing. Be careful to select the appropriate bottle for the well to be sampled. Most sample days have CM and SM wells that share a combination of numbers. For example, CM10-7 and SM10-7 are sampled on the same day. Ensure the appropriately labeled bottle for the well you are sampling has been selected

Rinse the sample bottle and lid with the water to be sampled. Fill the sample bottle and cap it, being careful not contaminate the water with your hands. Rinse the field sampling cup with the water to be sampled. Fill the field sampling cup. Place the sample in the cooler for return to the lab when the day's sampling queue is complete.

NOTE: Do not touch the sampled water with your hands as this could result in contamination of the sample.

Use the pH/conductivity meter to collect field measurements. The meter should be calibrated each day according to the manufacturer's recommendations prior to use. The probe should be inserted into the sample and gently swirled to remove air bubbles. Record the measurement (either pH or conductivity) when the reading has stabilized in the electronic tablet. Toggle to the other parameter (either pH or conductivity) and allow the reading to stabilize. Record the measurement in the tablet. After the sample has been collected, ensure that the well is shut-off. Record the stop time for all shallow monitor wells on the *Shallow Monitor Well Shut-off Confirmation Sheet* (CBR-EMP-FORM-017). This sheet will be kept in the lab and returned to the SHEQ Coordinator when complete.

1.22 Recording Measurements in the Electronic Tablet

All field measurements will be entered into the Microsoft Excel spreadsheet on the electronic tablet provided. Begin this process by opening the spreadsheet and clicking the “Clear Saved Data” button under the water levels tab. Next, enter the date at the top of this tab. This will cause the queue for that day to be retrieved. Enter the water level for each individual well. As you start wells, enter the start time on this page. As you are entering this information, click the save button periodically to ensure that data is not lost.

To enter field data, click on the field data tab. Start by selecting the well in the drop down menu provided. This will retrieve the sampler water level, water level, and casing volume. Manually enter gallons per minute, time (sample time), pH, conductivity, temperature, and total gallons pumped. When this is completed, click the save data button **once**. The recorded data will be transferred to tab 1, and the field data tab will be cleared for the next entry. Click the save button to ensure data is not lost. Field data will be recorded any time a stability sample is collected and when the final sample is collected.

1.23 Loading Field Data into SAP

An SAP database is used to store sampling data. To upload field sampling data from the electronic tablet to SAP, copy the Excel spreadsheet onto a USB memory device. Login to SAP on the main laboratory computer. Insert the memory device into the computer USB port. Click browse on the SAP data entry page. Select the appropriate spread sheet from the memory device. Click the upload button.

1.24 Sampling Excursion Wells

When a well is placed on excursion status, the sampling frequency is increased to weekly. Purge water from excursion wells must be captured and disposed of in the evaporation ponds. Otherwise, the sampling procedure is the same as for other monitor wells. Inexperienced samplers must consult with the SHEQ Coordinator or designee before sampling a well that is on excursion status. A monitor well remains on excursion status until three consecutive weekly sample results are below the excursion criteria. When a well is removed from excursion status, CBO continues to collect samples weekly for three more weeks.

2 ENVIRONMENTAL CONCERNS

The following environmental concerns should be taken into consideration when sampling monitor wells:

Is purge water moving away from the well casing? If purge water pools around the well casing and percolates to the screened interval of the well, a false excursion can be triggered.

- Where is purge water flowing? Ensure that purge water is not flowing into surface water sources or across public roadways.
- How long is the well pumping before the sample is collected? While the minimum amount of water must be pumped from a well, over-pumping a well can cause wellfield balance issues. Sampling order should be adjusted to ensure that wells are not pumped for excessive amounts of time.
- Do not obtain water levels in excursion wells or otherwise contaminated wells with a “clean” e-line. These levels must be obtained with a contaminated e-line or the depth sounder.
- The water sampler should be alert to changing conditions in the wellfield. Look for changes that may affect the flow of purge water or create a potential safety hazard.
- All wells must be labeled with the well number. CM wells must have a locking cover in place.
- Complete the *Annual Monitor Well Checklist* (CBR-EMP-FORM-013) annually. This form documents collection of annual Ra/U sampling, drawdowns, and an inspection of general conditions around the well. Upon completion, return the form to the SHEQ Coordinator.

3 SAFETY

Always use caution when working with electrical devices and working with suspended loads.

Park on as level ground as possible and ensure the sampling vehicle is secure (parking brake is set and transmission is in park or neutral) before exiting the vehicle to perform sampling work on a well. Ensure wheel chocks are in place as required.

4 HAZARDS

- Suspended loads – Generators are suspended from a crane winch to load and unload them for sampling purposes. Examine the winch cable and hook for wear before use each day and replace immediately if signs of wear are evident. Proper body positioning is critical to safely move the suspended generator, ensuring that no body parts are placed beneath the suspended load while it is moved into position.

- Pinch points – The sampler must be aware of potential pinch points during the generator loading and unloading process. Potential pinch points include but are not limited to the point between the generator and the pick-up box and the point between the cable hook and the lifting hook on the generator.

- Radiological precautions – There may be a potential for contamination from radioactive materials when sampling production zone wells. Wash hands before eating, drinking, or using tobacco products. Perform an alpha/beta survey before entering a designated clean area and at the end of shift before leaving site.

- Electrical shock – Most commercial monitoring wells and a number of shallow monitoring wells are pumped using a portable generator. The potential to receive an electrical shock exists. Ensure that purged water does not spray onto the generator and ensure that generator exhaust does not blow directly onto heat sensitive objects (cords, plugs, etc.)

5 PERSONAL PROTECTIVE EQUIPMENT

Hard hat, safety boots and safety glasses are required at all times.

6 RECORDKEEPING

Acknowledgement of Operational Monitor Water Sampler training will be documented on the *Operational Monitor Well Sampling Training Acknowledgement*, CBR-TRG-FORM-009. The stop time for all shallow monitor wells will be recorded on the *Shallow Monitor Well Shut-off Confirmation Sheet* (CBR-EMP-FORM-017). This sheet will be kept in the lab and returned to the SHEQ Coordinator when complete.

The *Annual Monitor Well Checklist* (CBR-EMP-FORM-013) documents collection of annual Ra/U sampling, drawdowns, and an inspection of general conditions around the well. Upon completion, return the form to the SHEQ Coordinator.

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