# Groundwater Monitoring Well Installation Work Plan CSMRI Site

## Prepared for:

Colorado School of Mines
Golden, Colorado

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# 1.0 Introduction

This monitoring well installation work plan outlines well installation activities and procedures Stoller will follow during monitoring well installation at the Colorado School of Mines Research Institute (CSMRI) site. Seven wells are proposed to track the effectiveness of uncontained source removal in addressing elevated uranium concentrations in groundwater beneath the Site, augment the characterization data, and provide a better understanding of the geohydrologic conditions in the alluvial/colluvial aquifer at the Site. In all instances, this document and the procedures contained herein comply with State of Colorado, Water Well Construction Rules, 2 CCR 402-2, January 1, 2005. The following sections present a brief history of the Site and the Site setting, followed by the procedures for well installation.

## *1.1 Site History*

The Site operated from 1912 until 1987, during which time numerous mineral research projects were conducted. These projects involved the mineral extraction and beneficiation of materials that contained naturally occurring levels of radionuclides and metals above the Site's background levels.

Beginning in 1992, a number of activities were performed that included excavation of contaminated soil and sediments, demolition and removal of buildings, water and sediment sampling, and closure of a settling pond. By the mid-1990s, all onsite buildings were demolished and removed. Characterization work in late 2002 identified soils with elevated metals concentrations and radionuclide activities around several of the former buildings' locations. The primary contaminants were found to be arsenic, cadmium, lead, mercury, radium, thorium, and uranium. Concentrations of uranium above the maximum contaminant level (MCL) were also detected in water samples collected from Site groundwater monitoring wells.

Remedial activities conducted in April through May 2004 were followed by requisite Site characterization activities that concluded in August 2006. The recent characterization work was designed to efficiently and accurately evaluate the Site, facilitate the use of appropriate clean-up goals, and determine the nature and extent of impacted material. The Site characterization determined the extent of impacted soil by relocating it to a centrally located, lined, and bermed stockpile. Data collected from the installation of additional groundwater monitoring wells will demonstrate the effectiveness of uncontained source removal, augment the characterization data, and provide a better understanding of the geohydrologic conditions in the alluvial/colluvial aquifer at the Site.

## *1.2 Site Setting*

The Site is located on the south side of Clear Creek, east of U.S. Highway 6, in Golden, Colorado, as shown on Figure 1. It covers an area of about six acres, and access is controlled by a chain-link security fence. The main entrance to the Site is located about 500 feet northwest of the intersection of Birch and 12th Streets. Due to recent activity, the Site is largely clear of vegetation except along the flood plain of Clear Creek. Although generally accessible to vehicle traffic, the ground surface is uneven and consists of alluvial/colluvial deposits and artificial fill.

Bedrock underlying the Site consists of four steeply dipping formations overlain by the surficial geologic units. The bedrock formations are the Pierre Shale, Fox Hills Sandstone, Laramie Formation, and Arapaho Formation. These formations range from fine-grained shales and coal beds to coarse-grained sandstones and conglomerates. A geologic map of the bedrock formations is provided as Figure 2. The surficial deposits overlying the bedrock formations are the Louviers Alluvium, Post Piney Creek Alluvium, Colluvium, and artificial fill. The alluvial deposits are composed of silty clayey sand with gravel on higher ground and cobbley gravel with boulders along the stream bed. Colluvial material is generally cobbley sand with inter-bedded clay and boulders and is up to 20 feet thick.

Groundwater occurs under unconfined conditions in the alluvium/colluvium of the Site. Depth to the water table ranges from about 3 to 30 feet below ground surface (bgs), depending on distance to the creek and depth to bedrock. Based on surface and bedrock topography, groundwater generally flows to the northeast toward Clear Creek. The alluvial/colluvial deposits are mainly recharged by infiltration of precipitation and to a limited extent by Clear Creek during periods of high flow. The alluvial/colluvial system naturally discharges to Clear Creek.

### 1.2.1 Water Quality

Groundwater in the shallow alluvium/colluvium has been shown to contain elevated levels of uranium, a contaminant of concern that occurs naturally in the bedrock formations and in the surficial deposits that comprise the Site. The groundwater concentrations in question have been attributed to migration of radionuclides from source materials formerly located on the Site and now residing in lined stockpiles. As previously stated, the proposed well installations will facilitate tracking the success of uncontained source removal in addressing elevated uranium concentrations in groundwater beneath the Site, augment the characterization data, and provide a better understanding of the geohydrologic conditions in the alluvial/colluvial aquifer at the Site. The elevated uranium concentrations have historically been detected in groundwater near proposed well 7B. Decreasing uranium concentrations continue to be detected in well 4. Well 4 is assumed to be located down-gradient of proposed well 7B. Therefore, groundwater quality in these two areas may potentially be related. If proven valid, their potential relationship would signify a contaminant plume whose extent is not well defined. Four of the proposed wells may provide data pertinent to clarifying this relationship. The following section explains the purpose of the additional wells and the reason for their selected locations.

### 1.2.2 Rationale for Monitoring Well Placement

The proposed locations were identified after an evaluation was made of site geology and topography, existing and abandoned monitoring wells, soil contamination zones, and project objectives. Figure 3 shows the proposed well locations.

Of the seven proposed wells, two replace previously abandoned wells and five complete the on-site encirclement of the remediated area. The two replacement wells, proposed well numbers 6B and 7B, re-establish previously abandoned wells csmri-06 and csmri-07.

Additional groundwater monitoring wells will provide the data necessary to track the effectiveness of the remedy. Those data will also confirm the success of uncontained source removal as it relates to elevated uranium concentrations in groundwater at the site. Additional wells will also refine our knowledge of the following elements:

- the direction of water flow across the site,
- the elevation and thickness of water on the terrace above the creek bed, and
- water quality both up and down gradient across the site.

Each of the proposed locations is discussed separately in the following sections.

#### 1.2.1.1 Proposed Location 6B

Abandoned well location csmri-06 was located topographically upgradient of the site. Bedrock elevations at csmri-06 and csmri-07 are about equal. Structural contours on the bedrock surface indicate the surface gradient of the Pierre Shale to be 0.01 foot per foot easterly (1 foot drop in elevation per 75 feet) and perpendicular to a line of strike between the two abandoned wells. Location csmri-06 is therefore cross-gradient to the former source area near csmri-07. Since the bedrock elevation at csmri-06 is above the elevation of the creek bed, water at csmri-06 originates topographically uphill and is influenced by gravity flow onto the site. Therefore, a replacement well for csmri-06 is desirable but should be located closer to the area of interest. Proposed location 6B is a logical location, because it meets the needs described above and it is outside the development envelope for the proposed soccer field.

#### 1.2.1.2 Proposed Location 1B

This location is selected because it appears to be upgradient to the source area near csmri-07 yet it is a reasonable distance away. It is topographically higher than csmri-07 and the bedrock elevation is also higher. This well replaces the upgradient well, csmri-1, placing it closer to the area of the soil removal.

#### 1.2.1.3 Proposed Location 7B

This location is a replacement well for csmri-07. It is desirable to have a control very close to the source area for comparison with historical data and to evaluate effects of source removal in the immediate area of most likely site source.

#### 1.2.1.4 Proposed Location 8

This location should be cross-gradient to the source area, but because of the steep drop in elevation off the terrace, it may receive some drainage from the source. Therefore, water quality needs to be evaluated at this location. The well will likely feel strong effects from flow levels in Clear Creek. This well will also provide an upgradient well if the creek is the dominant hydrological feature on the floodplain.

#### 1.2.1.5 Proposed Location 9

Location 9 is topographically about the same elevation as the source area at csmri-07 but is cross-gradient to the direction of groundwater flow from that source. It is a good location to monitor the water discharging to Clear Creek immediately above the existing wells csmri-04 and csmri-05. It also provides good control on the southeast side of the alleged contaminant plume between csmri-07 and csmri-04.

#### 1.2.1.6 Proposed Location 10

Location 10's purpose is similar to that of location 9 and essentially splits the distance between 9 and the source area at csmri-07. It effectively fills the gap along the northern boundary of the remediated area.

#### 1.2.1.7 Proposed Location 11

This location will provide data similar to that of location 6B and closes the circle around the remediated area.

### 1.2.3 Site Controls

Activities described in this work plan will largely occur within the fenced boundary of the Site. Access to the Site during this work will be controlled by Stoller.

## 2.0 Scope

This section describes the installation of seven groundwater monitoring wells at locations shown on Figure 3.

Drilling and installation work for the wells are listed below and in Table 2-1.

- Monitoring/Observation Wells – The monitoring wells will consist of 2-inch inside diameter (ID) schedule 40 polyvinyl chloride (PVC) completed in the alluvial/colluvial aquifer at seven locations. The wells shall be installed to maximum depths of about 40 feet bgs and completed with minimum of 10 feet of machine-slotted PVC screen. The actual well depths will be determined in the field by examination of drill cuttings by the Stoller geologist. All wells will be developed by surging and bailing.
- Drill Cuttings – The drill cuttings will be used by the Stoller geologist for lithologic logging and field radiological screening. The drill cuttings will be screened by Stoller as they are produced during drilling of the monitoring well boreholes. A minimum 5-feet screening interval will be used. More frequent screening may be required as the borings approach the total anticipated depths. The cuttings will be thin-spread adjacent to the work area barring radiological readings exceeding two times background.
- Core Samples – The drilling subcontractor will use a sonic drilling system which produces continuous core as the borehole is advanced. Samples of the core will be collected at the discretion of Stoller's geologist, based on inspection and screening of the core. Stoller will note on the boring log the area of the boring containing the highest screened activity in the event laboratory analysis is desired. Samples of the core are not anticipated to be sent to the analytical laboratory but will be held pending the outcome of the groundwater analyses. If ground water analyses identify elevated concentrations, the samples of the core will be considered for possible lab analysis to help understand the nature and source of the elevated ground water concentrations.

**Table 2-1**
**Summary of Wells, Borings, Estimated Depths, and Completion Details**

| Well/Boring Number | Estimated Depth of Boring (ft bgs) | Estimated Depth to top of Screen (ft bgs) | Screen Length | Well Diameter (inches) | Type |
|---|---|---|---|---|---|
| 6b | 40 | 30 | 10 | 2 | Monitoring |
| 1b | 25 | 15 | 10 | 2 | Monitoring |
| 7b | 20 | 10 | 10 | 2 | Monitoring |
| 8 | 20 | 5 | 15 | 2 | Monitoring |
| 9 | 25 | 10 | 15 | 2 | Monitoring |
| 10 | 25 | 10 | 15 | 2 | Monitoring |
| 11 | 40 | 30 | 10 | 2 | Monitoring |
| Total Footage | 195 | | 85 | 2 | Monitoring |

# 3.0 Monitoring Well Specifications

Specifications and requirements for the drilling and sampling tasks are presented in this section. Some factors such as final well location, borehole depth, and number of samples are subject to change as conditions in the field dictate.

Drilling and well completion activities will follow the procedures contained in ASTM D5092-90 (reapproved 1995). The boreholes and installed wells will be sufficiently plumb and straight and will have no interference with the installation, alignment, operation, or future removal of pumps or other down-hole equipment. Only non-hydrocarbon-based lubricants will be used on any down-hole equipment or tools. The use of contaminating additives (diesel fuel, oil, barite), hydrocarbon-based lubricants (grease or oil), and biocides (formaldehyde) in the boreholes or wells is strictly forbidden. Well installation materials (sacks of bentonite, screens, casings, etc.) will be delivered to each well site in factory-sealed containers and remain in such until used in the well installation.

## *3.1 Drilling Methods*

The drilling rig selected for installing the monitoring wells is a sonic rig that has the capability of preserving sample integrity while having the capacity to drill through cobbles. The proposed drilling method and equipment is capable and rated to penetrate and advance through clay, loose sand, and gravel with cobbles to cobbles reaching a depth of at least 50 feet. Lithologic samples should be provided from all depth intervals during drilling due to the use of the sonic drilling system.

## *3.2 Sediment Sampling Methods*

The driller will provide to the Stoller geologist drill cuttings of the sediments from the well locations at a minimum of every 5-feet-depth interval or as directed by the Stoller geologist for lithologic logging purposes. In addition to the drill cuttings, discrete sediment samples may be requested at selected intervals if the drill cuttings do not provide adequate resolution of lithologic changes. The discrete samples will be used to determine the desired total depth of the boring and

the screened interval for each well. The sonic drilling rig has continuous core capabilities that may be employed to provide continuous representative samples.

### 3.3 Well Installation and Completion

Installation of the well materials will be completed immediately after the desired total depth of the borehole is reached, as determined by the Stoller geologist. The Stoller geologist will track measurements of the depth of materials to the nearest tenth of a foot. The borehole diameter will allow a minimum of 3-inch annular space between the borehole and the well casing.

The monitoring wells shall be constructed using the following materials:

- Johnson well screen and casing (or equivalent) nominal 2-inch inside diameter
- schedule 40 PVC
- 0.020-inch machine slotted screen fitted with an end cap (no sump)
- 10-20 Colorado silica sand (or equivalent) for the primary filter pack
- 16-40 Colorado silica sand (or equivalent) for the secondary upper pack
- 3/8-inch bentonite pellets/chips seal
- schedule 40 PVC blank casing
- 30% solids bentonite grout or cement-bentonite grout with minimum 2% bentonite
- lockable J-plug or PVC slip cap

The monitoring wells will be constructed in accordance with the following guidelines:

- The installation of the well screen and casing will begin when the desired total depth of the borehole is reached.
- Well installation will continue with placement of the primary filter pack to 2 feet above the top of the screen or as determined by the Stoller geologist. Pre-completion well development will be performed, if necessary and as determined by the Stoller geologist, to ensure a uniform and complete filling of the annular space with the filter pack that is free of voids or bridges.
- The well installation will continue with the placement of a minimum 3 feet secondary filter pack.
- When the top of the secondary filter pack is at the correct height, as determined by the Stoller geologist, the placement of a 5-feet bentonite seal (3/8-inch bentonite pellets/chips) will be completed. The bentonite pellets/chips will be hydrated by adding 5 gallons of water and allowing at least a 15-minute period for hydration and expansion of the seal.
- The 30% solids bentonite grout or cement-bentonite grout seal in the annular space from the top of the bentonite seal to the ground surface will be installed. The placement of the grout will be completed by pumping it through a tremie pipe in one continuous action, completely filling the annular space. The grout will be prepared in accordance with the manufacturer's instructions and supervision of the Stoller geologist.

### 3.4 Well Development

All wells will be developed by a combination of surging and bailing. The development will continue until the well is free of sediment, as determined by the Stoller geologist. Development water will be collected at the surface in 55-gallon U.S. Department of Transportation (DOT) approved drums. Water from development drums will be emptied onto Stockpile B.

### 3.5 Well Head Protection

The following well head protection for the monitoring wells will be installed:

- A steel casing extending 30 inches above the surface fitted with a locking, weather-proof lid (about 2 inches of clearance) shall be placed over the riser casing of each well and cemented 3 feet in place, with a ⅛-inch drain hole drilled near the base. Stoller will supply the locks for the lids.
- The top 2 feet of the borehole shall be excavated and tapered away from the casing to allow the concrete to be placed below the frost line.
- 3-feet wide, 3-feet long, and 6-inch thick concrete pad (centered on the casing) having a slight slope away from the well casing shall be installed around each new monitoring well.
- The annular area between the cover and the riser casing shall be filled with ¼-inch pea gravel or coarse environmental sand up to 6 inches below the top of the riser. The finished height of the PVC casing shall be cut square and about 2 feet above ground level. The top of the casing shall be equipped with a schedule 40 PVC slip cap or lockable J-plug.
- The PVC well head will be surveyed by a licensed surveyor. Coordinant locations of each monitor well will be on the State of Colorado coordinant system; the elevation of each PVC well head will be recorded to within the nearest $1/100^{th}$ of a foot (0.01).

### 3.6 Source of Water

Only clean potable water from an approved source will be used for drilling and well construction tasks associated with the scope of work.

Tanks, hoses, pumps, and other equipment used to transport or store water will be clean and free from contamination. Further, the water will be protected from contamination during storage.

### 3.7 Equipment Cleaning

Debris and contamination will be removed from equipment with a high-pressure steam washer at the beginning of the drilling project and before leaving the project Site. Water from the approved water source shall be used for all cleaning operations. The Stoller geologist will direct equipment cleaning and verify it clean when it is visibly free of all soil, oil, grease, and previous fluids. Equipment will be radiologically screened prior to entry and before leaving the Site.

### 3.8 Drill Cuttings and Fluid Disposal

Drill cuttings will be surveyed for activity and if no elevated readings are noted, they will be spread evenly on the ground surface around the borehole after each borehole or well is completed. Elevated activity will be considered to be twice background. Water from development drums will be emptied onto Stockpile B.

### 3.9 Trash Disposal

Stoller will ensure the subcontractor collects and disposes of job-generated trash in a site-approved receptacle at least one time per day, at the end of each day, and maintain site housekeeping at all times.

### 3.10 Equipment Maintenance

Equipment maintenance, fueling, and repairs may be performed on location with the prior approval of the Stoller geologist. If, during the maintenance operation(s), the subcontractor spills hydrocarbon-based fluid, antifreeze, or other similar material, it shall immediately clean up and remove the spilled material at their own time and expense. Likewise, if at any time, fluid leakage occurs from any piece of the subcontractor's equipment, the subcontractor shall take immediate action to stop the leak and clean up the spill. If necessary, the subcontractor will protect the ground surface from equipment leaks by placing plastic sheeting under the equipment.

### 3.11 Utilities Clearance

Stoller will stake each proposed drilling location prior to the start of work. Stoller will contact the Utility Notification Center of Colorado (1-800-922-1987) to notify the utility companies no earlier than seven days and no later than 48 hours prior to start of work. Stoller will coordinate and escort the utility locators to each proposed monitor well location. Stoller will verify all utilities located, such as power lines or pipelines that might reasonably be expected to exist within the work area, prior to commencement of work.

### 3.12 Quality Assurance

A Stoller representative will be present during the field activities. Fieldwork will be performed in accordance with the requirements, specification, and procedures set forth herein. Variances required by Site conditions will be made known to the School and the CDPHE.

### 3.13 Permits and Licenses

Stoller will provide necessary access permits, well permits, and permits for cuttings/fluid disposal as required by federal, state, or other controlling agencies. The driller will be responsible for drilling and/or contractor license(s) and other permits required by federal, state, or other controlling agencies. The drilling subcontractor shall furnish a copy of a valid Colorado driller's license.

### 3.14 Cultural Resources

Persons knowingly disturbing historic and prehistoric archaeology sites or for collecting artifacts of any kind, including historic items, arrowheads, and or pottery fragments will be subject to prosecution.

It is unlikely that cultural resources will be encountered. However, if cultural resources are unearthed during operations, activity in the vicinity of the cultural resource will cease pending proper notice and inspection by authorized personnel.

### 3.15 Site Sanitation Facilities

Portable toilet facilities will be available at the job site.

# 4.0 Health and Safety

Health and safety requirements and procedures are summarized in the following sections. The complete Drilling Health and Safety Plan is attached in Appendix A.

## *4.1 Safety Requirements and Briefings*

The Stoller geologist, in collaboration with the Stoller site safety supervisor, will be responsible for operational health and safety coverage during the drilling activities. Onsite personnel shall comply with the Stoller operational health and safety regulations as outlined in the *Drilling Health and Safety Requirements*. The "Statement of Understanding" contained in the *Drilling Health and Safety Requirements* shall be signed by Site personnel prior to working on the project. Personnel working on the project shall be required to attend a pre-work briefing as soon as practical after mobilization before beginning work.

A safety tailgate meeting will be held prior to the start of each day's work. All personnel working on that day's shift shall attend. The topic of discussion and attendee signatures will be recorded on a form. A copy of each daily record will be maintained by the Stoller project manager.

The Stoller geologist and/or the drilling subcontractor will suspend work when an unsafe practice or condition is observed. Work will not proceed until the unsafe practice or condition is corrected and the Stoller geologist, or designee, approves the resumption of work.

Drilling rig trucks and/or carriers shall conform to applicable federal, state, and local safety requirements and regulations. Each truck or carrier shall be equipped with two DOT-approved, fully charged 2A:40BC dry chemical fire extinguishers, with current inspection tags.

## *4.2 Training*

No special hazardous waste or radiation worker training is required for drilling and well installation activities at the CSMRI Site.

## *4.3 Equipment Inspections*

The Stoller geologist will inspect the subcontractor's drilling rig and other subcontractor-furnished equipment at the start of the project and at other times, as necessary, and record the conditions on an appropriate form. The subcontractor shall inspect its drilling equipment on a daily basis and record this on the drilling report form each day. The subcontractor shall maintain and operate its equipment in accordance with applicable regulations.

## *4.4 Environmental Management System*

In accordance with the S.M. Stoller Environmental, Safety, and Health Policy and Environmental Management System, all personnel performing work must follow safe and environmentally sound work practices. Work must be conducted in compliance with applicable federal, state, and local regulatory requirements and in a manner that protects workers and the public. In addition, work must be conducted in a manner that prevents pollution, minimizes wastes, and conserves natural and cultural resources to the extent that such activities are technically and economically feasible.

# 5.0 Monitoring Well Sampling

## 5.1 Groundwater Sample Collection

Representative groundwater samples will be collected from the seven newly installed monitor wells. Physical dimension and water levels referenced to the top of casing of each monitor well will be measured to an accuracy of 0.01 foot vertically prior to sampling. Three casing volumes of water will be purged and field measurements of temperature, pH, conductivity, turbidity, ORP, DO, and conductivity recorded on field data sheets after each casing volume of purge water is removed from the well. Purged water will be retained at the surface in 55-gallon DOT-approved drums pending analytical data. Detailed field sampling procedures are presented in Stoller's Radioactive Materials License Application, SOP-RAD-024, a copy of which is provided in Appendix B.

## 5.2 Sample Containers, Preservation, and Holding Times

Soil samples and groundwater samples will be placed in laboratory supplied, screw-cap poly-containers, sealed, and labeled with the sample identification number, date and time of collection, analysis to be performed, and initials of the sampler. Filtering and sample preservation with nitric acid of aqueous samples will be conducted in the field. Preserved aqueous samples will have their pH checked in the field using narrow ranged pH paper strips prior to sealing. Additional nitric acid may be added in the field to achieve the requisite pH 2 or lower. The pH paper strips will not be dipped into the aqueous sample container, rather a small portion of the sample will be poured onto the paper strip. It is anticipated that several drops of aqueous sample will run-off the pH paper strip. Samples will be placed in a pre-cooled ice chest for shipment via courier to the contract laboratory. A completed chain of custody will accompany each ice chest submitted to the contract laboratory. Copies of the chain of custody will be included in the final report.

Prior to release from the sample collection site, swipe samples will be collected of the ice chest and the soil sample containers. The swipe samples will then be analyzed in the field using a radiation swipe counter. Activity values recorded in the soil core screening process and from the swipe samples of the sample containers will be communicated directly to Stoller's sample transportation manager. In the event that activity is greater than 20 disintegrations per minute (dpm), then Stoller's sample transportation manager will direct sample shipment to the laboratory per DOT regulations. Copies of the survey results will be recorded and accompany the shipping containers.

## 5.3 Quality Control Samples

One set of duplicate water samples from one well will be collected. The duplicate soil sample will be submitted to the analytical laboratory as a blind duplicate sample.

Quality assurance (QA) is defined as the program used to define procedures for the evaluation and documentation of investigation/characterization activities to provide a uniform basis for collecting, managing, and reporting data and information. Quality control (QC) is defined as the procedures and activities related to measuring the accuracy and precision of data and information and implementing corrective action to meet data quality objectives (DQOs). DQO as well as the

Quality Assurance Project Plan (QAPP) presented in CSMRI Site Final Site Characterization Work Plan, dated May 12, 2006 will be followed during this task of site work.

### 5.4 Sampling Procedures and Analytical Protocols

Sampling procedures to be used in this investigation are described in Stoller's Radioactive Materials License Application, SOP RAD-024 in Appendix B. Laboratory analyses to be performed with their corresponding sample containers and holding times are presented in Table 5-1.

**Table 5-1**
**Laboratory Analyses**

| EPA Method | Sample Preservation | Holding Time |
|---|---|---|
| Rad Suite<br>TH – EPA Method 714R10<br>U – EPA Method 714R10<br>Ra-226 – EPA Method 724R9<br>Ra-228 – EPA Method 724R7 | Monitor well: field filtered<br>1-liter poly with $HNO_3$ preserved to pH< 2 | 180 days |
| Anions/cations | Cations 1-liter poly field filtered if turbid and preserved to pH< 2<br>Anions: 1-liter poly. | 180 days |
| TDS | With above | 180 days |
| Metals Suite – EPA Method SW6010<br>Hg – EPA Method SW7470 | Monitor well: field filtered<br>1-liter poly with $HNO_3$ preserved to pH< 2 | 180 days |

## 6.0 Data Reduction, Validation, and Analysis

Data reduction will be accomplished through performance of a data quality review and construction of computer databases as necessary to compile and reduce data to usable data sets that meet the DQOs established for the project. Data validation will be conducted by the analytical laboratory and will include EPA Level 4 data package. The analytical laboratory will provide full EPA Level 4 documentation, including radiochemistry case narrative, raw data package, QA summary reports, laboratory bench sheets, standards traceability documents, and initial calibration standards traceability.

The groundwater data will be compared to the MCLs and other standards for the compounds of concern. The minimum radionuclide detection activity for this project will be at or below 1.0 picoCuries per liter (pCi/L) for water samples. Table 6-1 lists MDLs and various regulatory standards that may be used for data evaluation.

**Table 6-1**
**MDLs and Standards for Selected Analytes**

| Analyte | Method Detection Limit | Standard |
|---|---|---|
| **Radionuclides** | | |
| Radium 226 | 1.0 pCi/l | Combined Ra 226 and 228 = 5 pCi/l (MCL, GW) |
| Radium 228 | 1.0 pCi/l | |
| Thorium 228 | 1.0 pCi/l | No MCL, GW Established |
| Thorium 230 | 1.0 pCi/l | Th 230 +Th 232 = 60 pCi/l (GW) |
| Thorium 232 | 1.0 pCi/l | |
| Uranium 234 | 1.0 pCi/l * | Total U = 30 ug/l (MCL) |
| Uranium 235 | 1.0 pCi/l * | |
| Uranium 238 | 1.0 pCi/l * | |
| **Metals** | | |
| Silver | 0.01 mg/l | 0.05 mg/l (GW) |
| Arsenic | 0.01 mg/l | 0.010 mg/l (MCL, GW) |
| Barium | 0.1 mg/l | 2.0 mg/l (MCL, GW) |
| Calcium | 1.0 mg/l | No MCL, GW Established |
| Cadmium | 0.005 mg/l | 0.005 mg/l (MCL, GW) |
| Chromium | 0.01 mg/l | 0.1 mg/l (MCL, GW) |
| Mercury | 0.0002 mg/l | 0.002 mg/l (MCL, GW) |
| Potassium | 1.0 mg/l | No MCL, GW Established |
| Magnesium | 1.0 mg/l | No MCL, GW Established |
| Molybdenum | 0.01 mg/l | No MCL, GW Established |
| Sodium | 1.0 mg/l | No MCL, GW Established |
| Lead | 0.003 mg/l | 0.015 mg/l (AL); 0.05 mg/l (GW) |
| Selenium | 0.005 mg/l | 0.05 mg/l (MCL, GW) |
| Vanadium | 0.01 mg/l | 0.1 mg/l (GW Agric. Std.) |
| Zinc | 0.02 mg/l | 5.0 mg/l (GW Drinking Water Std.); 2.0 mg/l (GW Agric. Std.) |

ug/l – micrograms per liter
mg/l – milligrams per liter
pCi/L – picoCuries per liter
MCL = Maximum Contaminant Level, Colorado Primary Drinking Water Regulations
AL = Action Level, Colorado Primary Drinking Water Regulations
GW = Colorado Basic Standards For Ground Water Regulations
* - See Appendix C, Paragon Analytics Radiochemistry Case Narrative Isotopic/Total Uranium

Data will be plotted on a Site map so as to depict the extent of the impacted water. Data validation documentation as well as data summaries will be presented in report form for ease of viewing and understanding.

## 7.0 References

DOE, 2004. U.S. Department of Energy (DOE) Quality Systems Manual for Analytical Services, Revision 1, February 2004.

Hulse, S.E., Ibrahim, S.A., Stone, J.M., Whicker, F.W. 2000. Concentration of 232Th, 226Ra, 40K in soil around Rocky Flats and along Colorado's Front Range corridor. Technology 7:415-430.

Ott, L. and Longnecker, M. 2001. An introduction to statistical methods and data analysis. Fifth Addition. Duxbury. Pacific Grove, CA, USA.

RESRAD 2005. http://web.ead.anl.gov/resrad/home2.

# Appendix A
# Drilling Health and Safety Plan

# S.M. Stoller Corporation
# Drilling Health and Safety Plan

| | |
|---|---|
| Project Location: | CSMRI Site |
| Task Name: | Install groundwater monitoring wells and test holes |
| Duration of Activities: | 2 to 3 weeks. This HASP will be modified, as necessary, if new tasks are added. |

## Approvals

| Title/Organization: | Printed name: | Signature: | Date: |
|---|---|---|---|
| Project Manager | Steve Brinkman | | |
| Health and Safety Supervisors | Ralph Rupp<br>Robert Hill | | |
| Health and Safety Manager | Darin Dobbins | | |

## Scope of Work

Breakdown and description of work activities:

1. Conduct utilities locate. Coordinate with City of Golden and Utility Notification Center of Colorado
2. Mobilize drill rig, equipment, and materials to CSMRI Site
3. Drill to top of bedrock or maximum planned depth of ±40 feet bgs
4. Screen core samples for activity in the field and collect samples for laboratory analysis
5. Install monitoring well casing and screen, gravel pack, grout to surface
6. Construct well pads at ground surface
7. Demobilize equipment from CSMRI Site
8. Perform a radiological survey of all equipment and materials leaving the site

Should any off-normal event occur, work will immediately stop and will not commence until the hazards have been addressed and the necessary Task Hazard Analysis (THA), procedure or HASP modification completed. Particular attention will be paid to ensuring the stability of the ground for the drill rig.

The HASP on this template is to be used in conjunction with the Stoller EHS Policy Manual and the Drilling Health and Safety Requirements.

## Personnel

| Assigned Responsibility: | Name and Organization: | Phone Number: |
|---|---|---|
| Project Manager | Steve Brinkman | 303-546-4388 |
| Health and Safety Supervisors | Ralph Rupp<br>Robert Hill | 303-546-4321<br>303-546-4440 |

## Task Hazard Analysis

Task-specific hazard control measures are specified in each Task Hazard Analysis (THA). THAs have been developed for the following activities and are included as attachments. Activities with procedures have hazard abatement incorporated into the procedure and do not have THAs.

| Activities with a THA: | Notes and Comments |
|---|---|
| Drilling Operations | Manual STO 14 (Drilling Health and Safety Requirements) identifies hazards and control measures. |

## Permits

Required permits must be signed before work commences.

| Permit: | No | Yes | Notes and Comments: |
|---|---|---|---|
| Hot Work | | X | Hot work will be conducted with written authorization from Stoller's onsite Supervisor on an as needed basis. |
| Rad Worker | X | | Conditions identified on site do not warrant this permit. |
| Confined Space | X | | No confined space entry will be conducted. |
| Lockout/Tagout | X | | Systems will be de-energized and manufacturer recommended procedures followed for all rig maintenance or repair operations. |
| Excavation/Intrusive Soil Activity | | X | Intrusive soil activity (drilling) is required. Call for utility locates. Work will not commence until utilities are cleared. |
| Other: | | | |

## Personal Protective Equipment

The following personal protective equipment (PPE) will be used for the identified activities.

| Activity | Head/Face | Foot | Hands | Respiratory | Clothing |
|---|---|---|---|---|---|
| Drilling and soil sampling with sonic drill rig | Hard hat, safety glasses, hearing protection | Sturdy, over the ankle, safety-toe boots | Leather work gloves | None Required | Long pants and long-sleeve shirt (no loose clothing) |
| Radio-Isotope Monitoring | Hard hat, safety glasses | Sturdy, over the ankle, safety-toe boots | Synthetic gloves (nitrile) | None Required | Long pants and long-sleeve shirt |
| General Maintenance | Hard hat and safety glasses, minimum | Sturdy, over the ankle, safety-toe boots | Leather work gloves, rubber gloves if working with liquids | None Required | Long pants and long-sleeve shirt (no loose clothing) |

| | | | | | |
|---|---|---|---|---|---|
| Decontamination | Hard hat and safety glasses, face shield during any decontamination activities that produce splash hazards or flying particles | Sturdy, over the ankle, safety-toe boots | Leather work gloves for dry decon, rubber gloves for wet decon | None Required | Long pants and long-sleeve shirt, tyvek or raincoat as needed during wet decon |

The following competent person certifies that a hazard assessment for the identified activities has been performed and the selection of PPE is based on best available information.

| Printed Name: | Signature: | Date: |
|---|---|---|
| Darin Dobbins | | |

## Task Hazard(s) Summary

Potential health and safety hazards are listed below. The potential for encountering these hazards is ranked high, medium, or low based on the work to be performed and the hazard control measures to be used.

| Hazard Summary | Hazard Potential (High, medium, or low) | Description of Hazard Control or Protective Equipment |
|---|---|---|
| **General Safety:** Walking and working surfaces, falls, power and hand tools, materials handling | Medium | Be aware of uneven terrain or wet/snowy/icy conditions. Keep work area clean and remove slip and trip hazards if possible. Personal fall protection is required when climbing equipment to perform maintenance or repairs 6 feet or higher above the ground. Inspect hand tools before use, wear proper PPE, and ensure tools are properly guarded and grounded. Use GFCI's while operating tools and equipment. Keep hands and fingers out of pinch points. Use good ergonomic posturing when working with heavy or awkward items. |
| **Utilities**: Buried, overhead, or in general work area | Medium | Utility locates will be conducted prior to any drilling activities. Use hand auger or pothole to verify buried utilities if they are located within 10 feet of the borehole. Locate and identify all overhead utilities prior to equipment operation. Follow Tables 3-1 and 3-2, for clearance distances, in Manual STO 14, when working around high voltage power lines. Use a spotter when raising and lowering the rig mast. |
| **Chemical/Radiological**: Identify chemicals of concern and collect MSDSs | Low | Read MSDSs and follow chemical use recommendations. Data results indicate that rad concentrations in soil and air are sufficiently low that the PPE described for each task will reduce exposure potential. |
| **Physical**: Heat, cold, inclement weather, noise | Medium to High | Utilize the buddy system to check for heat or cold stress, take breaks as necessary, maintain proper hydration, use sunscreen, and dress appropriately. Wear hearing protection when operating tools or equipment that exceed noise control levels. |

| | | |
|---|---|---|
| **Biological**: Plants, animals, insects, spiders, infectious waste | Low to Medium | Beware of spiders/insects and possibly animals such as raccoons, foxes, coyotes, and squirrels. |
| **Site Instability:** Rig movement or settling during drilling operations | Medium | The site will be inspected prior to drill rig placement and closely monitored for drill rig stability during drilling activity. Any settling of the drill rig will cause the work to discontinue. Prior to startup an evaluation must be made by the drill rig operator and the safety and health lead. |
| **Rig and Forklift Operation - Hoisting and Rigging:** Interaction with heavy equipment | Medium to High | Operators must be trained. Inspect equipment before use and make sure it is rated for the material to be handled. Backup alarm or spotter required. Ground personnel make eye contact with equipment operator and stand clear during operation. Use only properly rated and inspected slings. Inspect all rigging prior to use. Use tag lines on all hoisting and rigging operations unless the health and safety lead determines that it is more hazardous to perform the lift with tag lines and approves the lift without. |
| **Flame and Spark Producing Activities:** Welding, cutting, grinding | Low to medium | Complete Hot Work Permit, inspect equipment before use, remove combustible and flammable material within 25', stage fire extinguishers. Provide fire watch during the duration of the hot work and for 30 minutes after or until the welded/grinded material is cool to the touch (do not use a bare hand to check temperature, always wear a glove or use a temperature measuring device such as an infrared thermometer). |
| **Equipment Refueling:** Fire | Low | Vehicles and equipment shall not be fueled with engine running. Cigarettes, open flames, or other ignition sources are not allowed within 50 feet of fueling location. Flammable and combustible liquids shall be handled and used in approved safety cans. A properly rated fire extinguisher shall be present during all refueling operations. |

## Site Monitoring

Task-specific monitoring requirements are identified below.

| **Direct Reading Exposure Monitoring (to monitor potential worker exposure)** | | | |
|---|---|---|---|
| **Activity(s)** | **Instrument** | **Action Level(s) and Actions** | **Frequency** |
| Scanning each soil core prior to sample collection | Geiger-Mueller Model 2 gamma detector | Record meter response in counts per minute (cpm) to compare with laboratory analytical results | Each soil core sample will be scanned |
| Frisking sample containers prior to leaving site | Geiger-Mueller Model 2 gamma detector | Record results | Each sample container |

| Integrated Personal Air Monitoring (full-shift worker exposure sampling and/or analysis) | | | |
|---|---|---|---|
| **Activity(s)** | **Contaminant** | **Method** | **Frequency** |
| NA | | | |
| Comments or special instructions: NA | | | |
| **Perimeter or Work Area Monitoring (ambient work area or fence line monitoring)** | | | |
| **Activity(s) /Location** | **Contaminant(s)** | **Method** | **Frequency** |
| NA | | | |
| | | | |
| Comments or special instructions: NA | | | |

## Site Control

Task-specific site control measures are specified below.

| Site Control for General Work Area(s) | |
|---|---|
| **Location** | **Site Control Procedure (discuss important elements such as signs, barricades, fencing, briefings, sign-in/out logs, etc.)** |
| General Work Area | Individuals present in the work area will be documented on the tailgate meeting log. A tailgate meeting will be completed for activities conducted at the site on a daily basis. |
| **Site Control for Potentially Contaminated Area(s)** | |
| **Location** | **Site Control Procedure (discuss important elements such as signs, barricades, briefings, qualifications, required supplies and equipment, sign-in/out logs, etc.)** |
| Support Zone | Non-essential vehicles will remain in the parking area. |
| Contamination Reduction Zone | Soil samples will be processed at the borehole location. |
| Exclusion Zone | The exclusion zone will be the immediate area around the rig to a distance equal to the mast height. Only essential personnel will enter the exclusion zone during drilling operations. This area shall be demarcated and signed. |

## Decontamination

Required decontamination procedures are described below.

| Type of decontamination | Identify activity(s) requiring decontamination, and describe decontamination steps, location, required equipment, and collection and disposal of potentially contaminated liquids and solids. |
|---|---|
| Personnel decontamination | Dry decontamination will be performed. Brush dirt and mud from clothing and boots before exiting the exclusion zone. |
| Equipment decontamination | Drilling equipment and downhole tools will be steam cleaned before arrival at the job site, before each new borehole, and before leaving the job site. Sample containers will be wiped clean before they are transported. |
| Other: | |

## Communications

A primary and back-up means of communications for field crews have been established as described below.

| Type of communication | Primary means | Back-up means |
|---|---|---|
| Communications with home base | Cell phones<br>303-546-4300, Stoller Office | |
| Communications among field crew members | Hand signals or voice communications | |
| Communications with client | Cell phones<br>303-273 3998 | |

## Medical Surveillance and Qualification

The following medical surveillance is required for on-site personnel working in the field.

| Required medical surveillance: | No | Yes | Job-specific medical testing: |
|---|---|---|---|
| Hazardous Waste | **X** | | Describe: NA |
| Respirator Use | **X** | | |
| Hearing Conservation | **X** | | |
| Other: | | | |

## Hazardous Chemicals

Hazardous chemicals (as defined in 29 CFR 1910.1200) to be brought or used on-site are identified below. This chemical inventory will be maintained and Material Safety Data Sheet(s) shall be maintained on the site.

| Chemical Name | Amount | Location | Purpose |
|---|---|---|---|
| None Anticipated | | | |

## Required Facilities and Equipment

The following facilities and equipment are required for safe completion of work.

| Facility | Yes/No | Type: | Location: |
|---|---|---|---|
| Worker Showers/Lockers | No | | |
| Restrooms | Yes | Portable | Site access gate. |
| Supplementary Illumination | No | | |
| Emergency eyewash/shower | Yes | Eyewash bottle | First Aid Kit |
| First Aid Supplies | Yes | Standard | Vehicle |
| Fire Extinguishers | Yes | 2A:40BC | Vehicle |
| Hazardous Materials Storage | No | | |
| Spill Containment/Clean-up | Yes | Standard | Vehicle |
| Other: | | | |

## Training

The following training is required for on-site personnel working in the field. Copies of training certificates and training records will be kept on-site.

| Training Required | Yes/No | Description |
|---|---|---|
| 40-hour General Site Worker | No | |
| 8-hour Supervisor | No | |
| 3-day On the Job | No | |
| 8-hour Refresher | No | |
| HASP Orientation | Yes | Field personnel and visitors must be trained on the requirements of the health and safety plan and the PPE requirements. |
| Hazard Communication | Yes | Training for onsite chemicals and MSDS locations will be conducted. |
| Hearing conservation | No | |
| Site-specific | No | As needed for currently undefined tasks. |

## Emergency Action and Response

Personnel responsible for coordinating emergency situations during site activity are identified below. A site map showing assembly points and directions to the authorized medical facility is attached. Documented rehearsal and critique of this plan is required at least once during the task, or more often as necessary.

| Responsibility | Name | Phone Number(s) |
|---|---|---|
| Task Emergency Coordinator | Ralph Rupp<br>Robert Hill | 303-546-4321<br>303-546-4440 |
| Client Interface | Linn Havelick | 303-273-3998 |
| Type/Frequency of Rehearsal | Briefing at beginning of project | |

***If an emergency situation develops that requires evacuation of the work area, the following steps shall be implemented.***

| Evacuation Step | Methods and comments: |
|---|---|
| Notify affected workers | Cell phones, hand signals, or voice communications |
| Evacuate to safe location | Parking area, immediately off-site |
| Assemble and account for workers | At parking area |
| Notify emergency services | Call 911 |
| Complete incident report | Affected worker and/or supervisor |

***Potential emergency situations and response actions are identified below:***

| In case of: | Response actions: |
|---|---|
| Fire and personal injury | 911 |

## Attachments

Applicable attachments to the task-specific health and safety plan are identified below:

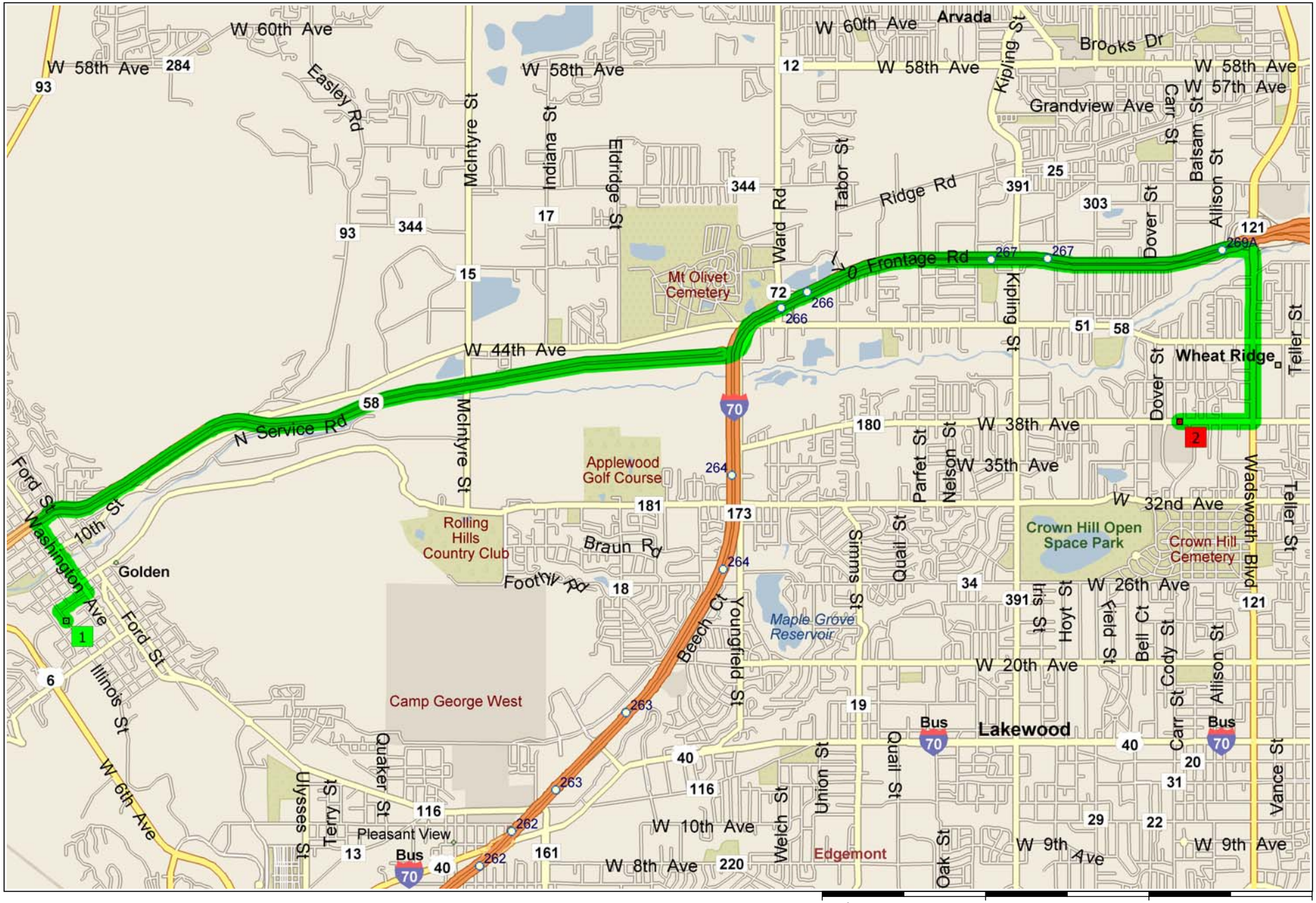
| Attachment Number: | Title: |
|---|---|
| 1 - Map and directions to hospital<br>2 - Tailgate safety meeting form<br>3 – Hot Work Permit<br>4 – Manual STO 14 | • Map and directions to hospital<br>• Tailgate Safety Meeting Form<br>• Hot Work Permit<br>• Drilling Health and Safety Requirements |

# SchoolofMines_LuthMedCenter

10.4 miles; 15 minutes

| | | |
|---|---|---|
| 9:00 AM | 0.0 mi | 1 Depart 1500 Illinois St, Golden, CO 80401 on Illinois St (North-West) for 120 yds |
| 9:00 AM | 0.1 mi | Turn RIGHT (North-East) onto 14th St for 0.2 mi |
| 9:01 AM | 0.3 mi | Turn LEFT (North-West) onto Washington Ave for 0.5 mi |
| 9:02 AM | 0.8 mi | Take Ramp (RIGHT) onto SR-58 for 4.6 mi towards CO-58 |
| 9:08 AM | 5.4 mi | Take Ramp onto I-70 for 3.4 mi towards I-70 |
| 9:11 AM | 8.7 mi | At exit 269A, turn RIGHT onto Ramp for 0.2 mi towards CO-121 / Wadsworth Blvd |
| 9:11 AM | 8.9 mi | Take Ramp (RIGHT) onto SR-121 [Wadsworth Blvd] for 1.1 mi towards Wheat Ridge / Lakewood |
| 9:14 AM | 10.0 mi | Turn RIGHT (West) onto W 38th Ave for 0.5 mi |
| 9:15 AM | 10.4 mi | 2 Arrive 8300 W 38th Ave, Wheat Ridge, CO 80033 |

# SchoolofMines_LuthMedCenter



Stoller

# TAILGATE MEETING DOCUMENTATION

| Tailgate Discussion Topic |
| --- |
| |

**Date of Meeting** _____

Meeting Conducted by:

**Printed Name** _____ **Signature** _____

**Meeting Attendees:** Attach Any Handouts and File in Project Files

| DATE | PRINTED NAME | SIGNATURE |
| --- | --- | --- |
| | | |
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STOLLER-NAVARRO
Battelle • INTERA • Weston Solutions

# HOT WORK PERMIT

Project Name _____ Project No. _____

Good for This Date Only ____/____/____ Time: From _____AM/PM To _____AM/PM

Hot Work Area _____

Specific Work to be Done _____

Personal Protective Equipment Required: _____

_____

_____

Emergency Equipment Required: _____

_____

| CHECKLIST | INITIAL: YES | INITIAL: DOES NOT APPLY |
|---|---|---|
| Area personnel have been informed of work to be performed. | | |
| All tanks, lines, valves are disconnected, blinded, or blocked out. | | |
| Electrical service has been locked out and tagged. | | |
| Equipment and all attached piping has been cleaned and purged with (check blank): Water _____ Steam _____ Inert Gas _____ Air _____ | | |
| All grounding/bonding wire in place. | | |
| Surrounding equipment and operations are safe for hot work. | | |
| No open vessels, lines, or combustible items within 35 feet of hot work area. | | |
| Fully charged and appropriate fire extinguisher easily accessible. | | |
| Fire watch has been provided. | | |
| No flammable gases greater than 10% LEL in hot work area. | | |
| Compressed gas cylinders kept upright and secured. | | |
| Air monitoring required. | | |

| AIR MONITORING (If Required) | | | | | | |
|---|---|---|---|---|---|---|
| EXACT LOCATION OF TEST | TIME | % LOWER EXPLOSIVE LIMIT | % OXYGEN | OTHER TEST ____ | OTHER TEST ____ | INITIAL |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Special Instructions: _____

_____

_____

Completed By: _____ _____ _____

Printed Name Signature Date

Manual STO 14

# Drilling Health and Safety Requirements

Stoller
Legacy Management Team
Battelle • Source One • MFG • Intera

**Work performed under DOE contract number DE–AC01–02GJ79491
for the U.S. Department of Energy.**

**STO 14**

**Copy No. _____**

# Drilling Health and Safety Requirements

# Drilling Health and Safety Requirements

**Technical Review:**

Thomas Maveal 3/1/04

Thomas Maveal, Safety Engineer Date

**Approved by:**

3/1/04

Michael R. Hurshman, Manager Date
Health and Safety

# Summary of Changes

## March 4, 2004

The only revision is the change from U.S. Department of Energy Grand Junction Office (GJO) to DOE. No other changes were made.

# Contents



# Tables



# Appendices

# 1.0 Introduction

In this document, Contractor refers to the Technical Assistance Contractor (TAC) for the U.S Department of Energy (DOE). The Occupational Safety and Health Administration (OSHA) Standards do not define drilling health and safety requirements specifically therefore, the following guidelines are offered in order to provide direction on the safety for drilling operations conducted by the Contractor. When these drilling health and safety requirements are incorporated by reference in a project planning document or subcontract, the requirements apply for drilling operations conducted under the authority of the Contractor.

## 1. Policy

The Contractor considers the prevention of illness, injury, and accidents in the work place to have greater importance than any other facet of the work. Safety will always take precedence over expediency or shortcuts, and every attempt will be made to reduce the possibility of injury, illness, or unwanted/unplanned occurrences in the performance of drilling operations.

All drilling tasks and related work assigned under a subcontract or purchase order issued by the Contractor shall be conducted in accordance with the OSHA, DOE, and other applicable Federal, State, Indian Reservation, County, and City Regulations, and this document. Oversight may be performed by the Contractor at any time during the course of the contracted work.

All personnel, including the contractor, subcontractors, lower tier subcontractors, consultants, and service personnel, who perform any task in relation to the drilling efforts or are visitors to the drilling site(s) must adhere to the provisions of this document.

Any other activities that are needed to accomplish project objectives while the field team is deployed to the various sites will be coordinated with project management and the Health and Safety staff and assessed through the DOE Integrated Safety Management System.

End of current text

# 2.0 Responsibilities and Authorities

## 1. General

The safety of all personnel takes priority over all other aspects of the drilling project. Contractor personnel have the authority to suspend all drilling operations when an unsafe practice or condition is observed. Drilling will not proceed until the unsafe practice or condition is corrected. The subcontractor shall not be compensated for efforts required to correct any unsafe act or unsafe condition created by the subcontractor's actions. All personnel, including Contractor, subcontractor, and site visitors shall participate in a daily safety briefing. Daily safety briefings should be conducted by the subcontractor, with input from the Contractor if necessary. Documentation of the on-site safety briefing shall be initiated by the Contractor for the project records. All visitors will be escorted while in the vicinity of drilling operations.

## 2. Contractor Personnel

The Line Supervisor is responsible for the implementation of these requirements for all drilling projects.

The Project Manager or line supervisor is responsible for assigning a qualified individual to each drilling activity. The assigned individual must be cognizant of the required tasks and knowledgeable of drilling techniques and the requirements of this document.
The Line Supervisor is responsible for the day-to-day field operations and compliance with these requirements. The Line Supervisor shall fully coordinate the field drilling activities with the Health and Safety staff to assure that all drilling tasks are performed in a safe manner. Should any variance from standard drilling procedures or project Statement of Work provisions be required to complete the drilling tasks, the line supervisor shall obtain concurrence from either the project manager, project drilling coordinator, or Health and Safety representative prior to implementation.

The SSS is responsible for providing health and safety oversight for drilling activities. It shall be the responsibility of all field personnel working on a drilling project to promote safety at all times in the performance of their assigned tasks. All field personnel shall be made aware of suspected site-specific hazards and associated controls. In addition, it is the responsibility of all field personnel to report any real or suspected unsafe situation, act, or questionable practice immediately to the PDC or line supervisor.

## 3. Subcontractor and Subcontractor Personnel

The subcontractor shall immediately (within one-half hour) notify the Contractor of any job related accident, injury, or near-miss situation. Any equipment and/or work site involved in an accident shall be secured and shall remain secured until the Project Manager has given permission to resume work.

The subcontractor shall conduct an investigation for all OSHA recordable injuries/illnesses, using guidelines provided by the Contractor. The Contractor shall provide a representative to assist the subcontractor with the investigation, if requested. Investigations shall be completed within 10 working days of the event.

The subcontractor must comply with all site-specific health and safety planning documents and permits.

Before work begins contractor personnel will perform an inspection of equipment to be used to ensure compliance with applicable requirements. Inspection for drill rigs will be documented on an "Equipment Safety Inspection Checklist for Small Auger, Rotary, and Core Rigs" form, a copy of which is attached. Other motor vehicles and material handling equipment will be inspected in accordance with the provisions of 29 CFR 1926.600-602. A "Beginning of Shift Motor Vehicle and Material Handling Equipment Inspection Form" (GJO2013e), or equivalent may be used to document the required inspections.

## 3.1 Drill Rig (Driller) Operator

It is understood that the subcontractor competent person is the Drill Rig Operator unless the subcontractor designates a different person in writing prior to the start of work.

The drill rig operator shall:

- Have and exercise the authority to enforce safety at all times.
- Assure that all drill rig workers have received the site-specific briefing and have signed the "Statement of Understanding" in Appendix A. All personnel are required to read and indicate an understanding of the provisions of these requirements.
- Enforce the use of proper personal protective equipment (PPE) and take appropriate corrective action when proper PPE is not being used or being used improperly by subcontractor personnel.
- Ensure proper maintenance of tools and equipment and general housekeeping on and around the drill rig.
- Ensure that equipment inspections are conducted in accordance with the requirements listed in Section 3.
- Assure that all crew members associated with the drilling operation are aware of the location and operation of all emergency shut-down devices.
- Monitor all gauges and warning lights and ensure that control levers are functioning properly while the rig is operating.
- Observe the performance of drill rig workers, and ensure compliance with safety requirements.
- Verify that there are two U.L. listed, 2A:40BC Dry Chemical fire extinguishers at the rig at all times.
- Verify that there is a fully stocked first aid kit at the rig at all times.

# 3.0 Guidelines

## 1. Personal Protective Equipment

The minimum requirements for PPE are:

- ***Clothing Safety***—Clothing must be close fitting and without loose ends, straps, draw strings or belts, or otherwise unfastened parts that might catch on rotating or moving components of the drill rig.

- ***Head Protection***—Approved safety hats (hard hats) will be worn properly at all times by everyone working or visiting within the perimeter of the drill site. The perimeter is defined as the distance equal to the height of the mast. Head protection shall meet the requirements of ANSI Z89.1, Class B (most current), and be nonconductive.

- ***Foot Protection***—Safety shoes or boots shall be worn by all drilling personnel and all visitors working within the posted perimeter of the drill site. Foot protection shall meet the requirements of ANSI Z41, Class 75 (most current).

- ***Eye Protection***—All drilling personnel and visitors to the immediate drill site area are required to wear approved safety glasses or goggles while the drill rig is in operation or other drilling functions are being performed. All eye and face protection shall meet ANSI Z87.1 (most current).

- ***Hand Protection***—All drilling personnel shall wear gloves for protection against cuts and abrasion which could occur while handling wire rope or cable and from contact with sharp edges and burrs on drill rods, drill pipe, and other drilling or sampling tools.

- ***Hearing Protection***—All drill crew personnel, site workers, and drill site visitors shall wear noise reducing ear protection when noise level exceeds 85 dBA. Hearing protection will be prescribed by the contractor.

- ***Other Protective Equipment***—For some drilling operations, environmental conditions may dictate that other protective equipment be used. When drilling is performed in chemical or radiological contamination areas, special protective equipment and clothing will be used as required by the site-specific health and safety controls established.

## 2. Housekeeping On and Around the Drill Rig

The minimum requirements for housekeeping on and around the drill rig are:

- Storing or transporting tools, materials, or supplies within or on the mast (derrick) of the drill rig is prohibited within the project site or area.

- Drill pipe, drill rods, casing, augers, and similar drilling tools shall be properly stacked and secured on racks or sills to prevent spreading, rolling, or sliding.

- Penetration or other driving hammers shall be placed at a safe location on the ground or secured on the rig to prevent movement when not in use.

- Work areas, platforms, walkways, scaffolding, and other access ways shall be kept free of materials, debris, obstructions, and substances such as ice, grease, or oil that could cause a surface to become slick or otherwise hazardous. Walking/working surfaces greater than six feet above a lower level shall be provided with a fall protection system.

- All hand controls, control linkages, and warning and operation lights and lenses shall be kept free of excess oil, grease, ice, or other foreign material that may interfere with safe operation.

- Transportation and storage of flammable liquids shall be in accordance with OSHA, state, and local regulations. Any engine to be refueled shall be shut off and sufficiently cooled before the refueling operation begins and the dispensing and receiving containers shall be electrically bonded.

- Engine exhaust spark arresters are required in areas of fire danger such as grasslands, wooded areas, or when specified in the site-specific health and safety planning documents.

- Storage tanks, including fuel, water (potable and nonpotable), hydraulic oil, etc., shall be labeled and/or placarded to identify contents.

- All oily rags, and other such materials used for maintenance shall be stored in a fire-resistant metal container until properly disposed.

## 3. Equipment Maintenance Safety

The minimum requirements for maintenance safety are:

- Emergency safety (kill) switches shall be checked daily to ensure they are functioning properly.

- Shut down the drill rig and/or auxiliary equipment engine(s) to make repairs or adjustments or to lubricate fittings. (Except adjustments that can only be made with the engine(s) running. In such case, a qualified operator shall remain at the shutdown control station during the maintenance.) Take precautions to prevent accidental starting of an engine during maintenance by removing the ignition key or ignition control(s).

- Block the rig carrier wheels and/or lower the leveling jacks, and set parking brakes before working under a drill rig.

- When possible and appropriate, release all pressure on the hydraulic systems, the drilling fluid circulation system, and the air pressure systems of the drill rig prior to performing maintenance or repairs.

- Welding or cutting on or near a fuel tank is prohibited.

- Replace all caps, filler plugs, protective guards or panels, high pressure hose clamps, and safety chains or cables that have been removed for maintenance before returning the drill rig to service.

- Personnel shall remain clear of all rotating equipment to the maximum extent possible.

- All exposed drive shafts, drive chains and sprockets, drive belts, and similar power transmitting components shall have guards installed if they are exposed to contact by employees.

- All exposed exhaust pipe(s) and/or systems shall be guarded or insulated adequately to protect personnel from burns and prevent fire hazard.

- All high pressure air/water hoses, swivels, and mud line connections shall be secured with safety chains or clamped to prevent whipping in the event of a break or failure.

- Pipelines, tanks, and other storage facilities (for fuel, oil, gas, mud, foamers, etc.) shall be inspected frequently and kept from leaking. Any spills or leaks will be cleaned up immediately.

### 4. Safe Use of Hand Tools

The minimum requirements for safe use of hand tools are:

- When a hand tool becomes damaged, the tool shall either be repaired before further usage or removed from service.

- Hand tools shall be used only for the express purpose for which they were designed.

- Keep all tools cleaned and stored in an orderly, safe manner when not in use.

- Never use pipe wrenches as a substitute for a drill rod holding device.

- Replace pipe wrench hook and heel jaws when they become visibly worn.

- When breaking tool joints manually on a hard surface or on a drilling platform, position hands so that fingers will not be injured between the wrench handle and the hard surface or the platform, should the wrench slip or the joint suddenly release.

## 5. Preparing the Work Site

Prior to drilling, adequate site cleaning and leveling shall be performed to accommodate the drill rig, ancillary equipment, and supplies. Drilling shall not commence until tree limbs, vegetation, unstable ground (caving, slides, loose boulders), or other site obstructions, which may cause unsafe tool handling or potential fire hazards, have been controlled.

## 6. Start Up

The minimum requirements for safety during start up are:

- All drill rig personnel and visitors shall be instructed to stand clear of the drill rig or auxiliary equipment immediately prior to and during starting of an engine.

- Make sure all gear boxes are in neutral, all drawworks clutches and hoist levers are disengaged or in the neutral position, all hydraulic levers are in the correct nonactuating positions, and the cathead rope is not on the cathead spool before starting a drill rig engine.

# 7. Safety During Drilling Operations

The minimum requirements for safety during drilling operations are:

- Before the mast (derrick) of a drill rig is raised and drilling is commenced, the drill rig must be first leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig shall be re-leveled immediately if settling occurs after the initial set-up.

- Before raising or lowering the mast (derrick), the area shall be inspected for potential safety hazards. All unnecessary drill rig personnel and visitors shall be cleared from the areas immediately to the rear, front, and the sides of the mast. Once the mast is raised into position, the mast or derrick locks will be secured. The rig shall not be operated unless mast locks are functional and are locked. Prior to lowering, mast hydraulic system(s) will be checked.

- No personnel, other than the assigned rig crew, shall be allowed on or under an operating rig deck for any reason. No Contractor personnel shall attempt to make any type of inspection of the subcontractor's equipment unless a subcontractor's representative is present during the inspection.

- Before raising the mast (derrick), always check for overhead wires and obstructions. An observer shall be posted at a strategic location to ensure adequate clearance is maintained. See Section 8. "Overhead and Underground Utilities."

- The drill rig shall not be moved from hole to hole with the mast (derrick) in the raised position.

- The operator of a drill rig shall operate a drill rig only from the driller's control station. The operator shall remain within 15 feet of the operating controls at all times when the rig is in operation.

- If it is necessary to drill within an enclosed area, make certain that exhaust gases are conducted out of the area and sufficient ventilation is provided.

- When using a mast or derrick ladder, face the ladder and grasp either the side rails or the rungs with both hands while ascending or descending. The three-point of contact system (2 hands and 1 foot or 2 feet and 1 hand) shall be used when climbing. Always make sure that shoe soles are clean and dry before attempting climbing or descending the mast.

- Anyone working on a derrick board, platform, or mast shall be provided with fall protection in accordance with 29 CFR 1926, subpart M.

- When working on a mast or derrick platform, do not guide drill rods or pipe into racks or other supports by taking hold of a moving hoisting line, traveling block, or other moving hoisting equipment. Rack only one pipe stand at a time. Always stay clear of moving hoisting line, traveling block, elevators, or hoisting plugs.

- Loose tools and similar items shall not be left on the derrick platform or on structural members of the derrick.

- All unattended boreholes must be adequately covered or otherwise protected to prevent people or animals from stepping or falling into the hole.

- Platforms, steps, handholds, and guardrails shall be provided on the equipment to assure safe access and footing. The platform and decks shall be coated with a nonskid surface.

- Personnel shall employ good ergonomic lifting techniques when lifting heavy objects, such as keeping the back straight, keeping weight close to the body, getting help when necessary and using mechanical assist when possible.

- Personnel shall not ride the hoisting line, catline, traveling block, the traveling block hook, the elevators, or suspended equipment as a means of ascending or descending to or from the derrick.

- All rig steps, ladders, stairways, platforms, and walkways shall be free of mud, snow, ice, tools, and other materials that may cause slipping or tripping.

# 8. Overhead and Underground Utilities

Overhead and underground utilities shall be located, noted, and emphasized on all boring location plans. No borehole will be drilled where it can reasonably be anticipated that utilities exist until the exact location to be drilled is surveyed by a qualified utility line locator.

The minimum requirements for overhead and underground utilities are:

- When overhead electrical power lines exist at or near a drilling site or project, personnel shall consider all wires to be energized and dangerous.

- Visually inspect the drill site for sagging power lines before entering the site. Do not lift power lines to gain entrance or exit. Call the responsible utility and ask them to lift or raise the lines or de-energize (turn-off) the power.

- An observer or “spotter” shall be posted at a sufficient distance from the rig to adequately monitor for safe clearance during the raising and lowering of the rig mast when operating in the vicinity of overhead power lines or other overhead obstructions.

- Before raising the drill rig mast (derrick) in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the drill rig to the nearest power line will be when the mast is raised and/or lowered. Do not raise the mast or operate the drill rig if this distance is less than the following:

**NOTE: UNDER NO CIRCUMSTANCES WILL THE FOLLOWING MINIMUM POWER LINE CLEARANCE REQUIREMENTS BE VIOLATED UNLESS THE LINES ARE DE-ENERGIZED, GROUNDED, AND TAGGED OUT BY THE RESPONSIBLE UTILITY COMPANY OR THEIR DESIGNEE.**

When operating near high voltage power lines:

*Table 3−1. Clearance Requirements for Operations*

| Normal Voltage (phase-to-phase) | Minimum Required Clearance |
|---|---|
| 50 kV and less | 10 ft (3.05 m) |
| Over 50 kV, not over 200 kV | 15 ft (4.60 m) |
| Over 200 kV, not over 350 kV | 20 ft (6.10 m) |
| Over 350 kV, not over 500 kV | 25 ft (7.62 m) |
| Over 500 kV, not over 750 kV | 35 ft (10.67 m) |
| Over 750 kV, not over 1000 kV | 45 ft (13.72 m) |

While in transit with no load and boom or mast lowered:

*Table 3−2. Clearance Requirements for Transit*

| Normal Voltage (phase-to-phase) | Minimum Required Clearance |
|---|---|
| 50 kV and less | 4 ft (1.22 m) |
| Over 50, not over 345 kV | 10 ft (3.05 m) |
| Over 345, not over 750 kV | 16 ft (4.87 m) |
| Over 750, not over 1000 kV | 20 ft (6.10 m) |

# 9. Electrical Safety

The minimum requirements for electrical safety are:

- Portable electric tools (except for battery-powered tools) shall be double insulated or three-wire-to plug case-grounded. Low-voltage tools shall be powered from an isolating transformer supplying no more than 50 volts.

- Any person using portable electric tools shall inspect them before each use for external defects and evidence of possible internal damage.

- Plugs and receptacles shall mate properly and provide proper grounding continuity. Adapters with pigtails and adapters that interrupt grounding continuity shall not be used.

- The outdoor use of portable electric tools shall require ground-fault circuit interrupter (GFCI) protection, even if plugged directly into a permanent electrical system.

- GFCI protection shall be provided for single-phase circuits supplying grounded electrical tools. Portable GFCIs shall be used in circumstances where permanent GFCI protection is not provided.

- The user shall test portable GFCIs daily before use by pressing the test button as specified by the GFCI manufacturer.

- All extension cords shall be designed for hard or extra-hard usage in accordance with the *National Electrical Code*, Article 400, Table 400-4. Examples are Types S, ST, SO, STO, SJ, SJO SJT, and SJTO.

- Cords and connectors shall be protected from wet or damp locations when possible, traffic of all kinds, excessive heat, chemicals, and other agents that might cause failure.

- Flexible electric cords connected to equipment shall not be used to raise or lower equipment. Flexible cords shall not be stapled, hung over nails, or otherwise hung in a manner that could damage the outer jacket or insulation.

- Before use, the person using any extension cord shall inspect it visually for external defects and evidence of internal damage. Defective cords shall not be used.

- All electrical wiring and devices shall be installed in accordance with the *National Electrical Code*.

- Only qualified electricians will perform repairs on electrical lines or install electrical devices.

- All lights positioned above the working areas shall be enclosed in cages or similar enclosures to prevent loose or detached lamps or vapor-tight enclosures from falling on workers. All light bulbs shall be heavy-duty, outdoor, and non-shattering type. Illumination of all working surfaces shall be a minimum of 5 foot candles and 10 foot candles on the drilling platform.

- Poles used to hold wiring and lights shall not be used for any other purpose.

## 10. Safe Use of Wire Line Hoists, Wire Rope, and Hoisting Hardware

Any required hoisting operations which are not performed with the drill rig equipment, (e.g., crane operations) shall be conducted in accordance with the *Health and Safety Standards* 2.12 “Hoisting and Rigging.”

The minimum requirements for safe use of wire line hoists, wire rope, and hoisting hardware are:

- All wire ropes and fittings shall be visually inspected in accordance with the manufacturer’s recommendations and applicable OSHA regulations during use and thoroughly inspected at least once a week for abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, improper reeving, jamming, crushing, bird caging, kinking, core protrusion, or damage to lifting hardware. Any discrepancies that create a hazard to employees shall be corrected before operations continue.

- Inspect at the start of each shift all rotating cable attachments, for example, safety hooks, deadman anchors, and hoisting apparatus, for freedom of movement and correct any deficiencies.

- All manufactured cable-end fittings and connections shall be installed according to the manufacturer's instructions and loaded according to the manufacturer's specifications. This includes cable clamps and thimbles. Cable ends should be seized.

- All water swivels and hoisting plugs shall be checked for possible frozen bearings and shall be properly lubricated before use.

- Wire rope size shall be properly matched to sheave groove size.

- Avoid shock loading of wire rope. Apply loads smoothly and steadily.

- Protect wire rope from sharp corners or edges. Avoid pile-up or uneven spooling of wire rope when possible.

- Replace faulty guides and rollers.

- Replace damaged safety latches on safety hooks.

- Know and do not exceed the rated capacity of hooks, rings, links, swivels, hoisting plugs, elevators, shackles, and other lifting aids. Never exceed the manufacturer's rated load capacity for any reason.

- Do not guide wire rope on hoist drums with hands or feet.

- Keep hands and other extremities away from hoists, wire rope, hoisting hooks, sheaves, and pinch points as slack is being taken up and when the load is being hoisted.

- Following the installation of new wire rope, lift a light load first to allow the wire rope to adjust.

- Never leave a load suspended when the hoist is unattended.

- Never hoist the load over personnel.

## 11. Safe Use of Catheads and Rope Hoists

The minimum requirements for safe use of catheads and rope hoists are:

- Never use frozen catline ropes. Keep ropes protected from adverse weather.

- Keep the cathead spool clean and free of rust, oil, and grease.

- Check the cathead periodically, with the engine not running, for rope wear grooves.

- Never wrap the rope from the cathead (or any other rope, wire rope, or cable on the drill rig) around a hand, wrist, arm, foot, ankle, leg, or any other part of the body.

- Do not use a rope that is any longer than necessary. A rope that is too long can form a ground loop or otherwise become entangled with the operators' legs.

- Do not use more rope wraps than are required to hoist a load or than can be safely released.

- Do not leave a cathead unattended with the rope wrapped on the cathead spool when the cathead power is engaged.

- Position all hoist lines to prevent contact with the operating cathead rope.

- The cathead operator must be able to operate the cathead standing on a level surface with firm footing and without distraction or disturbance.

## 12. Safe Use of Augers

If the manufacturer's operating instructions are not available, the following minimal general procedures and safe practices shall be used when starting a boring with continuous flight or hollow-stem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear, and the engine running at low RPM.

- Apply sufficient downward pressure prior to rotation to seat the auger head below the ground surface.

- Observe the auger head while slowly engaging the clutch or rotation control. Stay clear of the auger.

- Slowly rotate the auger and auger head while continuing to apply down pressure. Keep one hand on the clutch or the rotation control at all times until the auger has penetrated one foot or more below ground surface.

- If the auger head slides out of alignment, disengage the clutch or hydraulic rotation control and repeat the hole starting process.

- The use of mismatched auger sections should be avoided. Different brands and different weights shall NOT be used in the same auger flight.

- Only tight-fitting pins designed for the auger shall be used. Some pins lose their temper after very little use and the spring or clip section fails to hold the pin securely.

- An auger guide shall be used to start drilling through hard ground or pavement.

- Use only the manufacturers recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with hands, feet, wrenches, or any tools during rotation.

- Whenever possible, use tool hoists to handle auger sections.

- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of an auger section in the ground or other hard surfaces such as the drill rig platform.

- Never place feet under the auger section that is being hoisted.

- When rotating augers, stay clear of the auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason. A minimum of 18 inches clearance shall be maintained between personnel, clothing, footwear, and other personal apparel and the rotating augers, kellys, heads, drillrod or other rotating components of the drill rig.

- Use a long-handled shovel to move auger cuttings away from the hole, ensuring that the shovel blade does not come in contact with the rotating auger. Never use hands or feet to move cuttings away from the auger while auger is rotating.

- Never attempt to remove cuttings from rotating augers. Augers should be cleaned only when the auger driver is in neutral and rotation of the augers has ceased.

- Auger speed shall be only that speed necessary for penetration and cuttings removal. High speed auger rotation shall not be used for penetration or cuttings removal unless approved by the on-site PDC or line supervisor. In such case, all unnecessary personnel will be removed from the rig operating area.

- Free standing augers shall be secured to prevent accidental falling.

## 13. Safety During Rotary and Core Drilling Operations

The minimum requirements for safety during rotary and core drilling operations are:

- Water swivels, and hoisting plugs shall be lubricated and checked for frozen bearings before use. A swivel guide cable and anchor chain shall be used to prevent swivel hose whip in case of swivel failure.

- Pressure relief valves shall be installed and operable on all circulation systems and the discharge located to prevent personal injuries. Protective covers shall be installed on shear-type relief valves.

- Direct-reading pressure gauges shall be installed on all air drilling fluid delivery lines. Gauges shall be operable at all times and must represent the true pressure of the medium being transported in the line(s). This shall include all ancillary equipment, for example, grout mixers, auxiliary circulation pumps, and other such equipment.

- Drill rod chuck jaws shall be checked periodically and replaced when necessary.

- A string of drill rods shall NOT be braked, during lowering into the hole, by the chuck jaws. A catline or hoisting cable and plug should be used for braking prior to tightening of the chuck. Failure to follow this procedure will result in steel slivers on the rods, possible hand injuries, and loss of the rods down the hole.

- Drill rods or drill pipe shall not be held or lowered into the hole with pipe wrenches. Use slips, clamps, spiders, or other suitable holding devices.

- In the event of a plugged bit or other circulation (fluid or air) blockage, the pressure in the piping and hose(s) between the pump, or air compressor, and the obstruction shall be relieved or bled down before breaking the first tool joint. Line pressure shall be relieved prior to breaking any tool joint connection.

- When drill rods or drill pipe are hoisted from the borehole, they shall be cleaned for safe handling with a rubber pipe wiper or other suitable apparatus. Do not use hands to clean or strip drilling fluids from downhole tools as they are being hoisted.

- If work must progress over a portable drilling mud pit, do not attempt to stand on narrow sides or cross members. The mud pit shall be equipped with rough surfaced, fitted cover panels of adequate strength to support the combined weight of drill rig personnel and where required shall be equipped with guard rails.

- Drill rods and drill pipe shall not be lifted and leaned unsecured against the mast. A suitable method shall be provided for securing the upper ends of the drill rod or drill pipe sections for safe vertical storage or they must be laid down. Only personnel necessary to perform hoisting or tripping operations shall be on the rig during these operations.

- Remain well clear of moving rotary tables, kellys, drill rods, pull-down chains, drive lines, drive chains, and other rotating components at all times.

- When air rotary or air coring operations are in progress, all discharges, for example dust, cuttings, and fluids shall be contained. All shrouds, curtains, diverter head(s), cyclone separator(s), blooie line(s), and other necessary containment equipment will be used at all times. Any variance from these requirements must be approved in writing by the Contractor before implementation.

- All rig air-delivery systems used in environmental drilling applications will be equipped with oil-separating, 10 micron in-line filter(s) to remove oil that might be discharged into the air stream by the compressor(s). These filters shall be inspected daily and serviced as applicable.

## 14. Movement of Drilling Equipment and/or Components

The minimum requirements for safety during movement of drilling equipment and/or components are:

- Prior to moving drill equipment, a thorough inspection shall be made to ensure that the mast, drill rods, tools, and other supplies and equipment are secured to prevent displacement while in transit. Applicable traffic laws shall be observed in moving drill equipment over public roads. A check shall be made of steering mechanism, brakes, lights, load limits, and proper flagging or lighting of load extensions.

- Before off-road movement of a drill rig, visually survey the route of travel, inspecting the proposed route for unstable road beds and bridges, depressions, stumps, gullies, ruts, and similar obstacles which might impede safe movement of the equipment.

- Use caution when traveling on slopes. Conservatively evaluate side hill capability of drill rigs, as the arbitrary addition of drilling tools may raise the center of gravity. When possible, travel directly uphill or downhill.

## 15. Hazardous Materials and Waste

The minimum requirements for hazardous materials and waste are:

- The subcontractor shall provide material safety data sheets (MSDSs) for all hazardous chemicals used in the drilling operation(s) as per 29 CFR 1910.1200.

- Personnel must be trained in accordance with 29 CFR 1910.1200 for handling any such hazardous chemicals as well as any site-specific requirements pertinent to the particular task being undertaken.

- Chemicals shall be properly labeled, placarded, and stored.

- Any waste generated by drilling operations shall be handled as per site-specific project requirements.

- All cuttings, dust, fluids, and other waste generated by drilling activities must be contained and disposed of per site-specific project requirements.

- All spills and leaks, including but not limited to oils, fuels, grease, motor coolants, drilling additives, or other potentially hazardous wastes will be cleaned up immediately and properly disposed. The cause of such spills or leaks shall be determined and appropriate corrective action taken before drilling is resumed. Such events will be reported by the subcontractor to the Contractor.

# Appendix A

# Statement of Understanding

Drilling Health and Safety Requirements

## STATEMENT OF UNDERSTANDING

I, the undersigned have read and understand the *Drilling Health and Safety Requirements*

| | Name (Please Print) | Signature | Date | Position |
|---|---|---|---|---|
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# Appendix B

# Equipment Safety Inspection Checklist for Small Auger, Rotary, and Core Rigs

# Equipment Safety Inspection Checklist for Small Auger, Rotary, and Core Rigs

Contractor: _____ Rig Type: _____ Rig Number: _____ Date: ___/___/___

Safety Inspector: _____ Project: _____

**(Y) If OK** **(-) Not Applicable** **(X) If Correction Required**

**I. Rig Carrier**
( ) Overall Appearance
( ) Oil Leaks
( ) Fuel
( ) Fire Extinguishers (2)
( ) Back-up Alarm
( ) Exhaust System
( ) Wheel Chocks
( ) Outrigger Jacks
( ) Fuel Tank Placard(s)
( ) Portable fuel containers
( ) Other: _____

**II. Mast**
( ) Crown Block
( ) Hinge Pins
( ) Lock Pins/Devices
( ) Lights/Wiring
( ) Safety Climbing Device
( ) Safety Belts/Harness
( ) Racking Board
( ) Ladders
( ) Guy Wires/Fasteners
( ) Deadman Anchors
( ) Standpipe
( ) Swivel Hose
( ) Safety Chains/Clamps
( ) Mast Rams/Cylinders
( ) Other: _____
( ) Other: _____

**III. Rig Engine(s)**
( ) Fuels Tank(s)
( ) Exhaust System
( ) Electrical System
( ) Belt/Drive Line Guards
( ) Emergency Shut-down System(s)
( ) Heat Shields
( ) Fluid Leaks
( ) Gauges
( ) Clutches
( ) Other: _____

**VIII. Hoisting Equipment**
( ) Hoisting Plug(s)
( ) Lifting Iron(s)
( ) Elevators
( ) Weight Indicator
( ) Safety Hook(s)
( ) Spider(s)
( ) Slips
( ) Foot Clamps
( ) Other : _____
( ) Other : _____
( ) Other : _____

**IX. Downhole Equipment**
( ) Drill pipe
( ) Drill collars
( ) Core Rod
( ) Core Barrel(s)
( ) Augers
( ) Samplers
( ) Other : _____

**X. Safety Equipment**
( ) Placards/Warning Signs
( ) Applicable OSHA Postings
( ) First Aid Kit(s)
( ) Applicable Regulation Posting
( ) Emergency Medical Posting(s)
( ) Emergency Procedures
( ) Other : _____

**XI. Personal Protective Equipment**
( ) Hard Hats
( ) Safety Glasses
( ) Safety Boots/Shoes
( ) Other : _____

**XII. Other Items**
( ) _____
( ) _____
( ) _____

Comments: _____

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# Appendix B
# Stoller's Radioactive Materials License Application, SOP-RAD-024

Document No: SOP-RAD-024, Rev.1

Title: Groundwater Sampling

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Approved: _____ Date _____
Stoller Health and Safety Manager/
Radiation Safety Officer

Approved: _____ Date _____
Stoller Quality Assurance

Approved: _____ Date _____
Stoller Project Director and
Alternate Radiation Safety Officer

| Revision Number | Date |
|---|---|
| | |
| 0 | 1/17/05 |
| 1 | 10/11/05 |
| | |
| | |

**UNCONTROLLED WHEN PRINTED**

# 1. Purpose

This procedure describes actions to be used to sample groundwater from monitoring wells and piezometers. Monitoring wells are generally sampled on a semiannual, quarterly, or monthly basis, or by special request in support for specific projects. All wells are to be sampled using this procedure unless superseded by specific site, facility, or client procedures.

This procedure describes equipment decontamination and transport, site preparation, detection and sampling of immiscible layers, water level measurements, well purging, sample collection, field and analytical parameters, quality assurance/quality control (QA/QC) requirements, and documentation that shall be used for field data collection.

# 2. Scope

This document describes acceptable methods for the sampling of wells and piezometers.

# 3. Responsibilities and Qualifications

Personnel performing groundwater sampling procedures are required to have completed the initial 40-hour OSHA classroom training that meets the Department of Labor requirements at 29 CFR 1910.120(e)(3)(i), and must maintain a current training status by completing the appropriate annual 8-hour OSHA refresher courses. Personnel must also have read the appropriate project, site, or facility Health and Safety Plan(s). Prior to engaging in groundwater sampling activities, personnel must have a complete understanding of the procedures described within this procedure and, if necessary, will be given specific training regarding these procedures by other personnel experienced in the methods described within this procedure.

# 4. Groundwater Sampling Procedures

## 4.1 Introduction

Many monitoring wells are constructed of either 2-inch stainless steel, or 2- or 4-inch flush threaded PVC casing. Some piezometers are completed as monitoring wells, and they are usually constructed of ¾-inch inside diameter, flush threaded PVC casing. Some wells have been constructed to incorporate a sump below the well screen. Because these vary in length, the well construction diagrams should be consulted to determine the sump lengths for specific wells. Most piezometers are constructed with a flush threaded cap at the bottom of the well screen. However, the well construction diagrams should also be consulted for information about specific piezometers.

Procedures for groundwater sampling are designed to obtain a sample that is representative of the formation water beneath the site in question. Since an analysis of the quality of formation water is desired, standing water within the well must be purged before sampling. Also, a measure of the static water elevations is important to determine the effect of seasonal horizontal and vertical flow gradient changes during site characterization activities.

Groundwater sampling procedures can be initiated after sampling personnel take the required water level measurements and purge the well in accordance with this procedure. Methods for accomplishing each of these activities are included in this procedure and should be performed in the following sequence:

- Collection of immiscible layers samples, if present
- Well purging
- Groundwater sampling using a bailer

- Groundwater sampling using a peristaltic pump
- Groundwater sampling with a bladder pump

## 4.2 General Equipment Requirements

Down-hole sampling equipment shall be constructed of inert material such as polytetrafluoroethylene (Teflon®) or stainless steel. This equipment shall be assessed on an individual basis prior to use in the field.

The following is a primary list of well sampling and associated equipment:

- Bailers – Teflon®, stainless steel, or other appropriate inert materials
- Teflon® coated stainless steel cable with reels
- Peristaltic pumps and tubing
- Water level measuring devices – sufficiently accurate to measure water levels to the nearest 0.01 foot
- Graduated purge water containers
- Plastic sheeting
- Distilled or deionized water
- Decontamination equipment and supplies
- Organic vapor detector (OVD)
- Gloves (nitrile)
- Calculator and watch
- Sample containers precleaned to EPA specifications
- pH paper
- Custody tape
- Coolers with sufficient blue ice to cool samples to 4°C
- Preservatives (trace metals grade)
- Disposable in-line 0.45-micron membrane filters
- Logbooks and field forms
- Black waterproof pens
- Portable laboratory equipment for measuring field parameters for pH, temperature, specific conductance, and turbidity
- Total alkalinity reagent
- Beakers and graduated cylinders

Additional equipment may be required to meet project or client health and safety standards, to perform specialized sampling, or to meet personnel and equipment decontamination requirements.

## 4.3 Equipment Decontamination and Transport

Equipment associated with the tasks involved in groundwater sampling shall be decontaminated upon arrival at the sampling location. All sampling equipment shall be decontaminated between

sample locations. Decontamination frequency shall be increased appropriately as field conditions dictate.

Transportation of all equipment shall be performed in a manner that eliminates any possibility of cross-contamination. Calibration solutions, fuel, decontamination solutions and wastewater, and all other sources of contamination shall be segregated from sampling equipment during transport. Purge water being transported to holding areas shall be kept in closed containers.

If the decontamination of downhole equipment is not performed at the well, used downhole equipment shall be wrapped in plastic sheeting and/or segregated from clean equipment to eliminate the possibility of cross contamination. The equipment shall then be decontaminated as soon as possible.

### 4.3.1 Routine Field Decontamination

Decontamination of delicate equipment and the routine decontamination of sampling equipment prior to use at each well shall consist of the following steps:

- Vigorously scrub the equipment with a brush and solution of phosphate-free laboratory grade detergent (e.g., Liquinox) and distilled water.
- Rinse the equipment thoroughly with approved distilled water.
- If the decontaminated equipment is not immediately packaged to eliminate any adhesion of airborne impurities, perform an additional final rinse, or decontamination and rinse, immediately prior to actual sampling operations.
- Conduct a survey of field equipment prior to removing equipment from the work site.

### 4.3.2 Routine Decontamination of Sampling Pumps

The external surfaces of all non-dedicated pumping equipment shall be decontaminated as described in Subsection 4.3.1. Internal surfaces shall be decontaminated according to the following procedures, except under special situations where the pump(s) must be disassembled and the internal parts cleaned separately (see Subsection 4.3.3). For routine decontamination, the following procedures shall be followed.

- Pump several pump volumes of a solution of a phosphate-free laboratory grade detergent (e.g., Liquinox) and water through the equipment.
- Displace the soap solution immediately by pumping approved distilled water, equivalent to three or more volumes of the pump storage capacity, through the equipment.
- If any detergent solution remains in the pump, continue pumping distilled water through the system until the detergent is no longer visibly present. Sudsing is the common indicator used to determine incomplete rinsing.
- Conduct a survey of field equipment prior to removing equipment from the work site.

### 4.3.3 Unusual Decontamination Requirements

When equipment becomes grossly contaminated, such as from the collection of immiscible layer samples (see Subsection 4.5), routine decontamination of sampling equipment is not considered sufficient and thus is not allowed. This situation and other unusual equipment decontamination problems shall be reported to the field site supervisor. Under certain circumstances, a pump can be disassembled and the parts cleaned separately using approved solvents (i.e., hexane, alcohol, etc.). If specific instructions are required, the field site supervisor shall consult with a management representative for proper decontamination procedures.

### 4.3.4 Disposition of Decontamination Water

All water generated during the decontamination of equipment used for the sampling of wells shall be containerized in either a satellite container or in the purge water container in the groundwater sampling vehicle. It will then be disposed of according to the procedure designated in Subsection 4.6.3 of this procedure.

## 4.4 Site Preparation

Sheet plastic may be used to protect clean equipment from contacting contaminated surfaces. Plastic bags and sheeting, along with the segregation of clean and dirty equipment, can be used to reduce the chances of cross contamination. If a mechanical bailer retrieval system is used, the amount of plastic appropriate for protection of sampling equipment may be lessened. The sampling crew members are responsible for determining the amount of plastic sheeting required.

Disposable nitrile gloves, or gloves made of other approved materials, shall be used at all times when handling sampling equipment. Gloves shall be changed between each site and as often as necessary to ensure the integrity of clean sampling equipment.

## 4.5 Collection of Immiscible Layer Samples

When specified in the project sampling plan, or when the well to be sampled contains immiscible layers, immiscible phases must be collected before purging activities begin. The method of choice for collecting light non-aqueous phase liquids (LNAPLS) is a bottom valve bailer or peristaltic pump. Dense non-aqueous phase liquids (DNAPL) or "sinkers" shall be collected with a bottom double check valve bailer or peristaltic pump. Immiscible layers will be visible in most transparent or translucent bailers.

In all cases, the bailer shall be carefully lowered into the well so that agitation of the immiscible layer is minimal. Any bailer used to collect immiscible layers shall be dedicated to the well that is sampled. Peristaltic pumps shall be equipped entirely with silicon, or other chemical compatible tubing, when sampling immiscible layers. The project manager shall be responsible for determining the type materials to be used for specific projects. Dedicated equipment used for collecting immiscible layers shall be decontaminated prior to and after use as described in Subsection 4.3 of this procedure, if removed from the well.

Immiscible layer sampling shall be performed as follows.

- Remove dedicated bailers from the well and decontaminate as specified in Subsection 4.3 of this procedure. Decontaminate dedicated pump tubing, if used, prior to use.
- For LNAPLs, carefully lower the bailer intake or sampling port to the midpoint of the immiscible layer and allow it to fill while it is held at this level. The bailer must be lowered into the immiscible layer slowly so that minimal agitation of the immiscible layer occurs. Peristaltic pump intakes must also be lowered to the estimated midpoint of the immiscible layer based on previous sampling events.
- If a DNAPL layer is being sampled, use either the double check valve bailer or peristaltic pump. Lower the bailer into the well until bottom is encountered. Lower peristaltic pump intakes also to the well bottom. Care must be taken not to immerse the pump intake into accumulated sediments.
- Do not allow the bailer or line to touch the ground at any time or allow the ground to come in contact with other physical objects that might introduce contaminants into the well.
- Decontaminate all equipment immediately after sampling is completed. Suspend dedicated bailers in the well from the well cap above the high water level. Discard silicon tubing used with peristaltic pumps.

## 4.6 Well Purging

Purging stagnant water from a well is required so that the collected sample is representative of the formation groundwater. The device used (bailer or pump) depends upon aquifer properties, individual well construction, and data quality objectives. Wells that contain immiscible layers will not be purged unless specified in the site-specific work plan. Any well scheduled for purging and sampling that subsequently is found to contain immiscible layers must be reported to the site supervisor or project manager. The project manager shall be notified immediately prior to continued activities.

Before obtaining water level elevations or initiating purge activities, obtain the following information in reference to the well to be sampled, and enter the applicable information on the sample collection log.

- Location code (well number)
- Previous purge volume (information only)
- Depth to top of screen (bailed wells only)
- Well sample number
- Applicable sample numbers

Record the location code (well number), date, sampling team members, visitors, well condition, and any other pertinent information on the sample collection log. Enter the well number, time well is opened, and other information regarding the field activities on the Field Activity Daily Log.

The field instruments shall be standardized (to check calibration) and the results recorded on the sample collection form.

Measure the depth to the top of the water column and the total depth of the well in order to determine the height of the water column in the well. Calculate the well casing volume using the well casing inner diameter and the height of the water column in the well. The formula for calculating the volume in gallons of water in the well casing is as follows:

$(\pi r^2 h)\ 7.481$ = gallons; where

$\pi = 3.142$

r = inside radius of the well pipe in feet

h = linear feet of water in well

7.481 = gallons per cubic foot of water

1 gallon = 3785 ml

Calculations of the volume of water in typical well casings may be done as follows:

a. 2" diameter well:

0.16 gal./ft x (linear ft of water) = gallons of water

b. 4" diameter well:

0.65 gal./ft x (linear ft of water) = gallons of water

c. 3/4" diameter well:

87 ml./ft x (linear ft of water) = milliliters of water

4.6.1 Purging Duration

Purging shall be considered complete if any of the following conditions are met.

1. Purging is complete if at least three casing volumes of water are removed from the well, and the last three consecutive pH, specific conductance, and temperature measurements do not deviate by more than the following: 1) pH = ±0.1 pH units; 2) Specific Conductance = ±10% and; 3) temperature ±0.5°C. A turbidity measurement will be taken for every other purge sample for wells that are purged using a bailer. For wells that are equipped with a dedicated bladder pump, the turbidity will be measured each time the parameters are taken. The purge rate should be such that the turbidity is maintained at 5 NTU units or less (if possible). If the readings are not stabilized after three volumes, continue purging until stabilization or until five volumes have been removed. Field parameter measurements shall be collected after every half-casing volume (approximate) is removed from the well. When casing volumes are less than 1-liter, parameter measurements will be collected after each whole casing volume is removed. If readings do not stabilize after five well volumes have been recovered, obtain additional guidance from the project manager concerning the proper course of action.

2. A well is considered dewatered when only a few milliliters of water (or none) can be recovered each time the bailer is lowered into the well. When this occurs, a 10-minute recharge rate will be calculated (linearly). If, at the end of the 10-minute period, the well has not recovered sufficiently to continue the purge in thirty minutes, the purge is considered completed. If, at the end of the 10-minute period, there is sufficient water to collect the VOA samples, the samples may be collected at that time. If the well has not recovered sufficient water during the 10 minutes, and depending upon the well history, the samplers may elect to return to the well the same day (preferably within two hours), check the water level, and collect the VOA samples (first), and other samples as feasible. If the sample team cannot return the same day, the well will be checked in 24 hours to determine if sample collection is feasible. If an extended period of time is required to collect samples, the procedures in Subsection 4.8.1 shall be followed. The well will not require an additional purge before sampling.

Wells that dewater (have a slow recharge rate as specified in 2 above) will not be restricted by parameter stabilization requirements. Sampling of these wells will follow the protocol established in Subsection 4.8.

4.6.2 Purging Methods

Wells will be purged by either bailing or pumping. When purging a well, the rate of water withdrawal during purging should not exceed the rate of withdrawal at which the well was developed (if known). All purge times (initiation and completion) and the rate of purging will be recorded on the field log sheets.

4.6.2.1 Bailing

Generalized procedures for purging a well with a bailer are as follows.

- Prepare the sampling site as discussed in Subsection 4.4. Use properly decontaminated equipment to determine the static water level of the well. Measure the total depth of the well. Use this information to determine the volume of water in the well casing.
- Decontaminate all dedicated bailers prior to initiating purging as described in Subsection 4.3 of this procedure.
- Use a mechanical reel equipped with Teflon® coated stainless steel cable attached to a bailer for bailing and sampling operations. Lower the bailer slowly into the well until

water is encountered. Minimize agitation of the well water. Avoid lowering the bailer to the bottom of the well so sediments accumulated in the bottom do not become suspended. For wells that dewater, do not allow the bailer to strike the well bottom with force. Raise and lower the bailer carefully to limit surge energy and ensure that cable does not come in contact with any potentially contaminated surfaces. Do not allow the cable to drag along the well casing or against other objects that will cause fraying. Monitor the amount of water purged.

Wells with significant levels of contamination may have dedicated bailers installed. Dedicated bailer systems shall consist of a Teflon® bailer with check valve or double check valve for DNAPLS and a 5-foot leader of Teflon® coated stainless steel cable. Bailer sampling attachments and the stainless steel reel cable will not be dedicated to individual wells.

Dedicated bailers will be decontaminated at the conclusion of sampling activities and suspended from the well cap above the high water table. If the well interval above the high water table is not adequate to allow for storage in the casing, the dedicated bailers will be stored in labeled and sealed plastic bags at the equipment trailer.

#### 4.6.2.2 Pumping

Pump designs that meet the following criteria are allowed for purging.

- The pump is constructed of a material that does not introduce a source of contamination to the well.
- The pump drive system does not introduce a source of contamination into the well.
- All downhole parts to the pump can be easily decontaminated.
- A return check system that does not allow pumped water to return to the well is integral in the pump design.
- The pump is easily used and does not require excessive amounts of time to install, use, remove, and decontaminate.

The pumps currently in use to purge groundwater include peristaltic pumps and dedicated submersible bladder pumps. A procedure for the use of each style of pump is specific to its applications. User manuals, which accompany each pump, shall be referenced for operating procedures.

Basic operating procedures common to all pumps are as follows.

- Prepare the sampling site as described in Subsection 4.4 regardless of the type of pump being used.
- Use properly decontaminated equipment to determine the static water level and the total depth of the well. This information is utilized to determine the volume of water in the well casing.
- For wells with dedicated pumps, calculate the minimum purge volume using the pump storage volume and the volume of the discharge tubing. A total depth of a 2-inch well cannot be taken without the removal of the pump.
- Position a dedicated pump near the bottom of the well or according to the information on the well construction form. Monitor the discharge rates and the amount of water purged during purging. The pumping rate for purging can be higher than the pumping rate for sampling, however, the water level in the well should be monitored during purging to avoid excessive water level drawdown.

- Ensure that any tubing that enters the well casing is composed of inert material. Disposable silicon tubing will be used in the drive mechanism of peristaltic pumps and discarded after each well is purged. The air supply for all air-driven pumps (dedicated bladder pumps) will be free of oil (i.e., no hydrocarbon containing substances will be added to the compressor).

#### 4.6.3 Disposition of Purge Water

All water removed from a well during sampling operations shall be collected either in a satellite container or the purge water collection container in the groundwater sampling vehicle. The water from these containers will then be transferred to another approved collection container on the sampling or project site. When the collection container is filled, or is near capacity, it will be transported for disposition or treatment in accordance with approved project plans.

## 4.7 Measurement of Field Parameters

The following field parameters will be measured during groundwater purging operations unless otherwise specified by the project manager or the approved project work plans.

| Parameter | Relative Precision | Minimum Calibration |
|---|---|---|
| pH | 0.01 pH units | Daily |
| Conductivity | 10 $\mu$S/cm | Daily |
| Temperature | 0.1 °C | Weekly |
| Total Alkalinity (unfiltered) | 1 mg/l | None |
| Turbidity (photometric) | 2 FTU (or NTU) | Specified purge samples (bailed wells)<br>Daily (dedicated bladder pump wells) |

Use manufacturer's operating procedures for instrument operation and calibration.

The measuring equipment shall be stored and handled in a manner that will maintain the integrity of the equipment. Appropriate field manuals will accompany each instrument in the field. Each instrument will also be given an identification number. All logbook and field form references to individual instruments will refer to this number for ease of identification.

Field parameters will be measured and documented in the field form at the following intervals.

- Conductivity, pH, temperature, and turbidity shall be measured from the first water removed from the well when initiating well purging procedures. For bailed wells, the initial bail of water will be carefully removed from the well and the water transferred to a sample beaker by decanting the bailer through a bottom control valve. For wells purged with a peristaltic pump, similarly collect the first water removed in a sample beaker and then measure parameters. For wells with dedicated pumps, measure the parameters of the first recovered water that is collected in the continuous sampler.
- During purging operations, conductivity, pH, and temperature shall be measured for every half-casing volume (one half of the initial casing volume as calculated on the sample collection log form) of water removed from the well (because of the accuracy of the graduated containers for the purge water, the purge volume will be estimated as close as feasible). For wells that have half volumes less than the volume of a sample bailer (approximately 1 liter), only measure parameters after each full casing volume of water is removed from the well. Turbidity will be measured on every other sample recovered for parameters for bailed wells, or wells purged with a peristaltic pump. All parameters, including turbidity, will be measured at predetermined intervals while purging wells with dedicated pumps.

- During purging, if a well is dewatered prior to the measurement of the final required set of parameters, then conductivity, pH, temperature, and turbidity shall be measured immediately before the start of sample collection. These parameters may be delayed until sampling is completed if, at the discretion of the sampling crew, the well recharge has provided insufficient water volume to collect all the samples and also measure parameters. If there is insufficient water for samples and field parameters, the parameters will not be measured.
- Total alkalinity measurements shall be collected only once upon completion of purging. For wells that do not dewater and sample collection proceeds to completion immediately after purging, alkalinity will be measured after the completion of all other final purge field parameters. Wells that dewater and require repeated visits for the collection of samples would have alkalinity measured subsequent to the collection of the sample for inorganic water chemistry. Alkalinity will not be measured if sufficient water is not available.
- Whenever a method used to remove well water is changed, a set of field parameters shall be recorded from water removed with the new method.

## 4.8 Groundwater Sampling

Techniques used to withdraw groundwater samples from a well shall be based on consideration of the parameters of interest. The order of collection, collection techniques, choice of sample containers, preservatives, and equipment are all critical to ensuring that samples are not altered or contaminated. The preferred methods for collection of groundwater samples are either bailing and/or the use of bladder pumps. Table 1 presents sample containers and preservatives for groundwater samples for many common analytical parameters.

Sites shall be prepared prior to sampling as described in Subsection 4.4. All necessary and appropriate information will be recorded on the sample collection log and on the Field Activity Daily Log.

### 4.8.1 Sample Collection

The following discussion involves collection of groundwater samples using bailers and peristaltic or bladder pumps. Regardless of the collection method, care shall be taken not to alter the chemical nature of the sample during the collection activity by agitating the sample or allowing prolonged contact with the atmosphere. To minimize the potential for altering the sample and to maximize the available water, the following sample collection sequence is preferred.

- Radiation Screening
- VOC
- Nitrate/Nitrite, as N
- Dissolved Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- 239/240 Plutonium, 241 Americium
- 233/234U, 235U, 238U
- Gross alpha and beta
- 89/Strontium
- 137Cesium

- 226,228Radium
- Tritium
- Total Metals – TAL, with Cs, Li, Sr, Sn, Mo, Si
- TDS, CL, F, SO4, CO3, HCO3
- TSS
- BNA
- Pesticides/PCB
- Cyanide
- Orthophosphate

VOC samples shall be collected first and as soon as possible after the well has been purged. If a well is purged using a peristaltic pump, then all other samples shall be collected prior to removing the pump from the well. The VOC sample will then be collected using a bailer.

For wells that dewater, if a sufficient volume of water for VOC sample collection has still not accumulated within 48 hours after the completion of purging, VOCs will not be collected for that well. Other samples may be collected using a maximum of five attempts to recover sufficient sample water for analysis. This procedure is discussed in the following paragraph.

The containers used for sample collection from poor producing wells may differ from those used for high yield wells in some instances due to constraints on obtaining enough sample to fill sample containers. In some instances smaller containers may be utilized, or analyte samples normally collected in separate containers may be combined into a single container. Well histories can be used to identify which wells may require a modified sample suite and an extended sampling period. These wells will initially be sampled for a period of 48 hours after the completion of purging, with the exception of VOC sample collection, which is discussed in the previous paragraphs. The completion of purging will be considered 0 hour. At the end of 48 hours, any partial sample will be measured. The accumulated sample will be compared to the minimum volume requirement identified in Table 1 and the allowed sample holding time. If the minimum volume requirement for the target analyte has not been achieved, then sampling may continue as determined from the well recharge history. All analyte samples that have only minimum sample volumes collected and all uncollected samples will be documented on the sample collection log.

**Table 1**
**Sample Containers and Preservatives for Groundwater Samples**

| Parameter | Minimum Container[1] | Preservative | Holding Time |
|---|---|---|---|
| Radiation Screen | 120 ml poly | None | NA |
| VOC - CLP | 3 – 40 ml amber glass | Cool to 4° C | 4 Days |
| BNA | 1 L amber glass | Cool to 4° C | 7 Days |
| Pesticides/PCB | 1 L amber glass | Cool to 4° C | 7 Days |
| TSS | 125 ml poly | Cool to 4° C | 7 Days |
| TDS, Cl, F, $SO_4$, $CO_3$, $HCO_3$ | 1 L poly | Cool to 4° C | 7 Days |
| Dissolved Metals - CLP, | 1 L poly | *Filtered, $HNO_3$ to pH <2, Cool to 4° C | 6 Months |

**Table 1**
**Sample Containers and Preservatives for Groundwater Samples**

| Parameter | Minimum Container[1] | Preservative | Holding Time |
|---|---|---|---|
| with Cs, Li, Sr, Sn, Mo, Si | | | |
| TOC | 125 ml poly | $H_2SO_4$ < pH2, Cool to 4° C | 28 Days |
| COD | 125 ml poly | $H_2SO_4$ < pH2, Cool to 4° C | 28 Days |
| Total Metals - CLP with Cs, Li, Sr, Sn, Mo, Si | 1 L poly | Unfiltered, $HNO_3$ to pH <2, Cool to 4° C | 6 Months |
| Orthophosphate | 250 ml poly | Filtered, Cool to 4° C | 2 Days |
| Nitrate / Nitrite as N | 250 ml poly | $H_2SO_4$ to pH <2, Cool to 4° C | 28 Days |
| Cyanide | 1 L poly | NaOH to pH >12, Cool to 4° C | 14 Days |
| Gross Alpha / Beta | 550 ml poly | $HNO_3$ to pH <2 | 6 Months |
| $^{233/234}U$, $^{235}U$, $^{238}U$ | 100 ml poly | Filtered, $HNO_3$ to pH <2 | 6 Months |
| $^{239/240}Pu$ | 1 L poly | $HNO_3$ to pH <2 | 6 Months |
| $^{241}Am$ | 1 L poly | $HNO_3$ to pH <2 | 6 Months |
| $^{89/90}Sr$ | 700 ml poly | Filtered, $HNO_3$ to pH <2 | 6 Months |
| $^{226/228}Ra$ | 750 ml poly | Filtered, $HNO_3$ to pH <2 | 6 Months |
| $^{137}Cs$ | 2.5 L poly | Filtered, $HNO_3$ to pH <2 | 6 Months |

[1] The volume listed is the minimum amount required for analysis. Actual sample volumes may be slightly higher and some parameters may be combined in a single container.
* Some samples may not require filtering if taken from a well with a dedicated pump and turbidity of 5 NTU or less.

The order of sample collection may be changed at the discretion of the sampling team. Changes in the order shall be based on the predicted volume of water that will be recovered and the priority stated in the controlling document. The sampling team shall document their sample selections on the sample collection log.

Sample containers shall be stored away from sunlight and cooled to 4ºC prior to filling. Immediately after collection, samples requiring cooling shall be cooled to 4ºC. A chilled cooler shall be used as the storage container. Whenever a sample bottle that requires chilling is not being physically handled, it will be placed in the cooler to prevent heating or freezing, exposure to sunlight, and possible breakage.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve or directly from the pump discharge line on wells equipped with bladder pumps. The procedures for collecting VOC samples are discussed in Subsections 4.8.1.1 and 4.8.1.2 of this procedure.

VOC vials shall never be filled and stored below capacity because of insufficient quantities of water in the well. Except for the VOC vials, adequate air space should be left in the sample bottles to allow for expansion.

Samples shall be placed in the appropriate containers and packed with ice in coolers as soon as practical. VOC samples will be stored in the cooler in an inverted position immediately after collection. When sampling is complete, the well cap shall be replaced and locked.

Sampling tools, instruments, and equipment shall be protected from sources of contamination before use and decontaminated after use as specified in Subsection 4.3. Liquids from

decontamination operations will be handled in accordance with the procedures in Subsection 4.6.3 of this procedure. Sample containers shall also be protected from sources of contamination. Sampling personnel shall wear chemical-resistant gloves (e.g., nitrile) when handling samples, and the gloves will be disposed of between well sites.

4.8.1.1 Groundwater Sampling Using a Bailer

This subsection describes the use of a bailer for collecting groundwater samples that may be used to obtain physical, chemical, or radiological data.

A bailer attached to a Teflon® coated stainless steel cable is carefully lowered into the well. After filling within the well, the bailer is withdrawn by rewinding the bailer line, and the bailer contents are drained into the appropriate containers. Certain recommendations and/or constraints should be observed when using bailers for sampling groundwater monitoring wells, as follows.

- Use only bottom-filling Teflon® bailers or bailers made of other inert materials.
- Ensure that bailers are attached to a Teflon® coated stainless steel line that is pre-wound on a reel.
- Do not use bailers constructed with adhesive joints.
- Lower the bailer slowly to the interval from which the sample is to be collected.

VOC samples shall be collected using a bailer equipped with a bottom-decanting control valve. The first water through the valve assembly will be discarded into the purge water container. Vials will be filled by dispensing water through the control valve along the inside edge of the slightly tilted sample vial. Care shall be taken to eliminate aeration of the sample water. The vials will be filled beyond capacity so the resulting meniscus will produce an airtight seal when capped. The capped vial will be checked for trapped air by lightly tapping the vial in an inverted position. If air becomes trapped in the vial, the sample water shall be discarded, and the vial refilled. If two consecutive attempts to fill a VOC vial result in trapped air bubbles, the vial shall be discarded.

The remainder of the sampling water shall be collected in a stainless steel container from which the remaining sample bottles will be filled. Samples requiring filtration shall be filtered and then containerized.

4.8.1.2 Groundwater Sampling Using a Peristaltic Pump

Use of peristaltic pumps shall generally be limited to collecting sample aliquots for radionuclides, metals, and other species that are not subject to volatilization and degassing. Peristaltic pumps shall never be used to collect VOCs or other volatile species in routine wells, although such samples may be collected for special screening applications. All downhole tubing shall be Teflon® except in areas of special concern (e.g., where immiscible layers exist) where special tubing, such as stainless steel or Viton®, may be required. If so, the project manager will make this determination. Only the portion of tubing that is inserted into the mechanical drive shall be made of silicon. This drive portion of the tubing shall be discarded after each use.

4.8.1.3 Groundwater Sampling Using a Downhole Bladder Pump

Some wells are equipped with dedicated downhole bladder pumps for purging and sampling. These are wells that will normally produce an adequate amount of water during a single visit to complete the required sampling suite. The equipment required to purge and sample a well consists of a pump control unit, a portable air compressor, a continuous sampler for measuring the field parameters, and the necessary sample containers, graduated cylinders, and container(s) to collect

the purge and excess water. The following precautions should be observed during the sampling operation.

- Locate the compressor used to power the pump downwind from the well to eliminate the contamination of equipment and samples with exhaust.
- If the flow-through cell will not maintain a full sample chamber (tends to drain back), then clean the check valve on the pump if it is fouled, or replace the pump.
- Calculate the minimum purge volume using the procedure in Section 4.6. Note that a purge is considered completed only when the groundwater parameters have stabilized.
- Upon completion of purging, initiate sampling with the collection of the VOC sample(s). The pump should operate with minimum interruptions while the full sample suite is collected. Allowing the pump to stop for an extended period of time will cause the water trapped in the discharge lines to equilibrate to ambient temperatures, which is not acceptable. During sampling, the pump can be slowed to any rate that allows efficient sampling while also maintaining stable field parameters.
- Measure groundwater parameters periodically during sample collection and record them on the sample collection log to document conditions during sampling.
- Micropurging assumes that groundwater is constantly moving through the well screen and that the residence time fo water in a well is minimal. If micropurging is the method used for sampling, adjust the flow rate to limit the drawdown in the well. Also adjust the rate such that the turbidity is below 5 NTU for sampling. If this criterion is met, the samples need not be filtered.
- Operate the pump, pump control unit, and the flow-through cell according to the manufacturer's recommendations.

4.8.1.4 Groundwater Sampling Using a Push Type Sampler

This portion of this procedure describes the use of a Geoprobe® Screen Point 15 Groundwater Sampler, or similar type equipment, for collecting groundwater samples at predetermined depths. These samples may be used to obtain physical, chemical, or radiological analyses.

A Geoprobe® Screen Point 15 Groundwater Sampler, or equivalent tool, is driven to a predetermined depth by a push type-sampling rig. The Screen Point 15 Groundwater Sampler is equipped with a 41-inch retractable screen and expendable drive point. It can then be partially or fully withdrawn (up to 41 inches) to expose a portion or the entire deployed well screen. After groundwater enters the exposed screen, a sample is collected using either the procedures in Subsection 4.8.1.1, Groundwater Sampling Using a Bailer, or in Section 4.8.1.2, Groundwater Sampling Using a Peristaltic Pump. Note that these samples are collected only for screening purposes because the sampling tool hole has not been completed as a well.

The method for obtaining QC samples using the push type-sampling tool is provided in Subsection 4.8.4.1 for groundwater sampling. Duplicate groundwater samples shall be collected only if there is enough water to collect two full suites of analytes without dewatering the annulus. If insufficient water is available for the collection of a planned QC sample, it shall be explained and documented in the field log book, and the project manager informed. If insufficient water is available for two full suites of analytes, it may be come necessary to prioritize the analyte list. The prioritization sequence should be described in the project-specific work plan.

4.8.2 Sample Filtering and Preservation

Samples for dissolved metals, Gross Alpha/Beta, 233/234Uranium, 235Uranium, 238Uranium, 89/90Strontium, 137Cesium, 226Radium, 228Radium, and orthophosphate shall be filtered in the field at the well location during the sampling event through a disposable 0.45-micrometer membrane filter. If a peristaltic or bladder pump is used, a disposable filter may be attached directly to the sample delivery line so that the sample is filtered directly into the sample container as it exits the delivery line. Discharge pressure shall be gauged so it does not exceed 50 psi. Alternatively, sample water may be collected in a stainless steel container and filtered with a peristaltic pump. Before sample collection, 100 to 200 milliliters of sample water shall be passed through the filter in order to rinse the filter and filtration apparatus of possible contaminating substances.

Preservatives shall be added to the sample bottles prior to the introduction of the filtered sample water. The preservative shall be added in aliquots appropriate to the size of the bottle.

After sample collection has been completed, the pH of preserved samples shall be checked as follows.

- Pour a small amount of sample from the sample bottle directly onto approved pH paper. Use care so that the threaded neck of the bottle does not contact the pH paper. Do not, under any circumstances, insert the pH paper into the sample bottle.
- Check the pH paper against the supplied color chart. If the appropriate pH as indicated on Table 1 has not been achieved, add additional preservative to the sample in 5 ml aliquots and repeat the pH test after each addition.

#### 4.8.3 QA/QC Samples

The frequency and types of field QA/QC samples collected during groundwater sampling are described in project-specific work plans or quality assurance plan documents. These documents detail the applicable criteria for collecting QA/QC samples.

##### 4.8.3.1 Duplicates

Duplicate samples shall be collected only from wells that produce enough water to collect two full suites of analytes without dewatering. Wells that produce sufficient water shall be incorporated into the sampling program such that the required duplicate frequency can be maintained.

Wells scheduled for duplicate sample collection shall be sampled as described in Subsection 4.8 of this procedure, and in relevant sections of project-specific work plans and/or quality assurance documents. Field duplicates are collected following the same sampling procedures used to obtain the real samples. With the exception of VOCs, the typical procedure for a location is to collect the real and duplicate of each sample at the same time, in two equal portions, with each portion going to the laboratory in separate containers. This is accomplished by alternately filling two sample bottles one half at a time to minimize heterogeneity. Note that real and duplicate VOC samples shall be collected independently to reduce the possibility of volatilization of the sample.

When a well with a dedicated pump is being used for sample collection, all samples shall be collected in the normal order, with duplicate VOC samples being collected first. The remaining samples will be sampled as described above.

If a well is being used for matrix spike (MS) and matrix spike duplicate (MSD) samples, the duplicate shall be collected after collection of the MS and MSD.

All duplicate samples shall be given a sample number different from the original sample and the information recorded on the sample collection log and/or the field QC sample collection log.

4.8.3.2 Matrix Spike and Matrix Spike Duplicate

MS and MSD samples shall be collected only from wells that produce enough water to collect the required suites of analytes without dewatering. MS and MSD samples are not collected on a routine basis, but will be collected if so designated in site-specific sampling plans, or if requested by the project manager.

MS and MSD samples shall be collected as follows.

- Purge the well as described in Subsection 4.6 of this procedure.
- After completion of purging, collect VOC samples. Collect the real sample followed by the MS and MSD. Collect these samples in immediate succession.
- Collect the remaining samples not requiring filtering. For each sample parameter, collect the original sample, MS, and MSD concurrently. Fill the original sample bottle one-third full followed by the MS and MSD sample bottles, which are also filled one-third full. Rotate each bottle in the sequence, filling in one-third full until all three bottles are full. For analytes not requiring an MSD, collect only the original sample and the MS.
- After the real sample, MS, and MSD (where appropriate) are collected for one parameter, repeat the process for the next parameter.
- Similarly, collect samples requiring filtering. When a bailer is used, fill a stainless steel bucket with sample water. As samples are collected and the reservoir of water in the bucket is depleted, add more water with discretion. When a pump is used, attach the filter directly to the discharge line. Fill sample bottles as described above, partially filling the original sample, MS, and MSD in rotating sequence until each parameter bottle is full.
- Radiochemistry samples may have more than one bottle for each parameter group. In this case, include all required bottles in the rotating sequence.
- Field parameter measurements are not be required for MS and MSD samples.
- Retain the original sample number for MS and MSD samples. However, add a suffix of MS or MSD to the sample number to correspond with each QA/QC sample. Record all information on the field QC groundwater sample collection log.

4.8.3.3 Replicates and Splits

Replicate and split samples shall be collected in the same manner as described for the MS and MSD. Seek instruction from the project manager for replicates and splits exceeding three samples. Record all information will be recorded on the groundwater sample collection logs.

4.8.3.4 Field Equipment Rinses

Wells scheduled for equipment rinsate samples shall be sampled as described in Subsection 4.8 of this procedure, and field equipment rinses shall be collected as described in this Subsection and in relevant portions of project-specific QC documents and work plans. Field equipment rinses shall be collected in a manner designed to reflect sampling techniques. All equipment used during sampling will be fully decontaminated as described in Subsection 4.3, then rinsed with distilled or deionized water. The rinse water will then be collected in bottles identical to those used for the original sample, and assigned a separate sample number. Analytes requiring filtration will be filtered using a new filter and tubing as required for the real sample. All information will be recorded on groundwater sample collection logs.

#### 4.8.3.4.1 Bailed Wells

After completion of sampling, all equipment shall be decontaminated. Prior to leaving the well location, the equipment rinse will then be collected as follows.

- Fill the bailer with distilled or deionized water by pouring the water into the top opening.
- Decant the rinse water to the VOC vials through the bottom valve just as was done during sample collection.
- For the remaining unfiltered samples, fill the bailer with distilled or deionized water each time additional rinsate is needed. Transfer the rinsate to sample bottles or to a stainless steel bucket and then to sample containers in the same manner used during collection.
- Collect filtered samples in an identical manner as the real samples. Fill the bailer with distilled or deionized water. Then transfer the rinse water to a stainless steel bucket. Filter the rinse water in the bucket through a new disposable filter.
- Preserve rinse samples in the same manner as the real samples.

#### 4.8.3.4.2 Pumped Wells

Rinsate samples are not routinely collected from wells that are equipped with dedicated bladder pumps because the samples from these wells are collected directly from the pump discharge line. However, wells sampled using peristaltic pumps for sampling may be selected for rinsate sampling, with equipment used in sample collection (down hole tubing, filter tubing and the stainless steel bucket used for sample water collection, etc.) being decontaminated prior to rinsate sampling. The tubing at the pump head will be replaced, and a new filter used for filtered analytes. To collect the samples, distilled or deionized water will be poured into the decontaminated stainless steel bucket and pumped, using the decontaminated tubing, into the sample containers. The equipment used to collect the real VOC samples will also be decontaminated, rinsed, and used to collect the VOC rinse samples. All samples will be preserved at the same pH levels as the real samples.

#### 4.8.3.5 Distilled Water Blanks

Distilled water sample blanks are not submitted on a routine basis, but will be made up if so designated in a site-specific sampling plan. Samples of the distilled or deionized water used for the final decontamination of equipment will be transferred directly to sample bottles to determine any baseline contamination the water may have introduced into the samples. Five-gallon bottles of the distilled or deionized water will be opened in a controlled area, such as the bottle storage room, and then poured directly into the appropriate sample bottle. A Teflon®, glass, or stainless steel funnel may be used to help control flows into small mouth bottles. Blank samples will be preserved to the appropriate pH required for each analyte. All information will be recorded on groundwater sample collection logs.

## 4.9 Sample Handling and Control

Pre-cleaned sample containers will be obtained from a contract analytical sample container source. Preserving solution will be added to the bottles by a laboratory, the sample manager or qualified sampling personnel. The bottles will be labeled to indicate the preservative added.

The sampling containers, preservation requirements, and holding times for the various types of analyses are shown in Table 1. Groundwater samples will be properly labeled so that they can be easily identified. The sample numbering system will be assigned by project-specific sampling plan documents. A sample identification (ID) number will be assigned to each sample suite. The

sample ID number will contain the following information as part of a nine to twelve character, alpha-numeric code:

| Character(s) | Description | Code |
|---|---|---|
| 1 and 2 | Project ID | GW |
| 3 through 7 | Sample Number | 00001 to 99999 |
| 8 and 9 | Subcontractor ID | Alpha (e.g. TE = Tierra Environmental Consultants) |
| 10, 11, and 12 | QA/QC | MS for matrix spike, MSD for matrix spike duplicate |

In addition to a sample number, each well sampled will be assigned a current Record Identification Number (RIN), an event number (specific to the RIN), and bottle numbers that are specific to the RIN and event number.

## 5. Records

All field activities shall be recorded on a Field Activity Daily Log or Groundwater Sample Collection Log. Additional logs may be required to record QC samples and for recording well status. Refer to specific project, site, or facility work plans for further information. Summary information of the day's activities or other pertinent information should always be recorded on the field forms. Under some circumstances, the project manager may assign a bound field logbook to the field personnel that will remain in their custody during all sampling activities. The cover of each logbook shall contain the following information at a minimum:

- Name of the organization to which the book is assigned
- Book number
- Project name and job number
- Start and end dates

Logbook pages shall be sequentially numbered and marked with the book number before any data are recorded. All data and information pertinent to field sampling shall be recorded in the logbook or on the field forms that identify all required data entries. Enough detail must be included in the documentation to reconstruct the sampling event. Field form entries shall include the following minimum information:

- Date and time
- Names of field personnel
- Names of all visitors
- Location of field activities
- Description of sampling sites including weather conditions
- All field observations and comments
- Field parameters
- Sample identification information
- References to all prepared field activity forms and chain-of-custody records

Field logbooks, when required on specific projects, shall normally be kept only by the field sampling team leaders and the site supervisor and shall typically be used only to summarize field activities and to document project information not required by the procedure field forms.

Permanent ink shall be used for all entries in the logbooks and on the field forms. Mistakes shall be crossed out with a single line, initialed, and dated. Unused pages or partial pages shall be voided by drawing a line through the blank sections and initialing and dating the mark. Any deviation from this procedure shall require documentation in the site supervisor's logbook.

The field activity daily log narrative should create a chronological record of the sampling team's activities, including the time and location of each activity. Descriptions of problems encountered, personnel contacted, deviations from the procedure, and visitors on site shall also be included. The weather conditions, date, signature of the person responsible for entries, and the number of field activity daily log sheets used to record media team activities for a given day shall also be included.

The Groundwater Levels Measurement/Calculations Form and the Chain of Custody Record (see *Containing, Preserving, Handling, and Shipping Soil and Water Samples*) shall also be completed for each site. All blank fields on the forms must be completed or voided.

Forms and logbooks are to be maintained as records in the project file.

## 6. References

Environmental Protection Agency, 1982, Test Methods for Evaluating Solid Waste, SW-846, Volume II. Field Methods, 2nd edition.

Environmental Protection Agency, 1986a, Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, EPA Region IV Environmental Service Division.

Environmental Protection Agency, September 1986b, RCRA Ground Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1.

Environmental Protection Agency, 1987a, A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001. 1987.

Environmental Protection Agency, 1987b, Data Quality Objectives for Remedial Activities, Development Process, EPA/540/G-87/003.

Environmental Protection Agency, December 1988, User's Guide to the Contract Laboratory Program.

# APPENDIX A

STANDARD GROUNDWATER FORMS

# Appendix C
# Paragon Analytics Radiochemistry Case Narrative
# Isotopic/Total Uranium

# Paragon Analytics

## Radiochemistry Case Narrative
## Isotopic/Total Uranium

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**S.M. Stoller Corp.**

CO School of Mines

PA WO 0609097

1. This report consists of the analytical results and supporting documentation for seven water samples received by Paragon on 9/14/2006.
2. These samples were prepared according to Paragon Analytics procedures PA SOP776R10 and PA SOP778R10. Modifications were made to the method as described on QASS 291897.
3. The samples were analyzed for the presence of isotopic and total uranium according to Paragon Analytics procedure PA SOP714R10. The analyses were completed on 10/10/2006.
4. The total uranium results were determined by converting standard activity units to a mass basis, and adding these results to create an analyte called 'URANIUM, TOTAL' for each sample. The MDC equation cannot accommodate the different specific activities of each nuclide. Therefore, the MDC is not evaluated for the 'URANIUM, TOTAL' analyte.
5. Results for total uranium are included in Section 9 of this data package.
6. The analysis results for these samples are reported in units of pCi/L. The analysis results for total uranium are reported on a mass basis in units of ug/L. The water samples were not filtered prior to analysis.
7. This analytical method quantifies U-235 alpha activity in a specific region of interest corresponding to emission energies between those of U-234 and U-238. A potential limitation of this method is that measurable amounts of U-234 in the sample may cause a small amount of characteristic activity in the U-235 region of interest due to poorly resolved alpha activity at the boundary between the two regions. To minimize the potential for a high bias in the U-235 analytical results, the U-235 region of interest has been narrowed and limited to a lower energy region. An 85.1% abundance correction has been made to the final U-235 results.
8. U-235 activity is reported in the associated method blank above the minimum detectable concentration value. The measured blank activity is below the requested

MDC (0.2 pCi/L). Results are acceptable according to PA SOP 715, and are submitted without further qualification.

9. No further anomalous situations were encountered during the preparation or analysis of these samples. All remaining quality control criteria were met.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, Paragon Analytics certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Kathryn A. Rende
Radiochemistry Instrumentation

10/11/06
Date

Radiochemistry Final Data Review

10/12/06
Date