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ENVIRONMENTAL AND ENGINEERING SERVICES
STRATEGICALLY POSITIONED–TECHNICALLY PREPARED

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April 2, 2009

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Division of Reclamation, Mining and Safety

**Transmittal**
**Site Characterization Report**
**Centennial Project**
**Weld County, Colorado**

acs

NON CONFIDENTIAL

Dear Mr. Barry:

On behalf of Powertech (USA) Inc., R² Incorporated is pleased to submit the enclosed copy of the Site Characterization Plan for the Centennial Project in Weld County, Colorado. The report summarizes the preoperational monitoring activities conducted at the project site—the results of which will be used to establish an environmental baseline for inclusion in Powertech's radioactive materials license and reclamation permit applications. If you have any questions or comments, please contact us at (303) 832-7664.

Yours truly,

**R² Incorporated**

George Robinson
Principal Hydrogeologist, Project Manager

*GMLR/JER/kp*

Enclosure

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**Site Characterization Plan**
**Centennial Project**
**Weld County, Colorado**

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April 2009

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# List of Acronyms

| | |
|---|---|
| APE | Area of Potential Effect |
| cfm | Cubic Feet per Minute |
| cm | Centimeters |
| CPM | Consulting Project Manager |
| dB | Decibel, a unit of measure of sound |
| DO | Dissolved Oxygen |
| DQO | Data Quality Objectives |
| EDD | Electronic Data Deliverable |
| ELI | Energy Laboratories, Inc. |
| EPA | U.S. Environmental Protection Agency |
| GPS | Global Positioning System |
| ISR | In Situ Recovery) |
| km | Kilometer |
| LIMS | Laboratory Information Management System |
| m | Meter |
| NRHP | National Register of Historic Places |
| NRC | U.S. Nuclear Regulatory Commission |
| ORP | Oxidation Reduction Potential |
| Powertech | Powertech (USA) Inc, wholly owned subsidiary of Powertech Uranium Corporation |
| PM | Powertech Project Manager |
| PMP | Project Management Plan |
| QA | Quality Assurance |
| QC | Quality Control |
| RG | Regulatory Guide |
| $R^2$ | $R^2$ Incorporated |
| SCP | Site Characterization Plan |
| SEO | State Engineer's Office, Colorado Division of Water Resources |
| SC | Specific Conductivity |
| SHSO | Site Health and Safety Officer |
| TLD | Thermo-Luminescent Dosimeter |
| μSv | microSievert (1uSv = 0.1mrem) |

# 1.0 INTRODUCTION

On behalf of Powertech (USA) Inc. (Powertech), $R^2$ Incorporated ($R^2$) has prepared this Site Characterization Plan (SCP) to document the approach to and methods for the collection and analyses of background environmental data to be used to characterize the pre-mining site conditions of the Centennial Project in Weld County, Colorado. The process of preparing this SCP was initiated with the Colorado Division of Reclamation, Mining and Safety (DRMS) and other applicable agencies in 2007. In the absence of promulgated regulations under the 2008 statute, HB 08-1161, this report has been prepared to comply with the requirements found at 34-32-112.5(5)(a), (b) and (c), thus providing a more transparent and open record for all interested stakeholders regarding the collection and analyses necessary for characterization of the Centennial Project area.

## 1.1 Site Description

Powertech proposes to develop a uranium in-situ recovery (ISR) operation on its Centennial Project, located in Weld County, Colorado. This project area is situated approximately 15 miles northeast of Fort Collins, and approximately midway between the towns of Nunn and Wellington. A vicinity map, showing the location of the project area, in relation to major highways and landmarks, is provided in **Figure 1**. The project area is contained within the two SCP sample location maps for the Centennial Project (**Plates 1 and 2**). As of the date of this document, the project consists of approximately 10,000 acres. A final permit boundary will be established prior to the submission of Powertech's mine permit application.

## 1.2 Project Background and General Approach to Mining

The project area was extensively explored by Rocky Mountain Energy (RME) and Mobil Oil Company in the late-1970s and early-1980s. RME performed pre-mining feasibility studies on uranium resources in the southern portion of the project area, where uranium production (using conventional open pit mining and milling techniques) was planned. Due to low uranium commodity prices, RME abandoned the project in 1984. Powertech acquired the mineral rights to 5,760 acres in 2006 from Anadarko Petroleum Corporation, the successor to RME.

Powertech's proposed ISR operations will consist of a series of sequentially developed well fields, a satellite ion exchange (IX) facility (SF) and the central processing plant and associated process facilities (CPP) to recover and process the final uranium product.

## 1.3 Purpose of the SCP

The purpose of the SCP is to describe:

- the rationale used to determine sample location, frequencies and number of environmental samples required to adequately characterize the existing natural environment within the project site;
- the methodology used in the collection and field measurements of these environmental samples
- the analytical techniques, and
- the quality control measures applied to the handling and analyses of these environmental samples.

This Plan was designed to thoroughly characterize the pre-mining site conditions at the Centennial Project prior to Powertech's mining permit application. It was developed in a manner that is consistent with applicable regulatory guidance, current standards of practice, and defensible science. This SCP describes the procedures that Powertech has put into place and the activities performed to meet the environmental sampling criteria of DRMS, and at the same time, demonstrates how these procedures comply with the recent requirements as stated in 34-32-112.5(5)(a), (b) and (c) of 2008 statute, HB 08-1161.

Environmental data from State, Federal and other private sources will be combined with the results of this SCP and will be incorporated into Powertech's Designated Mining Operation (112d) permit application to be submitted to the DRMS, the Radioactive Materials License application to be submitted to CDPHE, the Underground Injection Control permit application to the Environmental Protection Agency (EPA), as well as numerous addition permit submittals. These documents, and all data collected, will be a matter of public record.

## 1.4 Regulatory Basis and References

1. This SCP was developed consistent with the regulatory intent and technical guidance provided in the following documents: Colorado Department of Health and Environment, Hazardous Materials and Waste Management Division, Radiation Control, 6 CCR 1007-1, Part 18, "Licensing Requirements for Uranium and Thorium Processing"
2. Colorado Statute HB 08-1161 (2008), amending the Colorado Mined Land Reclamation Act
3. Colorado Department of Health and Environment, Colorado Clean Water Act

4. Mineral Rules and Regulations of The Colorado Mined Land Reclamation Board for Hard Rock, Metal and Designated Mining Operations, May 1977, amended August 2006
5. NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills," 1980
6. NRC Regulatory Guide 3.46, "Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Mining", 1982
7. NUREG 1569, "Standard Review Plan for In Situ Leach Uranium Recovery License Applications", 2003
8. NUREG/CR 5849, "Manual for Conducting Radiological Surveys in Support of License Termination", J D Berger, 1992
9. NUREG 1575, "Multi Agency Radiological Site Survey and Investigation Manual" (MARSSIM), 2000
10. USEPA "Manual for Chemical Analysis of Water and Wastes" EPA-625-/6-74-003a, 1974.
11. NUREG 1910, Generic Environmental Impact Statement for In Situ Uranium Recovery, 2008 (Draft)
12. EPA Method 115, 40 Code of Federal Regulations (C.F.R.), Part 61, National Emission Standards for Hazardous Air Pollutants: Radionuclides; Final Rule and Notice of Reconsideration, December 15, 1989

## 1.5 Regulatory Interaction

During the course of planning and implementing the SCP, Powertech and $R^2$ representatives met with representatives of agencies responsible for licensing and permitting ISR facilities in Colorado. These agencies include:

- Weld County Planning and Zoning Department
- Weld County Public Health Environmental Health Services Division
- Colorado Department of Public Health and Environment, Radioactive Materials Division (CDPHE)
- Colorado Department of Natural Resources, Division of Reclamation, Mining and Safety (DRMS)
- Colorado Division of Water Resources
- U.S. Environmental Protection Agency, Region VIII, Underground Injection Control Division (EPA).

## 1.6 Technical Approach

Sample placement prescribed by Nuclear Regulatory Commission (NRC) Regulatory Guide 4.14 (RG 4.14) was modified in order to ensure the effort put forth in characterization of the project site is adequate and assures an appropriate determination of background parameters including radiation. Modification of the sampling program described in RG 4.14 is appropriate as this guidance was developed to be used in design of an environmental monitoring program for conventional uranium mill and tailings sites and was not specifically intended to address ISR operations. The modified sampling program adequately characterizes radiological and non-radiological aspects of the environment at the site and assists the applicant in the proper placement of operational monitoring sites to ensure standards for protection of human health and the environment will be met during mining operations. The modifications were reviewed with representatives of DRMS, CDPHE and EPA, as appropriate.

The SCP consists of the following components:

- Groundwater monitoring
- Domestic well water monitoring
- Surface water monitoring
- Air quality monitoring
- Surface soil monitoring
- Subsurface soil monitoring
- Radon flux measurements
- Thermo-Luminescent Dosimeter Program
- Direct radiation measurements
- Vegetation and food product sampling
- Animal tissue sampling
- Cultural resource inventory
- Noise survey

In general, sample collection and analyses were performed according to industry accepted, peer reviewed and/or EPA-approved methods. All samples were collected using clean and calibrated instruments and equipment. Glassware and plastic containers were furnished via a certified analytical laboratory, in sealed ice chests with pre-measured preservative chemicals. All non-disposable sampling equipment and implements used were washed with deionized water and/or a critical cleaner such as Alconox between each collection. Technicians donned clean gloves before collecting each sample and all necessary fields and sample information was recorded. Each sample was labeled, sealed, stored at appropriate temperature and was shipped to a certified analytical laboratory with proper 'Chain of Custody' documents before holding times expired.

# 2.0 ENVIRONMENTAL MONITORING PROGRAMS

Each component of the environmental sampling program is described in the following subsections. An overview of the entire sampling program is provided in **Table 2.1**. Sampling locations are shown in **Plate 1** (Centennial North) and **Plate 2** (Centennial South).

## 2.1 Groundwater Monitoring

The need for reliable groundwater sampling procedures has been recognized for years by a variety of professional, regulatory, public and private groups. Groundwater quality monitoring programs have unique needs and goals which differ fundamentally depending on the objectives. Conscientious efforts to design this ground-water investigation have been performed in order to provide an accurate characterization of the groundwater quality within the Centennial Project area.

**Figure 2** is a generalized, north-south geologic cross-section through the Centennial Project site. Sand units within the Upper Fox Hills Sandstone are hosts to uranium mineralization throughout the project. Groundwater samples were collected from Upper Fox Hills sands situated up-gradient of, down-gradient of and within identified uranium resource areas. In addition, water quality samples were collected from an underlying aquifer in the Lower Fox Hills Sandstone (B Sand) and overlying aquifers in the Laramie Formation. This sampling program was designed to obtain site-wide water quality data in order to establish the overall water quality conditions for the Laramie-Fox Hills aquifer within the Centennial Project area. Groundwater sampling and water quality characterization activities targeting specific operational areas will continue throughout the life of the project.

Initially, consistent with applicable guidance, groundwater samples were to be obtained quarterly for five quarters, from twenty-one monitoring wells. These wells included seven historic wells installed by RME, and fourteen new wells installed by $R^2$ in 2007 (**Plates 1 and 2**). At the request of DRMS, Powertech modified the SCP by adding three additional sampling events during the five-quarter sampling period, for a total of eight representative samples per well.

Groundwater wells were sampled utilizing the "Purging and Sampling" method, in which three well volumes are purged before parameters are checked for stability and the water sample is collected. The analytical program for groundwater samples from monitoring wells is presented in **Table 2.2**. Minimum sample volumes, preservation requirements, and holding times are presented in **Table 2.2**. As part of groundwater sampling procedures, depth to groundwater level and field parameters, i.e., pH, temperature, specific conductivity (SC), dissolved oxygen (DO), and oxidation reduction potential (ORP), are measured and recorded. The samples were placed in a cooler of ice and shipped via overnight carrier to Energy Laboratories, Inc. (ELI), Casper, Wyoming with proper chain of custody procedures.

## 2.2 Domestic Well Monitoring

Letters were sent to all landowners within a two kilometer radius of the proposed project boundary. Upon contacting and obtaining permission from each landowner to test the domestic water wells on their property, groundwater samples were collected from wells. Domestic well static water levels were not measured as well head seals precluded this.

Samples from thirty-six domestic water wells were collected as part of the SCP. The well locations, shown in **Plates 1 and 2**, are: (a) within the two-kilometer zone discussed in RG 4.14; (b) up-gradient and down-gradient of the planned mining operations; and, (c) from the aquifers within, above, and/or below the zone proposed to be mined. Water samples from domestic wells were collected only once.

Samples were obtained in a manner similar to that described in Section 2.1, with the following exception: rather than purging three well volumes as described, samples from domestic wells were taken from a tap close to the well, allowing the water to flow for approximately five minutes prior to obtaining the sample.

The analytical program for domestic well water samples is presented in **Table 2.2**. The analyses are in accordance with NUREG 1569, Section 2.7, and EPA "Manual for Chemical Analysis Water and Wastes" EPA-625-/6-74-003a, 1974. As part of domestic well water sampling procedures, pH, temperature, Specific Conductance, Dissolved Oxygen, and Oxygen Reduction Potential were measured in the field prior to shipping the water sample.

## 2.3 Surface Water

The primary objective of a surface water sampling strategy is to collect water quality samples that are representative of streams within a target area. However, no perennial or intermittent streams exist on or within one mile of the site. Stream flow is exclusively ephemeral in nature, only taking place during and following high-intensity or prolonged rainfall events and rapid snow melt. Mindful of these limitations, the focus was to establish representative surface water quality for the SCP. Surface water monitoring was accomplished through standard methods that include; (1) surface water sampling using passive samplers and grab techniques and (2) grab sampling of existing water impoundments. Sampling techniques and apparatus were designed in such a way to maximize collection of surface waters representative of the project area.

Monitoring locations were strategically chosen to provide an adequate representation of surface water quality within and adjacent to the project area. Surface water was obtained from two seasonal impoundments in Section 4 in T9N, R67W, and Section 33 in T10N, R67W **(Plate 1)** and thirteen passive storm water samplers, emplaced at accessible locations most likely to experience flow during storm events. The installed passive samplers are shown in **Figure 3.** The seasonal water impoundments were checked monthly; when water was present, samples were obtained. In addition, grab samples were collected at another five surface water sampling locations that were established to estimate potential flows from small ephemeral drainages associated with the project area. Ephemeral streams (storm water channels/grass swales) were monitored for flow via passive samplers. The frequency of sample collection and analysis from streams was dictated by storm events generating sufficient flow from which a sample could be obtained.

Passive samplers were monitored and samples collected using Nalgene storm water samplers following such events. All samples were placed in a cooler of ice and shipped via FedEx to Energy Laboratory, Inc. (ELI) with proper chain of custody. Surface water samples were analyzed for the parameters summarized in **Table 2.3**.

## 2.4 Meteorology and Air Quality

ISR process facilities do not affect air quality significantly (NUREG-1910, 2008). The impacts due to construction are classified as small if 1) the gaseous emissions are within regulatory limits; 2) the air quality in the region of influence is in compliance with the National Ambient Air Quality Standards (NAAQS); and 3) the facility is not classified as a major source according to the New Source Review or operating permit programs. Particulate air samplers were placed onsite and offsite to test for radiological and non-radiological parameters during preoperational conditions.

### 2.4.1 Meteorology

Powertech installed an onsite meteorological station in the north end of Section 3, T9N, R67W (Plate 2). (One of the air monitoring stations is co-located with the meteorological station.) It is situated at a location where the effects of obstructions—trees, buildings, etc.—is minimized. Meteorological parameters to be measured are horizontal wind speed and wind direction, vertical wind speed, temperature at 10 and 2 meters, differential temperature (between 2 and 10 meters), barometric pressure, and solar radiation. The meteorological parameters were measured continuously at a ten-meter level on an open-lattice meteorological tower using an electronic data logger. Temperature and solar radiation were measured at the two-meter level of the tower. The temperature sensors are housed in fan aspirated radiation shields. All meteorological data were averaged every 2 seconds and stored in memory every 15 minutes. The meteorological data collection program started November 15, 2007, and continued until mid December 2008.

A wind rose, generated from data collected by RME in 1983 from an on-site meteorological station, was utilized to locate the sampling stations (**Figure 4**)[1]. Dominant winds are from North through Northwest, particularly at night. Thus, the highest predicted air concentrations resulting from proposed project activities would be at South/Southeast site boundary locations. Additionally, Section 15, T9N, R67W (**Plate 1**) was chosen as the nearest residence (i.e., "maximally exposed offsite individual") since that area is South/Southeast of the planned central processing facility, and is expected to be at/near a site boundary.

### 2.4.2 Monitoring of Particulates in Air

The proposed ISR "mining" at the site takes place below-grade and, therefore, no radionuclide particulates are generated under routine operations. The proposed mine design includes a yellowcake circuit, however, modern vacuum dryers currently being used in the industry have virtually no particulate emissions. Thus, the only potential releases from these mining activities would be liquids from leaks and spills, and potentially radon gas[2]. The sampling location requirements were adjusted to reflect the inherent difference between conventional mining/milling operations and ISR.

Particulate matter (PM) monitoring was conducted for two categories. PM is the technical term for airborne dirt; the two categories monitored for the proposed action included: PM 10 that includes solid and liquid particles that are very small, having an effective aerodynamic diameter of 10 microns (μm) (approximately 0.0004 inches) or less. $PM_{2.5}$ is a measure of the particles with an aerodynamic diameter of 2.5 μm or less. Conducting preoperational dust monitoring allows the operator opportunity to design procedures and BMPs for site specific conditions in order to control fugitive dust in such a way that provides preventative measures to be implemented for the health and safety of personnel.

To characterize the representative particulate matter concentrations, background $PM_{10}$ [3] concentrations were monitored on a one-in-six day sampling schedule. $PM_{10}$ was measured using two co-located Tisch Environmental, AC-powered volumetric high-volume flow monitors, that are U.S. EPA certified as a reference measurement method for $PM_{10}$. The two particulate samplers are co-located, along with the tower with meteorological sensors, as shown in **Plate 2.**

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[1] The former meteorological station was located at Weld County Rd (CR) 100 just east of CR 19 and approximately 6 miles east of the Wellington exit off Interstate 25.

[2] Radon gas emissions, if any, will be continuously monitored during operations at the air monitoring stations.

[3] PM10 is the technical term for airborne particulates; it includes solid and liquid particles that are very small, having an effective aerodynamic diameter of 10 microns (μm) (approximately 0.0004 inches) or less.

Security fencing will surround the samplers. Measured concentrations at this location will be compared to the National Ambient Air Quality Standard (NAAQS) for $PM_{10}$. $PM_{10}$. Monitoring began in November 2007, and continued though mid-December 2008.

The particulate samplers collected an integrated, 24-hour average concentration for the period of midnight-to-midnight Mountain Standard Time (MST). The samplers were placed on sampling stands so that their inlets are located between 3 and 4 meters above ground level and the samplers separated by at least 2 meters to avoid interference for each other. Meteorological parameters were also measured on a single, 10-meter high tower site for a period of one year to establish the dispersion characteristics of the site. Monitoring of meteorological parameters was performed concurrently with the $PM_{10}$ monitoring. The monitoring variable was available for use in AERMET processing which can be used in AERMOD dispersion model for characterization of the site activities for permitting the facility.

### 2.4.3 Monitoring of Radionuclides in Air

Placement of particulate air samplers considered: (a) site boundary locations which, during operations, may represent "points of compliance" relative to permissible releases of radioactive materials in air to unrestricted (public) areas; (b) directions from project activities representative of prevailing/highest frequency winds; (c) the location of nearby residence(s) which would represent the potentially "maximally exposed offsite individual" from project airborne releases under normal operations and/or accidental releases (Regulatory Guide 4.14, 1980).

Five high-volume air sampling stations were installed within the project area, and one was set up off site as the control or background station. Two of the five stations were installed in Centennial North (**Plate1**), and three of the five stations were installed at Centennial South (**Plate 2**), including one station co-located with the meteorology station and the particulate air samplers. The control station is located West/Northwest (upwind") of the project site, near the intersection of Interstate 25 and Owl Canyon Road, north of Wellington, Colorado.

High-volume air sampling pumps, with flow rates greater than ten cubic feet per minute (cfm), were utilized to ensure minimum detection limits for radionuclides were achieved. Units were enclosed in weather resistant housings and consist of Hi–Q Environmental Product 4300 series automatic flow control units. Continuous air sampling was obtained via filter paper collection. Filters were changed weekly or as necessary, based on dust loading. Sampling was conducted continuously for twelve months; quarterly composites from each station were separately analyzed. Air particulate samples were analyzed for Uranium[4], Thorium (Th) 230, Radon (Ra) 226, and Polonium (Po) 210.

### 2.4.4 Radon in Air

Radon samples were collected continuously at each of the five high volume air monitoring station utilizing alpha track detectors with CR 39 (allyl diglycol carbonate) substrate designed for outdoor extended use. The instruments utilized included a Landaur Radtrak Long Term Radon Monitor obtained from Landaur, Inc., Glenwood, Illinois (Landaur). Detectors were exchanged and analyzed on a quarterly basis by Landaur. Sensitivities are typically in the 20- 40 pCi/l/day range. Assuming a quarterly (90-day) exposure period, sensitivities are expected to be less than 0.2-0.4 pCi/l in air.

## 2.5 Surface Soils

RG 4.14 assumes a centralized continuous site. ISR activities proposed at the site will occur within and over the ore bodies, which are generally long, narrow, and discontinuous. In addition, ISR "mining" takes place below-grade and, therefore, no radionuclide particulates are generated under routine operations. Thus, the only potential releases from these mining activities would be liquids from leaks and spills, and potentially radon gas[5]. The sampling location requirements were adjusted to reflect the inherent difference between conventional mining/milling operations and ISR.

As an alternative to the RG 4.14 approach—and mindful of the fact that there has not been historical uranium mining at or near the site—the sampling was performed in phases and utilized geostatistical analysis techniques to estimate the confidence of initial sampling locations and results, and thus guide subsequent sampling phases, if they were necessary. The geostatistical analysis utilized was the Krieg_2D module within C Tech Development Corp's MVS© spatial analysis and visualization software package. The resulting sampling locations are shown in **Plates 1 and 2**.

Surface soil samples were field-located using a hand-held Global Position System (GPS) unit. A soil sample was obtained at each location from the top fifteen centimeters or at the bedrock surface, whichever was shallower and collected once for analysis. The samples were shipped in glass or plastic containers within an ice chest with packing materials to guard against breakage. Samples were shipped via overnight carrier with proper chain of custody to ELI for analysis.

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[4] Uranium means "natural Uranium" i.e., combination of Uranium isotopes in mass percent as occurs in nature: U238 (99.3), U 235 (0.72) and U 234 (0.005).

[5] Radon gas emissions, if any, will be continuously monitored during operations at the air monitoring stations.

Fifty-five samples were analyzed for Uranium, Ra 226, gross alpha, and gross beta. Additionally, ten percent of the samples were analyzed for thorium (Th) 230 and lead (Pb) 210.

## 2.6 Subsurface Soil

To obtain a radiological profile of subsurface soils in the project areas, RG 4.14 suggests subsurface soil samples be obtained at the center of operations and at 750 meters in four cardinal compass directions and three samples should be obtained at each location one time, prior to construction, to a depth of one meter. In addition, NRC's NUREG 1569 suggests that a general description of the site soils and their properties be provided to support an evaluation of the environmental effects of potential construction and operation erosion.

Twenty-one soil profiles were collected at the locations shown in **Plates 1 and 2**. To locate the samples, a virtual axis was constructed through a plan view of the ore bodies, around which a grid was drawn 750 m from the axis. The number of sample locations in each 750 m radius of the traditional circular/polar grid was used to establish a basis of sample location density ($m^2$/sample) for each radial segment. It was then translated mathematically to an equivalent sample location density for the grid around the axis. The resultant number of samples per segment was then used to determine spacing of samples along the perimeters of each grid segment and along the central axis. Finally, in consultation with CDPHE, sample density was increased at ore body locations and decreased in area away from the orebodies.

Sample locations were established via a hand-held GPS unit. At each location, a profile was obtained by collecting three soil samples at the following depth intervals:

- 0-30 cm
- 30-60 cm
- 60-100 cm or at refusal

The samples were shipped in glass containers within an ice chest with packing materials to guard against breakage. Samples were shipped via overnight delivery with proper chain of custody to ELI for analysis. The samples were analyzed for the parameters listed in **Table 2.4**.

## 2.7 Direct Radiation Measurements

RG 4.14 suggests direct radiation measurements be obtained at 150 m intervals out to 1,500 m in eight cardinal compass directions from the center of the milling area, plus at air particulate stations one time to determine average exposure rate. A program was designed which utilized GPS-based scanning technologies capable of providing much higher measurement density and more uniform gamma measurements over large areas.

Preliminary survey coverage is shown in **Plates 1 and 2**. Surveys of the parcels was conducted by north-south transects spaced no farther than 0.1 miles apart. Transects were modified as necessitated by topography and field conditions. Higher density measurements were clustered near the planned central processing site, with more dispersed measurements at greater distances from the mill.

The equipment used to perform the gamma surveys include a Ludlum Model 2221 portable scaler rate meter, with probe type Ludlum Model 44-10 sodium iodide (NaI) gamma scintillator. This equipment was coupled with GPS equipment: Trimble PRO XRS Receiver and TSC1 Data Logger. The TSC1 Data Logger is connected to the Model 2221 and the GPS receiver. This assembly records two-second integrated count rates and couples with GPS coordinates. For the purpose of covering large outdoor areas, the equipment was mounted to an All-Terrain Vehicle with the 44-10 probe affixed to the front at a height of approximately two feet above the ground. No analysis is performed for the gamma survey.

## 2.8 Thermo-Luminescent Dosimeter Program

To supplement the real time gamma survey program, a thermo-luminescent dosimeter (TLD) program was implemented to estimate average direct radiation (gamma) exposure rates over extended time periods. It provides continuous integrated gamma exposure data with statistically valid "average" exposure rates over an extended period of time at locations judged to be "strategically important." It also supports and validates data from the "real time" gamma field survey program. TLDs have been part of background radiometric programs for many uranium mine, mill, and processing sites for over 30 years. The program utilized the InLight® Environmental/Low Level dosimeter manufactured by Landaur, Inc., Glenwood, Illinois (Landaur). The dosimeter fully meets ANSI N545-1977, NRC Regulatory Guide 4.13, and Health Physics Society Draft Standard N13.29 for environmental dosimetry.

The 10 TLD locations are shown in **Plates 1 and 2**. As shown, five are located at air particulate stations and the remaining five were located in areas where initial gamma readings were either at the high end or low end of the range of site readings. The locations also considered security and preservation – cows are known to be attracted to the TLD sites and the TLD's have been used for unlawful target practice. The TLDs are replaced with new, "unexposed" units after an approximate 90-day exposure period. All TLDs were shipped via the U.S. Postal Service with proper chain of custody. Exposed TLDs were sent to Landaur for analyses for integrated exposure in units of x, gamma, and beta radiation to a sensitivity of 0.1 mrem.

## 2.9 Radon Flux Measurements

The methods described herein are consistent with EPA Method 115, 40 Code of Federal Regulations (C.F.R.), Part 61, National Emission Standards for Hazardous Air Pollutants: Radionuclides; Final Rule and Notice of Reconsideration, December 15, 1989. RG 4.14 suggests obtaining radon flux measurements at the center of operations, and at locations 750 m and 1500 m from the center of operations, in four cardinal compass directions on a quarterly basis.

A total of three sampling events occurred for radon flux within the project site during the spring, summer and fall, for a total of twenty-one samples. Measuring radon flux involves the adsorption of radon on activated charcoal in a large-area collector. The radon collector is placed on the surface to be measured and allowed to collect radon for a time period of 24 hours. Measurement locations are shown in **Plates 1 and 2**. Measurement points were located in a manner similar to that which is to be utilized for subsurface soil. Transfer of charcoal to and from canisters (typically 25 cm in diameter PVC end cap) was performed carefully inside an enclosed work area. All canisters were sealed prior to deployment and shipment via FedEx (with proper chain of custody) to ELI for analysis. The radon collected on the charcoal was measured by gamma-ray spectroscopy by ELI. QA/QC protocol and standard sampling procedures were strictly employed.

## 2.10 Vegetation and Food Products

RG 4.14 suggests that vegetation be sampled three times during the growing season, and at grazing areas in sectors near the site with the highest expected air particulate concentrations.

Vegetation samples were collected at the approximate locations shown in **Plates 1 and 2**. These sectors are downwind from planned ISR operations, and thus would be expected to have the highest predicted air particulate concentrations during proposed project operations. Vegetation and food crop samples were collected three times during the growing season. Grassland vegetation (grasses such as blue grama, western wheat grass, and buffalo grass) was sampled by clipping above ground stems. A total of fifty-three, one kilogram samples were collected for each major species and bagged for analysis. Small grain dry land crops, including the local food crops wheat, and oats, were collected. Consumption of game animals and / or domesticated meat sources is not expected to be a significant pathway. However, an animal sampling program was conducted as described in Section 2.11. All samples were shipped in sealed bags with proper chain of custody to ELI. Vegetation samples were analyzed for Uranium, Th 230, Ra 226, Po 210, and Pb 210. QA/QC protocol and standard sampling procedures were strictly employed.

## 2.11 Animal Tissue Sampling Program

Consumption of game animals and/or domesticated meat sources is not expected to be a significant pathway; thus, it is probably unnecessary to collect and analyze animal tissue as part of establishing environmental site conditions. Fish are not available for sampling since there are no perennial streams or bodies of water in the immediate project vicinity that support fish populations. There are no large cattle operations in the vicinity of the proposed project site that constitute a food pathway to humans. Game animals (pronghorn and game birds) are mobile and are not connected to a specific location. Researchers at Colorado State University (CSU) studying uptake of radionuclides from a uranium mill site have shown a concentration ratio of 0.03 to 0.007 for soils to plants (Simon and Ibrahim 1990), and negligible uptake and effects on birds and mammals (Whicker 1972).

Nevertheless, prairie dogs were sampled for radionuclide concentrations for specific uptake on the proposed project site[6]. The prairie dog study for radionuclide uptake and concentrations in a small mammal provides baseline information on the current status of the relationship of natural radionuclides in a species of interest. The prairie dog (*Cynomys ludovicianus*) was selected as the best animal for study for the following reasons:

- It is a semifossorial (burrowing and ground-dwelling) animal that inhabits a series of burrows in a specific location. Main burrows are 3-5 feet deep and may extend to 14 feet below ground.
- The animals live underground and forage on vegetation in the immediate vicinity of their burrows.
- The baseline study can be replicated during operations and post-operations to compare concentrations over time.

As shown on **Plate 2**, ten prairie dogs were harvested on property owned by Powertech in the NW ¼ Section 14, T8N, R67W in Weld County. From each animal, a tissue sample and bone sample were submitted for analysis. Prior to sampling, a Colorado Division of Wildlife (CDOW) scientific collections permit was obtained, and the local District Wildlife Manager was notified of the activity prior to harvesting. All salvaged tissue was double-bagged (flesh and bone separate) in one-gallon zip-lock freezer bags, labeled, and placed in a cooler of ice within three hours. Viscera and skin were discarded. One prairie dog (both flesh and bone) was split into separate sample bags to serve as a field duplicate. Only a single sampling event was performed. All samples were double-bagged, placed in a cooler of ice and shipped with the

[6] Fish are not available for sampling since there are no perennial streams or bodies of water in the immediate project vicinity that support fish populations.

proper chain of custody via FedEx to ELI. Soft tissue was analyzed for uranium and the bone was analyzed for Ra 226.

## 2.12 Cultural Resource Inventory

A Class III cultural resources inventory was performed to identify any cultural resources within the proposed project areas of potential effect (APE), and to assist the National Register of Historic Places (NRHP) in the evaluation and management of cultural resources which may be affected by the proposed undertakings (i.e., those that lie within the defined APE). The work was performed consistent with Colorado Historical Society Office of Archaeology and Historic Preservation guidelines for conducting cultural resource inventories in Colorado. Discovered cultural resources were (and will be) evaluated using the criteria established for NRHP eligibility (36 CFR §60.4 a-d).

The proposed APE was inventoried by walking a series of parallel transects spaced no more than twenty meters apart. Special attention was given to areas of enhanced subsurface visibility, such as erosion cuts, road ditches, anthills, and the back-dirt of animal burrows. Discovered cultural materials were classified as sites[7] or isolated finds[8], documented on appropriate Colorado cultural resource survey forms, and plotted on the appropriate 7.5-minute USGS topographic quadrangle maps. The full extent of each site was delineated, a site sketch map created, and digital photographs taken of the site area and any distinctive features. Diagnostic artifacts also were photographed. Global Positioning System (GPS) readings were taken, as appropriate, to assist in locating and mapping sites. GPS readings were differentially corrected and post-processed for accuracy. No cultural materials were collected during the inventory. No laboratory analyses were performed as part of the program.

## 2.13 Noise Survey

A noise survey was performed to establish baseline noise levels at key locations of the proposed Centennial project site. The focus of study is Centennial North as it is the least populated (and thus likely to have the lowest noise levels). It is the zone where the majority of construction would take place, where the proposed central processing facility would be located (in the NE

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[7] For documentation purposes, a cultural resource a site is defined as a location of past human activity that took place over 50 years ago and which left physical traces of that activity in the form of (1) an intact cultural feature, (2) five or more artifacts found within about 60 m of each other, and/or (3) an intact subsurface cultural deposit regardless of the number of artifacts.

[8] An isolated find is a location with four or fewer artifacts or one that is identified by the archeologist(s) as representing an area of very limited past activity. Isolated finds are considered not eligible for nomination to the NRHP due to their limited potential for providing further important archaeological data.

quarter of Section 9, T9N, R67W) and, because of the greater well depth, the zone where most of the drilling would occur.

As shown on **Plate 1**, three sites were selected to perform the noise survey. Location No. 1 is along the proposed access road to the central processing facility; Location No. 2 is near the proposed central processing facility site; and Location No. 3 is situated near the intersection of the two most traveled roads in the area, County Road 17 and County Road 100. Site selection was constrained to areas where access was permissible by the land owner or occupant. The three sites were in areas where the monitors would be accessible, secure and relatively free from cultural noise that would skew the measured dB values. Traffic noise would skew the data if the instruments were placed too close to any roadway. The ambient noise north, south, east and west of the site was about the same as long as the monitors were located several hundred feet from any roadway or residence. In order to obtain a good estimate of the ambient or existing noise environment, it is necessary to take measurements of sufficient duration so that the environment can be observed on an hour by hour basis so that any effects such as high winds, precipitation or wildlife can be excluded from the measured data. For this reason it was decided to run the three noise monitors continuously for two weeks and record the average noise level for each and every hourly increment during the entire period.

The noise monitoring equipment used consisted of a Quest Model 1900 noise monitor. Noise monitoring occurred continuously over an approximate two-week period. Each noise monitor was set to measure the energy equivalent level (Leq) for every hour of the measurement period. The Leq value is different than the average value because the Leq is based upon the mean square average of the acoustic energy rather than the simple numerical average of the sound pressure level. The Leq value is always equal to or greater than the average value. The Leq results will be presented along with statistical exceedance levels at each of the three noise sites. No analysis was required.

# 3.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

This section summarizes the Quality Control (QC) and Quality Assurance (QA) procedures used to assure reliability of data associated with this SCP.

## 3.1 Data Quality Objectives

The overall objective of the SCP is to establish an accurate characterization of the pre-mining environmental conditions at and surrounding the project area in accordance with applicable and appropriate regulatory requirements and guidelines. Data Quality Objectives (DQOs) were used to plan and implement the environmental sampling activities so that the data acquired is reliable. The DQOs established for this program include the following:

Assess the quality of data generated to assure that all data are scientifically valid and of known and documented quality. This is largely accomplished by establishing acceptance limits for parameters such as precision, accuracy, completeness, representativeness, and comparability, and by testing generated data against acceptance criteria established for these parameters.

Achieve an acceptable level of confidence in the decisions that are made from data by controlling the degree of total error permitted in the data using quality control (QC) checks. Data that fail the QC checks or do not fall within the acceptance criteria established will be evaluated for usability in meeting project objectives during data review.

The project standard operating procedures (SOPs) and the analytical program (Tables 2.2 through 2.4) for field sampling, sample custody, equipment operation and calibration, laboratory sample analysis, data reduction, and data reporting were implemented to assure data reliability and usability and thus assure conformance with these DQOs.

## 3.2 Project Organization

An important component of any QA/QC program is the capabilities and experience of the project team. This section presents the organizational structure for the SCP.

### Consultant Project Manager

The consulting project manager (CPM) for the permitting and licensing efforts is responsible for all facets of the sampling and analysis program. The CPM has over thirty years of experience in providing engineering and environmental services to natural resource industries, including experience in permitting uranium recovery facilities. He has the overall responsibility for performing the work required to obtain the necessary licenses and permits on time, within budget, and within the quality standards defined for the project. The CPM reports to Powertech's project manager (PM). The CPM will act as the interface between Powertech and $R^2$ unless otherwise directed by the CPM.

### Health/Safety and Radiation Safety Officer

The Health/Safety and Radiation Safety Officer develops or reviews and approves SOPs related to the collection of radiological background data, and reviews and validates radiological sampling results. He reports to the CPM, and is certified by the American Board of Health Physics and has over 35 years of experience in the Uranium industry. The project Site Specific Health and Safety Plan provides additional information and requirements regarding to industrial and radiation safety programs and procedures.

### Site Manager/Site Health and Safety Supervisor

The Site Health and Safety Officer (SHSO) is a registered professional engineer in Colorado with over 20 years experience in planning and implementing field monitoring and investigation programs. The SHSO reports directly to the CPM and is responsible for $R^2$ personnel and subcontractors working in the field. Specific responsibilities include the following:

- Overseeing the implementation of the field sampling and health and safety
- Ensuring that all field activities adhere to this SCP and associated SOPs
- Informing the CPM of any decisions that involve changes to the SCP

The SHSO was also responsible to the CPM for the required progress reports, tracking the field budget against the milestones set forth in the scope of work, requesting change orders, and all other matters relating to the implementation of the envronmental monitoring plan.

### Field Staff

Field staff implements sample collection, handling, storage, and shipping activities among others. They maintain the field sampling logs and notebooks and are responsible for properly labeling sample containers. They also obtain the required radiation and industrial safety training, and read and understand the health, safety, and quality control protocols. Field staff report to the Site Manager. It is the responsibility of field staff to notify the Site Manager of any problems or potential changes to the SCP.

### Laboratory Services

Energy Laboratories Inc. (ELI) of Casper, Wyoming, performed soil, water, air, and animal tissue analyses; Paragon Analytics, Ft. Collins, Colorado (Paragon) performed water analysis of groundwater samples from domestic wells sampled as part of this SCP. Both ELI and Paragon are Colorado Certified laboratories and participate in NRC's National Voluntary Laboratory Accreditation Program (15 USC 285). The analyses were conducted in accordance with approved methods or methods summarized on Tables 2.2 through 2.4.

## 3.3 Field Sampling Procedures

Specific field sampling procedures for groundwater, surface water, radionuclide particulates in air, radon in air, surface soil, and subsurface soil sampling (as well as direct radiation and radon flux measurements) are described in the project Standard Operating Procedures (SOPs) and summarized throughout this document.

Sample preservatives, containers, and holding time requirements for each analyte is summarized in **Tables 2.2 through 2.4.** Reporting limits and quality control sample requirements are also are provided in **Tables 2.2 through 2.4**.

## 3.4 Analytical Methods and Procedures

### Laboratory Analytical and Measurement Procedures

Laboratory analytical and measurement procedures were provided to the by each project analytical laboratory. Labeled sample containers were provided by the laboratories. Preservatives were added to the bottles by the laboratories as required by the method. Temperature sensitive samples such as water and tissue were stored on ice in an insulated cooler immediately following sample collection, to maintain a temperature of less than or equal to 4°C. Soil and sediment samples did not require additional preservation. Allowable holding times for chemical parameters are listed in **Tables 2.2 to 2.4**. Samples were shipped to the laboratory after collection in sufficient time to allow the laboratory to meet holding time requirements.

### Sample Preparation

The laboratories prepared samples for analyses in accordance with methodology described in the analytical methods, listed in Tables 2.2 through 2.4. Specific sample preparation requests are noted on the chain of custody form.

## 3.5 Quality Control Checks

### Internal

Field personnel will review and verify 100 percent of the data generated in the field. The CPM will be responsible for ensuring field and laboratory data is validated and verified in accordance with the methods described in Section 3.6.

### External

The project analytical laboratories are responsible for implementing the QC requirements defined in the methods listed in Tables 2.2 through 2.4 and for implementation of their internal QC program.

## 3.6 Data Verification and Validation

Validation and verification of data generated during field activities are essential to obtaining data of acceptable quality. Data values that are significantly different from the rest of the data population are called "outliers." A systematic effort must be made to identify any outliers or errors before field and laboratory personnel report the data. Outliers can result from improper sampling or analytical methodology, matrix interferences, data transcription errors, or calculation errors, or may be the result of real variability in sample chemistry. Outliers that result from errors found during data verification will be identified and corrected; those that cannot be attributed to analytical, calculation, or transcription errors will be reported in the case narrative section of the analytical report. Additional verification methods for field and laboratory activities and procedures for review and validation of analytical data are described in the following sections. Separate from outliers, is the validation criteria which indicates areas of laboratory and matrix precision, accuracy and contamination. These are noted below.

**Field Data Verification**

Project team personnel will validate field data through reviews of data sets to identify inconsistencies or anomalous values. Inconsistencies discovered are resolved immediately, if possible, by seeking clarification from the field personnel responsible for data collection. Field personnel are familiar with field instrument operations manuals and calibration procedures to ensure instrumentation is in proper working and operating condition. All field personnel will be responsible for following the sampling and documentation procedures described in the SAP so that defensible and justifiable data will be obtained.

**Laboratory Verification of Data**

Laboratory personnel verify analytical data at the time of analysis and reporting by reviewing raw data for nonconformance with analytical methods requirement. Detailed procedures for laboratory verification and corrective action are provided in the laboratory issued QA plan.

**Analytical Data Validation**

Organic and inorganic analytical data will be validated according to protocols developed from method-specific criteria and USEPA guidelines. For organics, analytical data will be validated in general accordance with National Functional Guidelines for Organics Methods Data Review, (OSWER 9240.1-46, USEPA-540-R-07-003, July 2007) or 1999 revision as applicable to the method requested. Inorganic analytical data and cursory level radiochemistry will be validated in general accordance with USEPA National Functional Guidelines for Inorganic Review, (OSWER 9240.1-45, EPA 540-R-04-004, October 2004). Radiological data are reviewed in general accordance with requested EPA criteria as a basis for review of fully validated data. Data validation procedures are described in the SOPs. The project radiation safety officer reviews radiological data and as necessary, interacts with laboratory personnel to resolve issues that may impact completeness and/or quality of radiological data.

# FIGURES

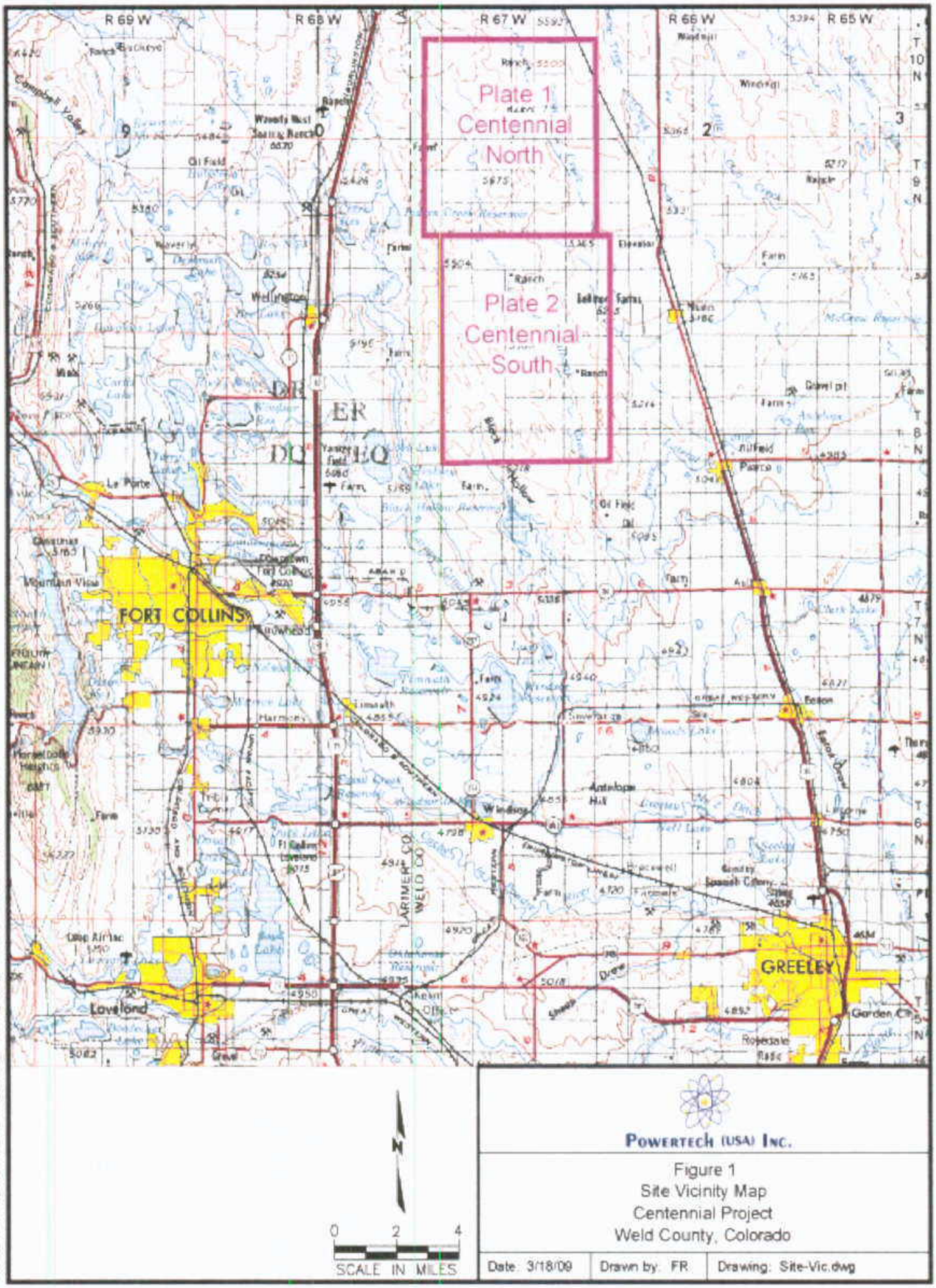


Figure 1
Site Vicinity Map
Centennial Project
Weld County, Colorado

Date: 3/18/09 | Drawn by: FR | Drawing: Site-Vic.dwg

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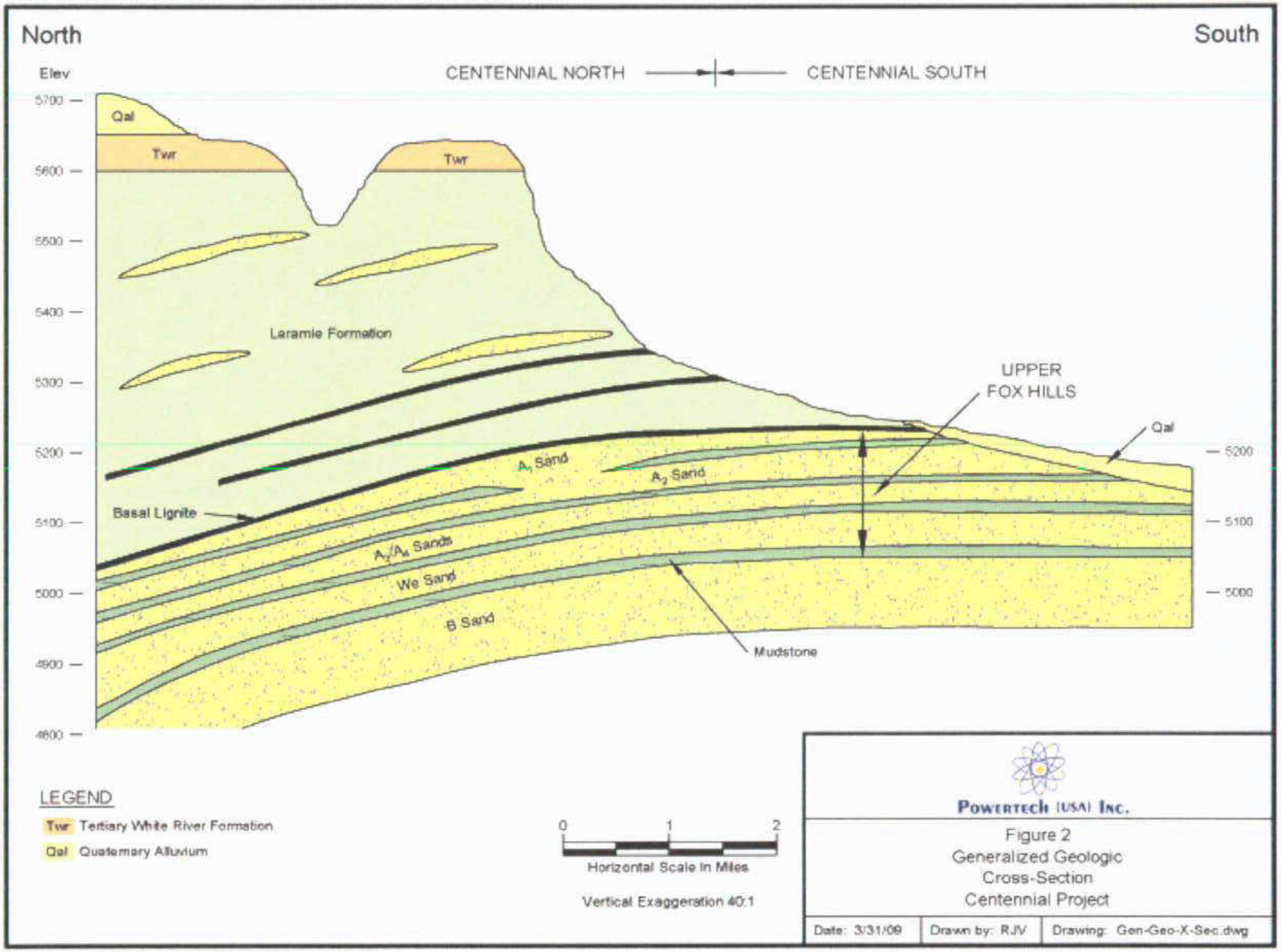



Figure 2
Generalized Geologic Cross-Section
Centennial Project

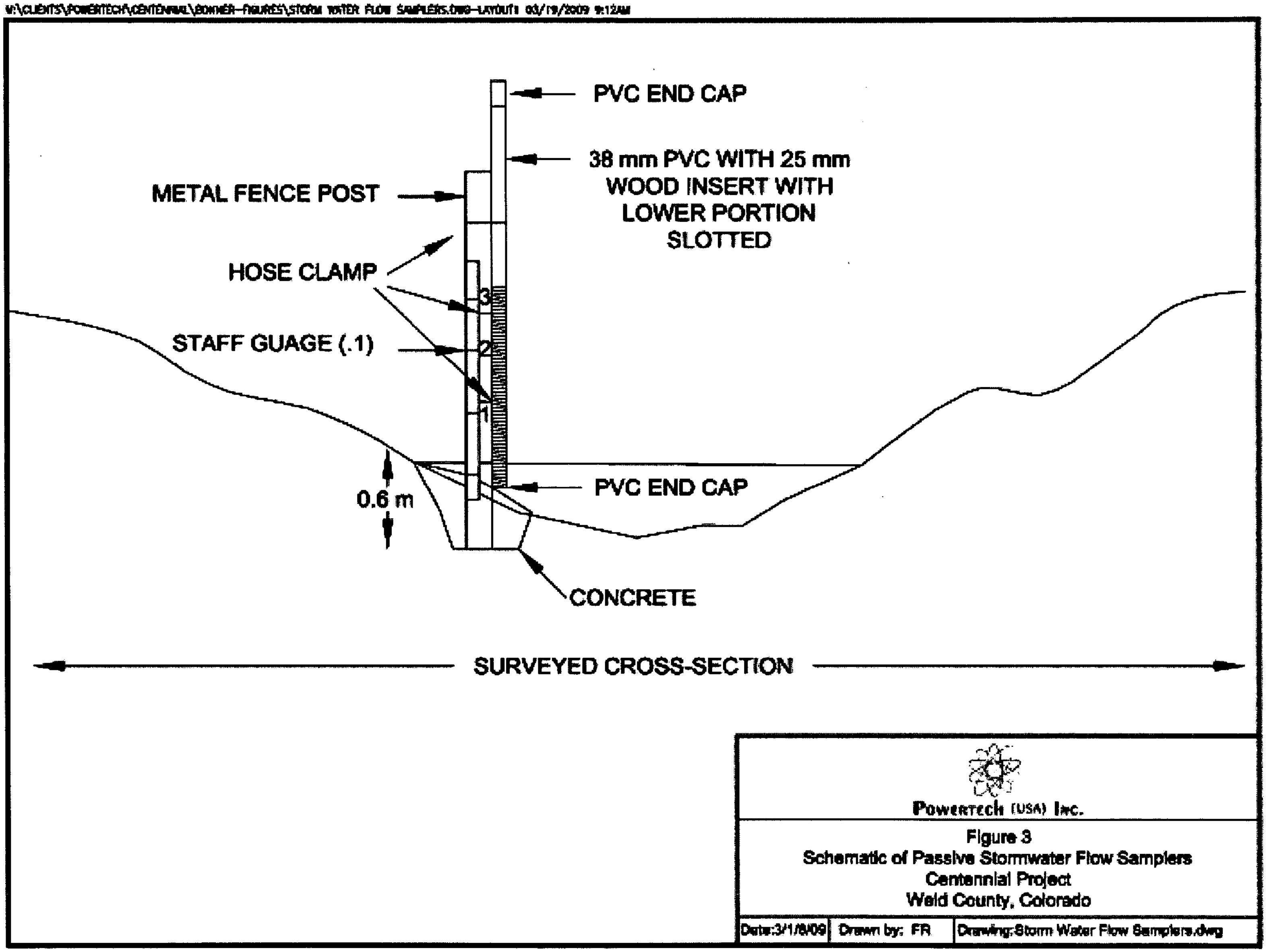
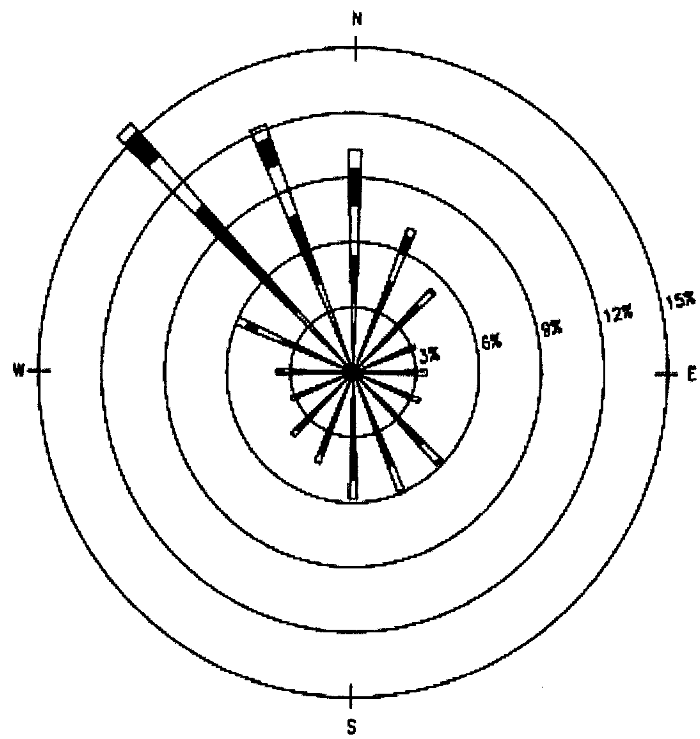
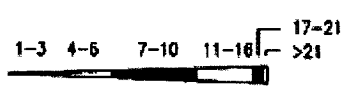



Figure 3
Schematic of Passive Stormwater Flow Samplers
Centennial Project
Weld County, Colorado




NOTES:
DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION.
WIND DIRECTIONS IS THE DIRECTION FROM WHICH THE WIND IS BLOWING.
EXAMPLE–WIND IS BLOWING FROM THE NORTH 10.3 PERCENT OF THE TIME




WIND SPEED CLASSES
(KNOTS)

POWERTECH (USA) INC.

Figure 4
Project Wind Rose
Centennial Project
Weld County, Colorado

| Date: 3/18/09 | Drawn by: FR | Drawing: Project Wind Rose.dwg |
|---|---|---|

# TABLES

**Table 2.1 Environmental Monitoring Overview**
**Centennial Project**
**Weld County, Colorado**

| Sample Type | Number of Sampling Points (a) | Sampling Frequency | Map |
|---|---|---|---|
| **Groundwater** | | | |
| Water Quality (New + Existing) | 21 | 8 events over 5 quarters | Plates 1 and 2 |
| Domestic Wells | 36 | Once | |
| | | | |
| **Surface Water** | | | |
| Streams | 18 | When possible | Plates 1 and 2 |
| Impoundments | 2 | Quarterly | Plate 1 |
| | | | |
| **Soils** | | | Plates 1 and 2 |
| Surface Soils (RAD) | 55 | Once | |
| Soil Profiles | 21 | Once | |
| | | | |
| Radon Flux | 21 | Once per season, excluding winter | Plates 1 and 2 |
| | | | |
| **Direct Radiation Measurements** | | | Plates 1 and 2 |
| Gamma Survey | Multiple | Once | |
| TLDs | 10 | Quarterly for 12 months | |
| | | | |
| **Particulates** | | | Plates 1 and 2 |
| High Volume Samplers | 5 | Continuous with quarterly composite analysis | |
| PM10 | 2 | Every 6 days for 12 months | |
| Radon | 5 | Quarterly for 12 months | |
| | | | |
| Vegetation | 53 | Three times during growing season | Plates 1 and 2 |
| | | | |
| Animal Tissue | 10 | Once | Plate 2 |
| | | | |
| Noise | 3 | Once | Plate 1 |

Notes:

(a) Samples were collected in accordance with project Standard Operating Procedures

(b) Sampling locations are shown in Plates 1 and 2

(c) Samples were also obtained from five additional locations that did not have passive sampling systems (Figure 3) installed

**Table 2.2. Groundwater Analytical Program**
Centennial Project
Weld County, Colorado

| Analytical Parameter | Maximum Contaminant Level (MCL, mg/L) | Analytical Method (a) | Reporting Limit, mg/L unless otherwise specified (f) | Estimated Number of LAB QC Samples (b) | | Estimated Number of FIELD QC Samples | | | | Filter in field? | Preservation | Number of Container(s)/ Minimum Volume (d) | Sample Hold Time (from collection) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MS | MSD or DUP | Field Dup | Trip Blank | Field Blank | Rinsate Blank (c) | | | | |
| **Dissolved Metals (mg/L) (e)** | | | | | | | | | | | | | |
| Aluminum | none | E200.7/E200.8 | 0.1 | 1 per 20 samples | | 1 per 20 samples | NA | | 1 per 20 samples | Yes | Filter (0.45 micron) then add $HNO_3$ to pH < 2 | 1-1 gallon poly with RAD analytes | 6 months |
| Antimony, low level | 0.006 | E200.8 | 0.001 | | | | | | | | | | |
| Arsenic | 0.01 | E200.8 | 0.001 | | | | | | | | | | |
| Barium | 2 | E200.7/E200.8 | 0.1 | | | | | | | | | | |
| Beryllium | 0.004 | E200.7/E200.8 | 0.001 | | | | | | | | | | |
| Boron | 0.75 | E200.7 | 0.1 | | | | | | | | | | |
| Cadmium | 0.005 | E200.7/E200.8 | 0.001 | | | | | | | | | | |
| Chromium | 0.1 | E200.8 | 0.01 | | | | | | | | | | |
| Copper | 1.3 | E200.7/E200.8 | 0.01 | | | | | | | | | | |
| Iron | 0.3 | E200.7 | 0.03 | | | | | | | | | | |
| Lead | 0.015 | E200.8 | 0.01 | | | | | | | | | | |
| Manganese | 0.05 | E200.7/E200.8 | 0.01 | | | | | | | | | | |
| Mercury | 0.002 | E200.8 | 0.00025 | | | | | | | | | | |
| Molybdenum | none | E200.8 | 0.01 | | | | | | | | | | |
| Nickel | 0.1 | E200.7/E200.8 | 0.010 | | | | | | | | | | |
| Selenium | 0.05 | E200.8 | 0.001 | | | | | | | | | | |
| Silver | none | E200.7/E200.8 | 0.05 | | | | | | | | | | |
| Uranium | 0.03 | E200.8 | 0.0003 | | | | | | | | | | |
| Thallium | 0.002 | E200.8 | 0.001 | | | | | | | | | | |
| Vanadium | None | E200.7/E200.8 | 0.1 | | | | | | | | | | |
| Zinc | 5 | E200.7/E200.8 | 0.01 | | | | | | | | | | |

**Table 2.2. Groundwater Analytical Program, continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Radiological (pCi/L)** | | | | | | | | | | | | |
| Gross Alpha | 15 | E900.0 | 1 pCi/L | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | Yes | pH < 2 with $HNO_3$ | 1-1 gallon poly with dissolved metals | 6 months |
| Gross Beta | 4 mrem/year or approx. 50 pCi/L | E900.0 | 2 pCi/L | | | | | | | | | |
| Radium 226 | 226Ra+228Ra=5 | E903.0 | 0.2 pCi/L | | | | | | | | | |
| **Non-metals (mg/L)** | | | | | | | | | | | | |
| Ortho phosphate, dissolved | none | E365.1 | 0.01 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | Yes | Filter (0.45 micron) then add H2SO4 to pH < 2 cool to 4 °C | 1 -250 ml poly | 28 days (preserved) |
| Nitrate (as N), dissolved | 10 (total) | E353.2 | 0.05 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | Yes | Filter (0.45 micron) then cool to 4°C | 1-250 ml poly | 28 days |
| Total dissolved solids (TDS) | none | E160.1 | 10 | | | | | | | | | 7 days |
| Alkalinity (total as $CaCO_3$) | none | EPA 310.1/A 2320B | 1 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | No | Cool to 4 °C | 1-500 ml poly | 14 days |
| Bicarbonate ($HCO_3$) | none | | 1 | | | | | | | | | |
| Carbonate | none | | 1 | | | | | | | | | |
| Chloride | 250 | E300.0/ A4500 Cl B | 1 | | | | | | | | | 28 days |
| Fluoride (mg/L) | 4 | A 4500 F C | 0.1 | | | | | | | | | 28 days |
| Hardness (total as $CaCO_3$) | none | A 2340 B | 1 | | | | | | | | | 6 months |
| Silica | | E200.7 | 0.1 | | | | | | | | | 28 days |
| Sulfate | 500 | E300.0/ A4500 SO4 E | 5 | | | | | | | | | 28 days |
| Total suspended solids (TSS) | none | E160.2 | 10 | | | | | | | | | 7 days |
| Nitrate/Nitrite as N | 11 (g) | E353.2 | 0.1 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | No | pH < 2 H2S04Cool to 4 °C | 1- 250 ml poly | 28 days |

**Table 2.2. Groundwater Analytical Program, continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Calculated Parameters/Data Quality** | | | | | | | | | | | | |
| Anions (meq/L) | none | Standard Methods 20th Edition & ASA Mono. #9, Part 2, Method 10-3.4 (SAR) | NA | NA | | | | | | | | |
| Cations (meq/L) | | | NA | | | | | | | | | |
| Cation - Anion Balance (mg/L) | | | NA | | | | | | | | | |
| Total dissolved solids | | | 10 | | | | | | | | | |
| Total dissolved solids - ratio | | | NA | | | | | | | | | |
| Sodium Absorption Ratio (SAR) | | | NA | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | |
| Depth to Water (ft) | NA | | 0.01 | NA | NA | NA | NA | NA | | NA | NA | NA |
| Total Depth (ft) | NA | | 0.01 | | | | | | | | | NA |
| Water Elevation (ft AMSL) | NA | | 0.01 | | | | | | | | | NA |
| Temperature (°C) | none | | 0.1 | | | | | | | | | Analyze immediately |
| Specific Conductance (mmhos/cm) | none | | 0.001 to 0.1 (range dependent) | | | | | | | | | Analyze immediately |
| pH (standard units) | 6.5-9.0 | | 0.01 | | | | | | | | | Analyze immediately |
| Oxidation/Reduction Potential (mV) | none | | 0.01 | | | | | | | | | Analyze immediately |
| Dissolved oxygen (mg/L) | none | | 0.01 | | | | | | | | | Analyze immediately |

Notes:
(a) Proposed/equivalent analytical methods may be used pending EPA approval.
(b) As applicable to the Method.
(c) Assumes no dedicated or disposable sampling equipment will be used and therefore, equipment blanks are necessary for groundwater, surface water and sediment samples.
(d) Parameters requiring the same preservation, similar container type and being analyzed by the same laboratory may be collected as one aggregate volume.
(e) MCLs are for total analyte concentrations only.
(f) The reporting limit (RL) is equivalent to the practical quantitation limit (PQL).
(g) Sum of MCLs for nitrate as nitrogen (10 mg/L) and nitrite as nitrogen (1 mg/L).
Total number of groundwater samples: 25 (9 existing RME wells + 16 new wells)
Refer to Plates 1 and 2 for monitoring well locations.

**Table 2.3. Surface Water Sampling Program**
Centennial Project
Weld County, Colorado

| Analytical Parameter | Maximum Contaminant Level (MCL, mg/L) | Analytical Method (a) | Reporting Limit, mg/L unless otherwise specified (f) | Estimated Number of LAB QC Samples (b) | | Estimated Number of FIELD QC Samples | | | | Filter in field ? | Preservation | Number of Container(s)/ Minimum Volume (d) | Sample Hold Time (from collection) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | S | MSD or DUP | Field Dup | Trip Blank | Field Blank | Rinsate Blank (c) | | | | |
| **Dissolved Metals (mg/L) (e)** | | | | | | | | | | | | | |
| Arsenic | 0.01 | E200.8 | 0.001 | 1 per 20 samples | | 1 per 20 samples | NA | | 1 per 20 samples | Yes | Filter (0.45 micron) then add HNO3 to pH < 2 | 1 -250 ml poly | 6 months |
| Boron | 0.75 | E200.7 | 0.1 | | | | | | | | | | |
| Cadmium | 0.005 | E200.7/E200.8 | 0.001 | | | | | | | | | | |
| Copper | 1.3 | E200.7/E200.8 | 0.01 | | | | | | | | | | |
| Iron | 0.3 | E200.7 | 0.03 | | | | | | | | | | |
| Lead | 0.015 | E200.8 | 0.01 | | | | | | | | | | |
| Manganese | 0.05 | E200.7/E200.8 | 0.01 | | | | | | | | | | |
| Molybdenum | none | E200.8 | 0.01 | | | | | | | | | | |
| Selenium | 0.05 | E200.8 | 0.001 | | | | | | | | | | |
| Zinc | 5 | E200.7/E200.8 | 0.01 | | | | | | | | | | |
| **Total Metals (mg/L)** | | | | | | | | | | | | | |
| Aluminum | none | E200.7/E200.8 | 0.1 | 1 per 20 samples | | 1 per 20 samples | NA | | 1 per 20 samples | No | HNO3 to pH < 2 | 1-1 gallon poly with RAD analytes and total recoverable metals | 6 months |
| Antimony | 0.006 | E200.8 | 0.001 | | | | | | | | | | |
| Arsenic | 0.01 | E200.8 | 0.001 | | | | | | | | | | |
| Barium | 2 | E200.7/E200.8 | 0.1 | | | | | | | | | | |
| Beryllium | 0.004 | E200.7/E200.8 | 0.001 | | | | | | | | | | |
| Cadmium | 0.005 | E200.7/E200.8 | 0.001 | | | | | | | | | | |
| Chromium | 0.1 | E200.8 | 0.01 | | | | | | | | | | |
| Iron | 0.3 | E200.7 | 0.03 | | | | | | | | | | |
| Lead | 0.015 | E200.8 | 0.01 | | | | | | | | | | |
| Uranium | 0.03 | E200.8 | 0.0003 | | | | | | | | | | |
| Nickel | 0.1 | E200.7/E200.8 | 0.010 | | | | | | | | | | |
| Mercury | 0.002 | E200.8 | 0.00025 | | | | | | | | | | |

**Table 2.3 Surface Water Sampling Program, continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Selenium | 0.05 | E200.8 | 0.001 | 1 per 20 samples | *per 20 samples | NA | 0 | 1 per 20 samples | No | HNO3 to pH < 2 | 1-1 gallon poly with RAD analytes and total recoverable metals | 6 months |
| Silver | none | E200.7/E200.8 | 0.05 | | | | | | | | | |
| Thallium | 0.002 | E200.8 | 0.001 | | | | | | | | | |
| Vanadium | none | E200.7/E200.8 | 0.1 | | | | | | | | | |
| **Radiological (pCi/L)** | | | | | | | | | | | | |
| Gross Alpha | 15 | E900.0 | 1 pCi/L | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | No | pH < 2 with $HNO_3$ | 1-1 gallon poly with total metals | 6 months |
| Gross Beta | 4 mrem/year or approx. 50 pCi/L | E900.0 | 2 pCi/L | | | | | | | | | |
| Radium 226 | 226Ra+228Ra =5 | E903.0 | 0.2 pCi/L | | | | | | | | | |
| **Non-metals (mg/L)** | | | | | | | | | | | | |
| Ortho phosphate, dissolved | none | E365.1 | 0.01 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | Yes | Filter (0.45 micron) then add H2SO4 to pH < 2 cool to 4 °C | 1 -250 ml poly | 28 days (preserved) |
| Total dissolved solids (TDS) | none | E160.1 | 10 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | Yes | Filter (0.45 micron) then cool to 4°C | 1-250 ml poly | 7 days |
| Alkalinity (total as $CaCO_3$) | none | EPA 310.1/A 2320B | 1 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | No | Cool to 4 °C | 1-500 ml poly | 14 days |
| Bicarbonate ($HCO_3$) | none | | 1 | | | | | | | | | |
| Carbonate | none | | 1 | | | | | | | | | |
| Chloride | 250 | E300.0/ A4500 Cl B | 1 | | | | | | | | | 28 days |
| Fluoride (mg/L) | 4 | A 4500 F C | 0.1 | | | | | | | | | 28 days |
| Hardness (total as $CaCO_3$) | none | A 2340 B | 1 | 1 per 20 samples | 1 per 20 samples | NA | 0 | 1 per 20 samples | No | Cool to 4°C | 1-500 ml poly | 6 months |
| Silica | none | E200.7 | 0.1 | | | | | | | | | 28 days |
| Sulfate | 500 | E300.0/ A4500 SO4 E | 5 | | | | | | | | | 28 days |

**Table 2.3. Surface Water Sampling Program, continued**

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total suspended solids (TSS) | None | E160.2 | 10 | 1 per 20 samples | 1 per 20 samples | NA | | 1 per 20 samples | no | | | 7 days |
| Nitrate/Nitrite as N | 11 (g) | E353.2 | 0.1 | 1 per 20 samples | 1 per 20 samples | NA | | 1 per 20 samples | No | pH < 2 H2S04 Cool to 4 °C | 1- 250 ml poly | 28 days |
| **Calculated Parameters/Data Quality** | | | | | | | | | | | | |
| Anions (meq/L) | none | Standard Methods 20th Edition & ASA Mono. #9, Part 2, Method 10-3.4 (SAR) | NA | | | | | NA | | | | |
| Cations (meq/L) | | | NA | | | | | | | | | |
| Cation - Anion Balance (mg/L) | | | NA | | | | | | | | | |
| Total dissolved solids | | | 10 | | | | | | | | | |
| Total dissolved solids - ratio | | | NA | | | | | | | | | |
| Sodium Absorption Ratio (SAR) | | | NA | | | | | | | | | |
| **Field Parameters** | | | | | | | | | | | | |
| Depth to Water (ft) | NA | | 0.01 | | | | | | | | | NA |
| Total Depth (ft) | NA | | 0.01 | | | | | | | | | NA |
| Water Elevation (ft AMSL) | NA | | 0.01 | | | | | | | | | NA |
| Temperature (°C) | none | | 0.1 | | | | | | | | | Analyze immediately |
| Specific Conductance (mmhos/cm) | none | | 0.001 to 0.1 (range dependent) | NA | NA | NA | NA | NA | NA | NA | NA | Analyze immediately |
| pH (standard units) | 6.5-9.0 | | 0.01 | | | | | | | | | Analyze immediately |
| Oxidation/Reduction Potential (mV) | none | | 0.01 | | | | | | | | | Analyze immediately |
| Dissolved oxygen (mg/L) | none | | 0.01 | | | | | | | | | Analyze immediately |

**Table 2.3. Surface Water Sampling Program, continued**

Notes:

(a) Proposed/equivalent analytical methods may be used pending EPA approval.

(b) As applicable to the Method.

(c) Assumes no dedicated or disposable sampling equipment will be used and therefore, equipment blanks are necessary for groundwater, surface water and sediment samples.

(d) Parameters requiring the same preservation, similar container type and being analyzed by the same laboratory may be collected as one aggregate volume.

(e) MCLs are for total analyte concentrations only.

(f) The reporting limit (RL) is equivalent to the practical quantitation limit (PQL).

(g) Sum of MCLs for nitrate as nitrogen (10 mg/L) and nitrite as nitrogen (1 mg/L).

Total number of groundwater samples: 49 (26 existing RME wells + 23 new wells)

Refer to Plates 1 and 2 for surface water sampling locations

**Table 2.4. Soil Sampling Program**
Centennial Project
Weld County, Colorado

| Analytical Parameter | Analytical Method (a) | Reporting Limit, mg/L unless otherwise specified | Estimated Number of Samples (b) | Estimated # of QC Samples | Number of Container(s) /Minimum Quantity | Sample Hold Time (from collection) |
|---|---|---|---|---|---|---|
| Total Uranium | SW 6020 | 0.2 mg/kg-dry | 240 Surface; 105 subsurface (35 locations, 3 samples / depth profile) | 1 per 20 samples | 200 grams | |
| Thorium 230 | E907.0 | 2E-7 uCi/g | 10 % of above | | 200 grams | |
| Radium 226 | E 901.1 | 2E-7 uCi/g | Same as Uranium | | 200 grams | |
| Lead 210 | E 905.0 | 2E-7 uCi/g | 10 % of above | | 200 grams | |
| Gross Alpha | E 900.0 | 2E-7 uCi/g | Same as Uranium | | 200 grams | |
| Gross Beta | E 900.0 | 2E-7 uCi/g | Same as Uranium | | 200 grams | |
| Organic matter | ASTM D2974 | N/A | Same as Subsurface | N/A | 200 grams | N/A |
| Saturation % | ASTM D4643, D854 | | | | 200 grams | |
| Sand % | ASTM D6913 | | | | 200 grams | |
| Vegetation free sand % | | | | | 200 grams | |
| Silt % | ASTM D1140 | | | | 200 grams | |
| pH | | | | | 200 grams | |
| Conductivity | | | | | 200 grams | |
| Ca, Mg, Na (meq/l) | | | | | 200 grams | |
| Sodium Absorption Ratio | | | | | 200 grams | |
| Clay % | ASTM D422 | | | | 200 grams | |

Notes:

(a) Proposed/equivalent analytical methods may be used pending CDPHE approval.

(b) Refer to Plates 1 and 2 for soil sampling locations.

# PLATES