FINAL

AMEC Geomatrix

PLAN OF STUDY

FOR EVALUATING POTENTIAL SOURCES OF LOW-LEVEL PETROLEUM HYDROCARBON COMPOUND DETECTIONS

MAY 2009

FINAL

PLAN OF STUDY
for
EVALUATING POTENTIAL SOURCES OF LOW-LEVEL PETROLEUM HYDROCARBON COMPOUND DETECTIONS

INTERIM PLAN, PAPA ROD

PINEDALE ANTICLINE OIL AND GAS EXPLORATION AND DEVELOPMENT PROJECT

Sublette County, Wyoming

Prepared for:

U.S. Department of Interior, Bureau of Land Management, Pinedale Field Office
Wyoming Department of Environmental Quality, Water Quality Division
U.S. Environmental Protection Agency, Region 8
Shell Rocky Mountain Production
Questar Market Resources
Ultra Resources, Inc.

Prepared by;

AMEC Geomatrix, Inc.
1001 South Higgins Avenue, B-1
Missoula, Montana 59801

AMEC Geomatrix

May 15, 2009

TABLE OF CONTENTS

1.0 INTRODUCTION 2

1.1 Background 2
1.2 Study Objective 3
1.3 Plan of Study Organization 3

2.0 STUDY AREA DESCRIPTION 5

2.1 Hydrogeologic Setting 5
2.2 Petroleum Hydrocarbon Compounds Occurrence and Distribution 6

3.0 DATA QUALITY OBJECTIVES 8

3.1 Study Goals and Objectives 8
3.2 Information Inputs 8
3.3 Measurement Performance Criteria 9
3.4 Precision 10
3.5 Accuracy 10
3.6 Completeness 11

4.0 APPROACH 12

4.1 Compile/Review Available Information and Supplement Project Database 12
4.2 Prepare and Execute Sampling and Analysis Plans 14
4.3 Assess Drilling, Pump Installation, and Sampling Practices 16
4.4 Prepare Technical Report for Low-Level Petroleum Hydrocarbon Evaluation 17

5.0 QUALITY ASSURANCE AND QUALITY CONTROL 18

5.1 Field Quality Control 18
5.2 Laboratory Quality Control 19
5.3 Database and Reporting 21
5.4 Data Review 22

6.0 SCHEDULE 25

7.0 PERSONNEL 26

8.0 REFERENCES 27

TABLE OF CONTENTS – continued

LIST OF FIGURES (Appendix A)

Figure 1 Project Location Map
Figure 2 Wells Containing Measurable Petroleum Hydrocarbons

LIST OF TABLES (Appendix B)

Table 1 Summary of Information for Inventoried Wells
Table 2 Summary of Water Wells with One or More PHC Detections
Table 3 Media-Specific Parameters for Laboratory Analysis
Table 4 Precision, Accuracy, and Completeness Goals

LIST OF APPENDICES

Appendix A Figures
Appendix B Tables
Appendix C Matrices
Appendix D Standard Operating Procedures
Appendix E Standard Field Forms
Appendix F Health and Safety Plan

1.0 INTRODUCTION

A consortium of agencies and companies prepared an Interim Plan (Geomatrix 2008a) that was designed to fulfill certain requirements of a recent U.S. Department of Interior, Bureau of Land Management (BLM) Record of Decision (ROD; BLM 2008) for the Pinedale Anticline Oil and Gas Exploration and Production Area (also known as the Pinedale Anticline Project Area, or PAPA) in Sublette County, Wyoming (**Figure 1**). The group is comprised of representatives and technical specialists with the BLM, Wyoming Department of Environmental Quality's Water Quality Division (DEQ/WQD), and Region 8 of the U.S. Environmental Protection Agency (EPA), as well as Shell Exploration and Production Company (Shell), Questar Market Resources (Questar), and Ultra Resources, Inc. (Ultra). AMEC Geomatrix, Inc. (Geomatrix) is providing technical support to the group. Collectively, the agencies are referred to herein as the "BDE" (BLM/DEQ/EPA) and the three oil and gas companies are referred to as the "Operators."

1.1 BACKGROUND

To fulfill requirements of the 2000 ROD (BLM 2000), the Operators contracted the Sublette County Conservation District (SCCD) to develop a surface water and groundwater monitoring program and to collect and manage resulting data. The SCCD began collecting groundwater data in the PAPA in 2000. Data are stored in a Microsoft Access database constructed and maintained by the SCCD. Groundwater information contained in the database include:

- Results of initial field inventory of water supply wells that required monitoring in accordance with the ROD.
- Water well permit information, including ownership, location, depth and a summary table cross-referencing permit numbers and SCCD well IDs.
- Well locations determined using survey grade and non-survey (e.g., recreational) grade GPS units.
- Well construction information, including type and size of casing, screened or perforated intervals, and total depth.
- Lithologic descriptions recorded on driller's well logs.
- Static water level measurements from monitored wells.
- Water quality sampling results, including field measurements and laboratory analytical results for general chemical parameters and petroleum hydrocarbon compounds (PHCs). As of December 2007, laboratory analytical data for groundwater have been collected at 167 industrial wells, 50 domestic wells, and 22 stock wells. Surface water samples have been collected at eight stations along the New Fork River and some tributary streams (Geomatrix 2008b).

The Operators retained Geomatrix to compile and analyze existing groundwater data in the PAPA, and develop a hydrogeologic conceptual model. Results of this effort are presented by Geomatrix (2008b), which documents the occurrence of low-level concentrations of PHCs in 73 industrial wells including benzene, toluene, ethylbenzene, and xylenes (BTEX), total petroleum hydrocarbons (TPH) in the gasoline (TPH-GRO) and diesel (TPH-DRO) ranges. These low-level detections of PHCs are the focus of this Plan of Study.

While the Operators identified backflow of PHC-containing fluids into wells from pits and tanks at drilling locations as the cause of PHC detections in at least four industrial water supply wells, the source of PHC detections in most of the remaining wells has not been determined definitively to date. Other potential sources include:

- Natural sources (e.g., natural gas and/or condensate);
- Water well drilling/installation practices (e.g., introduced PHCs from pipe dope, tape, and compressed air);
- Sampling artifacts (e.g., pumps, drop pipe);
- Oil and gas activities (current and historic); and
- Laboratory analytical issues/discrepancies.

The 2008 ROD (BLM 2008) states that no new rights-of-way or other approvals will be granted for installation of new industrial water supply wells in the PAPA until the sources of hydrocarbon detections have been identified and mitigated.

1.2 STUDY OBJECTIVE

Subtask 3A of the Interim Plan (Geomatrix 2008a) requires development of this Plan of Study, which describes an approach that will be followed to identify potential sources of low-level PHC detections in industrial water supply well samples so that additional mitigation measures may be developed and implemented, if necessary.

1.3 PLAN OF STUDY ORGANIZATION

Section 2 of this Plan of Study describes the hydrologic and hydrogeologic setting of the PAPA. **Section 3** describes the Data Quality Objectives for this Plan of Study. **Section 4** describes four specific tasks that are designed to identify potential sources of low-level PHC detections at each affected water supply well location. Quality assurance and quality control are described in **Section 5**. A tentative schedule for completing the four tasks is included in **Section 6**. Key personnel identified to complete the tasks are presented in **Section 7**. Cited references are listed in **Section 8**. Figures and tables associated with this Plan of Study are compiled in **Appendices A** and **B**, respectively. Matrices developed to identify potential PHC sources and associated target analytes are included in **Appendix C**. **Appendix D** includes standard operating

procedures unique to this study, and **Appendix E** contains standard field forms. An example Health and Safety Plan is in **Appendix F**; this will be updated during later field planning activities.

2.0 STUDY AREA DESCRIPTION

Natural gas exploration and production targets natural gas accumulations in a subsurface geologic trap called the Pinedale Anticline. The uppermost gas-bearing geologic formations of economic significance are located approximately 8,000 to 12,000 feet below ground surface. The Anticline Crest is approximately 2 to 3 miles wide, and is oriented northwest to southeast parallel to the Wind River Range located to the east. The PAPA encompasses an area of approximately 308 square miles, and is about 12 miles wide by 26 miles long (**Figure 1**). More detailed information about the PAPA is presented in the Geomatrix (2008b) hydrogeologic conceptual model report.

2.1 HYDROGEOLOGIC SETTING

Near-surface geology within and adjacent to the PAPA consists of the Tertiary-aged Wasatch and Green River sedimentary formations, unconsolidated glacial outwash, and alluvium along surface water courses. The Wasatch Formation generally underlies the entire PAPA and was deposited in a piedmont environment in an internally-drained depositional basin contemporaneous with the Green River Formation, which represents lacustrine (lake) deposition. The Wasatch Formation primarily consists of discontinuous, lenticular arkosic sandstone beds representing river channel deposits, and sandy shale and siltstone representing overbank and floodplain deposits. Due to changes in the position of the lake shoreline over time, Wasatch sediments intertongue with Green River sediments. The Green River Formation is comprised predominantly of lacustrine deposits of fine sandstone, siltstone, and shale. Beds in both of these formations are generally horizontal.

Overlying the Wasatch Formation on the Mesa are coarse alluvial glacial outwash gravels of Quaternary age that originate from the Wind River Range. Based on well logs, these terrace gravels are approximately 10 to 35 feet thick. Recent alluvial deposits of unconsolidated sand, gravel, and some clay occur in the valleys of the Green River, New Fork River and their tributaries. Alluvial deposits in the PAPA are up to 80 feet thick.

Geomatrix (2008b) describes the current hydrogeologic conceptual model, which identifies the following principal hydrostratigraphic units (HSUs) in the PAPA: River Alluvium, Shallow Wasatch Formation bedrock, and Regional Wasatch Formation bedrock. These hydrostratigraphic divisions and interconnection between the three HSUs will be further investigated and defined as described in the Hydrogeologic Data Gaps Plan of Study (Geomatrix 2008b). In particular, the existence of a fourth HSU on the Mesa (e.g., Mesa Gravel HSU) will be confirmed or denied through the installation of new study wells. The currently defined HSUs are characterized as follows:

- Groundwater in the River Alluvium HSU occurs in sand and gravel deposits adjacent to the principal water courses in the PAPA and is hydraulically connected to both rivers

and streams and to the underlying Wasatch Formation. Where present, groundwater in terrace gravels on the Mesa is likely of limited quantity and extent.

- Groundwater in the Shallow Wasatch HSU occurs in discontinuous sandstone units or lenses within siltstone or mudstone/shale units. The Shallow Wasatch Formation HSU is topographically elevated above the Green River and New Fork River valleys within the PAPA (e.g., the Mesa). Based on information from driller's logs, this HSU does not appear to be continuously saturated and may be separated from the underlying Regional Wasatch HSU by unsaturated intervals at some locations. Groundwater flow in the Shallow Wasatch is primarily directed vertically downward to the Regional Wasatch Formation HSU, although some water emerges from hill slopes as springs and seeps.

- The Regional Wasatch Formation HSU consists of laterally and vertically discontinuous porous sandstone beds interbedded with less permeable shale, siltstone, and mudstone. It is characterized as a heterogeneous or compound system as the water-bearing sandstone beds are not continuous. Because sandstone beds are lenticular and variable in location, it is not possible to correlate individual beds between boreholes based on existing well spacing in the PAPA. Due to expected hydraulic conductivity contrasts between fine-grained units and sandstone, and the discontinuous nature of the individual sandstone beds, this HSU is probably best described as a semi-confined or leaky confined aquifer. Most private wells and most industrial water supply wells that support natural gas exploration and development activities are completed in this HSU.

All industrial water supply wells (i.e., Operator wells) are completed in the Regional Wasatch HSU, typically to depths between 500 and 1,000 feet below ground surface (**Table 1**). All domestic wells for which there is available information are also completed in this HSU; however, domestic wells are typically completed at shallower depths (generally 80 to 250 feet below ground surface). Stock wells may be completed in either the Shallow Wasatch HSU (e.g., on topographic features such as the Mesa or Blue Rim) or in the Regional Wasatch HSU, depending on geographic location.

2.2 PETROLEUM HYDROCARBON COMPOUNDS OCCURRENCE AND DISTRIBUTION

Table 2 summarizes PHC data for all water supply wells where at least one hydrocarbon constituent has been detected (per SCCD database current as of August 2008). The applicable Wyoming groundwater quality standard is also indicated in **Table 2**, and concentrations that exceed standards are highlighted. Locations of these PHC occurrences are illustrated on **Figure 2**. Based on information in **Table 2**, the following PHCs have been detected in the indicated concentration ranges:

- Non-Polar TPH – 6 occurrences ranging in concentration from 20 to 456 milligrams per liter (mg/L);

- TPH-DRO – 56 occurrences ranging in concentration from 0.052 to 380 mg/L;
- TPH-GRO – 30 occurrences ranging in concentration from 0.028 to 241 mg/L;
- Benzene – 30 occurrences ranging in concentration from 0.0005 to 7.6 mg/L;
- Toluene – 84 occurrences ranging in concentration from 0.00055 to 34 mg/L;
- Ethylbenzene – 19 occurrences ranging in concentration from 0.0005 to 2.5 mg/L;
- Total xylenes – 7 occurrences ranging in concentration from 0.00435 to 19 mg/L;
- Meta- and para-xylenes – 34 occurrences ranging in concentration from 0.00055 to 25 mg/L; and,
- Ortho-xylene – 19 occurrences ranging in concentration from 0.00052 to 4.9 mg/L.

In some cases, Operator wells with PHC detections have been enrolled in the Wyoming DEQ Voluntary Remediation Program (VRP). This program provides regulatory oversight of investigations, cleanup, and monitoring of contaminated sites under a cooperative agreement between the Operator and DEQ. These sites are differentiated from other well locations where PHCs have been detected as shown on **Table 2** and **Figure 2**.

As of August 2008, PHCs had not been detected in any domestic water supply well. In 2008, however, PHCs were detected for the first time in a water sample from a stock well. This well (AS014) is located in T30N, R107W, Section 19, in an area that is hydraulically upgradient from most oil and gas activity (SCCD 2008). Detection of PHCs at AS014 occurred shortly after installation of a new submersible pump (personal communication with Merry Gamper, BLM).

3.0 DATA QUALITY OBJECTIVES

The Data Quality Objective (DQO) process is used to establish performance or acceptance criteria for data collection activities. These criteria in turn serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support goals of the study. The DQO process is systematic and begins by defining the problem and identifying the goals and objectives of the study (Section 3.1). Subsequent steps identify information inputs (Section 3.2) and measurement performance criteria (Sections 3.3 through 3.6). Data collection methods, definitions of the boundaries of the study (specific data collecting points within or adjacent to the PAPA), and the analytic approach (sample type/frequency) are designed to satisfy study goals and objectives and are presented in Section 4. Specific procedures for ensuring data quality assurance and quality control are explained in Section 5.

3.1 STUDY GOALS AND OBJECTIVES

At many of the water supply well locations where PHCs have been detected in water samples, the source(s) for PHC is unknown. The purpose of this study is to identify potential sources of low-level PHC detections in industrial water well samples so that additional mitigation measures may be developed and implemented, if necessary. Objectives of this study are to:

- To the extent possible, identify potential sources of low-level PHC detections within the PAPA using readily available information.
- Perform spatial and temporal analyses of groundwater PHC data with respect to potential sources to identify the most likely sources of PHCs at each well location where they occur.
- Identify data gaps for each location and develop a Sampling and Analysis Plan (SAP) to fill gaps.
- In order to determine PHC source(s) at individual well locations, conduct additional environmental sampling at individual locations where PHCs occur. Evaluate new environmental samples for a list of analytes determined by likely sources using matrices described in Section 4.
- Recommend additional mitigation measures, if necessary.

3.2 INFORMATION INPUTS

Various field and analytical data are required to meet the objectives stated above. For this Plan of Study, the following general field and laboratory activities are proposed with respect to the evaluation of low-level PHC detections in water supply wells located in the PAPA:

Media	Typical Data Parameters	Data Uses
Groundwater	Dissolved gases: methane, ethane, ethene, propane, propene, iso-butane, n-butane, propane, propene; Stable isotopes of methane: ^{13}C and deuterium; PHCs: TPH-DRO, TPH-GRO, BTEX, naphthalene, and 2-methylnaphthalene. Other parameters (e.g., common ions, total dissolved solids) as indicated by potential source analysis (**Section 4.1**) See **Table 3**.	Determine the origin of dissolved gas in groundwater (i.e., thermogenic or biogenic); Evaluate correlation between PHC associated with natural gas and PHC measured in groundwater samples; Evaluate a potential source of PHC in groundwater samples collected from water supply wells; Define the distribution and concentrations of methane and other light hydrocarbons associated with natural gas production to evaluate potential impacts due to natural gas exploration and production.
Produced Gas	Methane, ethane, propane, isobutane, n-butane, isopentane, n-pentane, benzene, toluene, and other light hydrocarbon groups through C13 (these data will be supplied by Operators); See **Table 3**.	Compare hydrocarbon and isotopic signatures of produced gas to signatures for groundwater and well headspace gas for the purpose of source evaluation.
Headspace gas from groundwater wells	Dissolved gases: methane, ethane, propane, isobutane, n-butane, isopentane, n-pentane, benzene, toluene, and other light hydrocarbon groups through C13; Stable isotopes in methane: ^{13}C and deuterium; See **Table 3**.	Determine the origin of gas in well headspace (i.e., thermogenic or biogenic); Evaluate correlation between PHC associated with gas in well casing and PHC measured in groundwater samples; Evaluate a potential source of PHC in groundwater samples collected from water supply wells; Define the distribution and concentrations of methane and other light hydrocarbons associated with natural gas production to evaluate potential impacts due to natural gas exploration and production.

Information and data gathered as part of this Plan of Study will in turn be used to evaluate potential operational sources of PHC identified in the "Rainbow Matrix" (Table 1; Geomatrix 2008a) and to develop recommended mitigation measures for these sources, as necessary. These efforts are described in the Interim Plan under Tasks 3b and 3c.

3.3 MEASUREMENT PERFORMANCE CRITERIA

Measurement performance criteria are established for each field and laboratory parameter or similar group of parameters. Measurement performance criteria are established by defining

acceptance criteria and quantitative or qualitative goals (e.g., control limits) for precision, accuracy, and completeness. Quality control acceptance criteria for accuracy and precision of data to meet DQOs for the project are presented in **Table 4**. Requirements for laboratory analytical data precision, accuracy, and completeness are provided in the following sections.

3.4 PRECISION

Precision is a measure of the degree to which two or more measurements are in agreement. Determining the agreement among replicate measurements of the same sample assesses the precision of the analytical method; combined precision of sampling and analysis methods is assessed from the agreement between measurements of duplicate samples.

Precision of sampling and analysis methods will be assessed through the collection of field duplicate samples at a minimum rate of one field duplicate per 10 samples for each sample media. The relative percent difference (RPD) in the results for each analyte will be computed for each field duplicate pair using the equation provided below. The goal for precision of field duplicate results is ± 35 percent RPD for water samples. However, if one or both samples in a field duplicate pair have a concentration less than 10 times the method detection limit (MDL), the field precision goal will be ± 5 x MDL.

$$RPD = [(\text{sample} - \text{duplicate value}) \div [(\text{sample} + \text{duplicate value}) \div 2]] \times 100$$

Precision of the analytical method for PHC and inorganic parameters in water will be assessed through duplicate analyses of laboratory QC and field samples. The RPD for each analyte will be computed for each analytical duplicate pair. Data for duplicate analysis will be evaluated only if the both of the samples in the duplicate pair have a concentration greater than the laboratory MDL. The laboratory precision goal for water samples is ± 20 percent RPD.

Precision of laboratory analytical results for dissolved gases in groundwater samples will be evaluated using duplicate analyses of laboratory control and matrix spike samples, as well as field duplicate samples. For headspace samples of extended gas and stable isotopes of methane, precision will be quantified using field duplicates.

3.5 ACCURACY

Accuracy is the degree of agreement between an observed value and an accepted reference or true value. Data accuracy will be evaluated using results from laboratory control samples and matrix spike samples, expressed as percent recovery or percentage of the true (known) concentration that is measured. Accuracy is controlled by proper use, calibration, and maintenance of both field and laboratory equipment for measurement of physical and chemical parameters.

Accuracy in the field will be assessed through collection of equipment blanks and field blanks and adherence to all sample handling, preservation and holding time requirements. The accuracy objective for equipment and field blanks will be non-detect results (<MDL) for all analytical parameters of interest.

Laboratory accuracy may be evaluated by the analysis of laboratory control and matrix spike samples, with results expressed as a percentage of recovery measured relative to the true (known) concentration. For water samples, laboratory control and matrix spike samples should be in the recovery range of 80 to 120 percent (75 to 125 percent for dissolved gas samples) and 75 to 125 percent (70 to 130 percent for dissolved gas samples), respectively. In addition, laboratory preparation blank results may be used to measure any contamination introduced during the analytical process. The accuracy objective for laboratory preparation blanks will be non-detect results (<MDL).
For extended gas and stable isotope analyses of headspace samples collected from well casings, accuracy will be assessed by comparing results for a laboratory control sample to a calibration standard. Results should be within 3 percent and less than 9 percent of the standard values for extended gas and isotope analyses, respectively.

3.6 COMPLETENESS

Completeness is the percentage of valid measurements or data points obtained, as a proportion of the number of measurements or data points planned for the project. Completeness is affected by such factors as sample bottle breakage and acceptance/non-acceptance of analytical results. Percentage completeness (C) is calculated by the following equation:

$$C\ (\%) = V \div P \times 100$$

where: V = number of valid measurements/data points obtained; and
P = number of measurements/data points planned.

Laboratory completeness will be affected by factors such as sample bottle breakage and acceptance/rejection of the analytical results during the data validation process. The percentage of completed analyses required will depend on the sampling design and data use. Expectations of completeness should be higher when fewer samples are collected per event or site. The laboratory completeness goal is 95 percent.

4.0 APPROACH

This section describes four specific tasks that will be completed to determine potential sources of low-level PHC detections in the PAPA.

4.1 COMPILE/REVIEW AVAILABLE INFORMATION AND SUPPLEMENT PROJECT DATABASE

The initial effort of this study will be to compile all available information on PHC sources within the PAPA and enter this information in the project database. The BDE has listed many of the potential sources in the "Rainbow Matrix" (see *Interim Plan, Subtask 3B, Table 1* [Geomatrix 2009a]), which will be utilized as an initial point of reference. Sources and types of additional information include:

- Locations, construction, and abandonment information for all current and abandoned natural gas exploration and production wells will be obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC) database, Operator records, and other sources, including:

    - USGS publications and maps;
    - BLM Pinedale Field Office database;
    - Wyoming DEQ records;
    - Wyoming State Engineer's Office (SEO);
    - Historic aerial photographs; and
    - U.S. Department of Energy publications/reports.

- Locations of historic spills, releases, and other potential PHC sources (e.g., underground storage tanks) will be obtained from searches of public databases and inquiries to regulatory agencies (BLM; DEQ; Environmental Quality Council; EPA), as well as interviews of knowledgeable people (e.g., oilfield workers and water well drillers).

- Locations, construction, operational history, and status of any active and historic nonhazardous oilfield waste disposal pits, Class II injection wells located in or near the PAPA, and condensate and produced water disposal information will be accessed from records on file with WOGCC and DEQ.

- Geomatrix will investigate potential natural sources of PHC by first conducting a literature review to identify which compounds have been found in groundwater from oil shale, seepage from natural gas reservoirs, and coal. Literature will also be reviewed to identify natural gas occurrences in the Wasatch Formation or similar environments, as well as case studies conducted in other natural gas fields. An attempt will be made to

identify geologic structures that could act as natural pathways for gas migration by requesting this information from Operators and other appropriate sources (e.g., USGS, Wyoming Geological Survey, WOGCC). Geomatrix will also request information from the BLM and Operators regarding hydraulic fracturing fluids in an attempt to identify a suitable surrogate, or proxy, of the fluids for groundwater sampling. Based on results of this review, a geochemical sampling plan will be developed to help differentiate between naturally occurring PHC and other potential sources.

Information obtained from these various sources will be ranked and qualified, as appropriate, based on the source of the information and the ability to independently verify it. Discrepancies between information sources (e.g., BLM and WOGCC databases) will be addressed. If discrepancies cannot be resolved, the information in question will either be discarded or, if used, it will be qualified accordingly. Section 3 (Data Quality Objectives) and Section 5 (Quality Assurance and Quality Control) describe the process by which the credibility of data and information will be determined.

Geographic coordinates will be determined for all identified sources. The locations and PHCs associated with each source will be entered into the project geodatabase. A map(s) will be created using GIS illustrating the locations of each source relative to PHC-affected water supply wells. The following will also be performed to evaluate PHC distribution, magnitude, and trends in relation to potential sources:

- PHC data for all locations will be summarized in tables and shown on maps generated from the Project's GIS geodatabase.

- A correlation analysis for all PHC and inorganic (e.g., chloride) constituents will be performed.

- Charts will be prepared showing temporal trends for PHC for each affected well.

- A "PAPA-Wide Potential PHC Sources Matrix" will be developed that includes all potential PHC sources for which information is readily available, their physical and chemical characteristics, and associated target analytes. This matrix will be provided to BDE for review and comment prior to implementing any field sampling program. An example matrix is included in **Appendix C**.

- A "Site-Specific Potential PHC Source Matrix" that includes each well with PHC with potential sources indicated will be developed. This matrix will be provided to BDE for review and comment prior to developing/implementing any field sampling program. An example matrix is included in **Appendix C**.

- Data gaps for each location will be identified, as necessary.

4.2 PREPARE AND EXECUTE SAMPLING AND ANALYSIS PLANS

A Sampling and Analysis Plan (SAP) will be developed to fill data gaps for each location identified in Section 4.1. Each SAP will be based on the site-specific conditions of a particular location and the source-specific analytes indicated for that location by the analysis of most likely PHC sources. Results of the Credible/Suitable Well Determination (Geomatrix 2009a) will be considered during SAP development. Although the specifics of the SAPs are unknown at this time, some investigative strategies that might be employed are described below:

- Sampling and analysis of headspace gas in well casings – In an effort separate from this study, Geomatrix collected and analyzed ambient air samples from inside the casings of three industrial water supply wells in the PAPA where the presence of combustible gas was identified by the SCCD. The resulting analytical data indicated that the gas consisted of thermogenic methane and associated light hydrocarbon compounds. In order to evaluate the occurrence of gas in shallow groundwater within the PAPA and further evaluate the correlation between gas occurrence and the occurrence of PHC in groundwater, Geomatrix will collect ambient air samples from additional well casings. Geomatrix will survey additional PAPA wellheads for the presence of methane gas using a methane-specific gas analyzer concurrent with wellhead surveying and water level measurements. Based on this field survey, ambient air samples will be collected from additional well casings for analysis of parameters listed in **Table 3** (**Appendix B**), which includes methane and other light hydrocarbons through C13 (e.g., pentane, propane, benzene, toluene). Stable isotopes of carbon (^{13}C) and hydrogen (deuterium) in methane will also be analyzed. These analyses will provide both the hydrocarbon signature of the gas present in these wells and a definitive conclusion as to the source of the methane gas, either biogenic or thermogenic. Biogenic gas is formed at low temperature and shallow depths by the anaerobic breakdown of organic matter by bacteria whereas thermogenic gas is formed from organic material concurrently with oil production in deep reservoirs at high temperatures. The presence of thermogenic gas in water supply wells may indicate that pathways exist, either natural or anthropogenic, for natural gas migration from the deep Cretaceous-age rocks that form the natural gas reservoirs within the Pinedale Field to the shallow Tertiary-age formations.

- Sampling and analysis of methane and other hydrocarbons dissolved in groundwater – Groundwater samples from a representative number of wells with a history of PHC detections but without an identified source of PHC will be sampled using low flow sampling techniques to minimize vertical mixing (see SOP 20, **Appendix D**) and analyzed for dissolved methane gas, other light hydrocarbons through C13 (e.g., pentane, propane, benzene, toluene), TPH-DRO, TPH-GRO, and BTEX. Stable isotopes of carbon (^{13}C) and deuterium (^{2}H) in methane will also be analyzed. A control group consisting of samples from a representative number of wells with no history of PHC will be subjected to the same analyses, including background wells installed as part of the

Hydrogeologic Data Gaps Study. Finally, water samples will also be collected and similarly analyzed from the same water wells where additional well casing ambient air samples are collected (see previous bullet). Results from these analyses will be used to evaluate if the occurrence and magnitude of PHC is correlated with the occurrence and concentration of methane.

- Produced gas analyses - Produced gas analyses for each well pad included in the PHC and control groups (see preceding bullets) and the well casing ambient air sampling group will be requested from the Operators. Hydrocarbon signatures for these produced gas samples will be compared to those for both groundwater and ambient air in well casing.

- Sampling and analysis of other indicator parameters in groundwater – The Mamm Creek Field (Garfield County, Colorado) case study indicates there is a correlation between chloride and methane. All groundwater samples collected from PHC and control wells will be analyzed for chloride and other inorganic parameters indicated by results of the correlation analysis described in Section 4.1. PAPA gas field practices will also be compared to those described by URS (2006) and S.S. Papadopalos & Associates, Inc. (2008) for the Mamm Creek Field (e.g., unlined produced water pits, uncemented production casing) to determine if operations suspected to have caused impacts to groundwater in the Mamm Creek Field are similar to operations in the PAPA.

- Soil gas surveys – In some instances where methane or other volatile organic compounds (VOC) have been identified in groundwater, soil gas surveys may provide source information. Questar is providing soil gas data collected by W.L. Gore and Associates for several areas at and in the vicinity of the PAPA. These data will be reviewed to evaluate the utility of conducting additional soil gas data for this study. In such instances, soil gas samples will be obtained from implants installed within relatively shallow (<10 feet) boreholes and analyzed for methane and/or other PHC. Concentration gradients would be defined and the area of investigation expanded until the source was identified.

- Sampling and analysis of pump installation materials – In some instances, water in the well casing may be in contact with PHC-containing substance such as pipe dope, which is a general term for anti-seize compounds used by water well contractors on threaded joints during installation of well equipment to facilitate breaking the joint at a later time. Although Operators have instructed their pump installation contractors to use PHC-free pipe dope, past practices may be responsible for some PHC occurrences in groundwater samples. Pump equipment, including drop tubing, may be removed, disassembled, examined for the presence of pipe dope. If present, samples of these substances will be collected and analyzed for PHC. Another technique that may be employed is to create a sample spiked with a small amount of pipe dope, similar in

amount to what might be found in water discharged from a submersible pump, and have it analyzed for PHC.

- Subsurface investigations – In some instances, soil and groundwater samples independent of an existing water supply well may need to be collected to investigate the occurrence of PHC. Sampling may be performed in unconsolidated material using a hollow-stem auger or direct push technology. New wells may need to be installed to investigate the horizontal and vertical distribution of PHC. If so, these wells will be installed considering the needs of the Hydrogeologic Data Gaps Plan of Study. Inflatable packers may be used in existing water supply wells in order to obtain samples from various intervals to assess zonation of water quality.

- Other techniques – Other techniques such as down-hole video inspection may be employed based on results from implementation of Section 4.1 and previous bullets in this section. The purpose of a down-hole video inspection would be to evaluate the well casing for damage that might allow shallow groundwater that potentially contains PHC to enter the well above the perforated interval, to identify any foreign substances adhered to the casing or at the well bottom that might contain PHC, or to investigate the source of methane gas in the water column.

All field work associated with this Plan of Study will be performed according to procedures described in Standard Operating Procedures in this Plan of Study (**Appendix D**) and in the hydrogeologic data gaps Plan of Study (Geomatrix 2009b).

4.3 ASSESS DRILLING, PUMP INSTALLATION, AND SAMPLING PRACTICES

The potential for past and current water well installation and sampling practices to have resulted in some of the PHC detections will be assessed by a critical examination of these practices. The following activities will be undertaken for this task:

- Drilling and pump contractors will be interviewed about current and past standard practices, including use of pipe dope, decontamination of well construction materials, and decontamination of pumps and drop tubes.

- SCCD personnel will be interviewed about practices used to collect samples for PAPA water supply well monitoring.

- To the extent possible, Geomatrix will observe and document well installation, pump installation, and groundwater sampling procedures. Recognizing that BLM will not issue any new rights-of-way for new water wells (BLM 2008), Geomatrix will look for opportunities to observe new water well installations on State or private land.

4.4 PREPARE TECHNICAL REPORT FOR LOW-LEVEL PETROLEUM HYDROCARBON EVALUATION

A technical report will be prepared that presents the study approach, results, conclusions, and recommendations for additional work, if necessary. All PHC and Well Completion data will be included in the GIS geodatabase along with the Well Location feature dataset. This will allow the user to add the Well Location feature dataset to ArcGIS and join the PHC data and/or Well Completion data for display and analysis. Also, layer files with color-coded symbology and explanations will be included in the geodatabase. The layer files will be identical to the legend displayed on all hard-copy maps. The Project's geodatabase will be used to create tables, matrices, maps, and figures for analysis and display, will be included with the technical report as an appendix or as a separate deliverable. This will allow a future user to interactively view and analyze all data and information associated with tabular and graphic visualizations included in the report. Specifically, the technical report will include the following:

- Map(s) illustrating locations of all identified potential PHC sources in relation to water supply wells where PHCs have been detected.
- Table summarizing PHC data for all water supply wells where they occur.
- Results of the analysis performed to correlate PHCs with other inorganic (e.g., chloride) constituents.
- Charts showing temporal trends for PHCs at each affected well.
- Matrix listing all potential PHC sources, their characteristics, and associated target analytes.
- Matrix listing each well containing PHCs and indicating potential sources.
- List of data gaps, if any, for each PHC-impacted well and the associated SAP created to eliminate data gaps.
- Analytical laboratory reports and data summary tables.
- Well construction and/or soil boring diagrams, sample location maps, and photographs, as applicable.

The report will include a discussion of information and data listed above, and conclusions and recommendations for additional mitigation, if necessary. These conclusions and recommendations (if any) will be used to evaluate potential operational sources of contamination and level of risk to the various PAPA HSUs (see *Interim Plan, Subtask 3B* [Geomatrix 2008a]).

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

The quality assurance and quality control (QA/QC) program described herein has been developed to ensure the usability and reliability of water resources monitoring data, and provides for routine application of procedures for controlling the measurement process. Standard procedures described in this section ensure that data collected in the field, analyzed by the laboratory, and entered into the PAPA database will be of appropriate quality to meet the data needs and data quality objectives (see Section 3).

Quality control is a system of routine technical activities that accounts for and quantifies as many potential measurement errors as possible in order to evaluate uncertainties associated with any given measurement. Errors that influence environmental measurements can be introduced in the field during sample collection, during shipment, in the laboratory, and during database entry.

5.1 FIELD QUALITY CONTROL

Field quality control consists of collecting quality control samples, decontaminating field sampling equipment, operating/maintaining/calibrating field equipment in accordance with manufacturer's instructions, using disposable equipment where possible, following standard operating procedures (SOPs – **Appendix D**), using standard field forms (**Appendix E**), using skilled personnel for sampling, and adherence to this Plan of Study. The SOPs in **Appendix D** of this Plan of Study are unique to the tasks described in Section 4; other applicable SOPs are in the hydrogeologic data gaps Plan of Study (Geomatrix 2009b).

Quality control checks of field sampling procedures and laboratory analyses are performed using one or more of the following samples:

Field Duplicate Sample: Field duplicates are two samples taken from the same media at the same time and under similar conditions, both sets of which are submitted to the same laboratory. The duplicate sample bottles are labeled in a way that does not reveal their identity to the laboratory.

Field Split Sample: Field split samples are the same as "field duplicate samples", with the exception that the duplicate sample is submitted to a different laboratory.

Field Trip Blank Sample: A field trip blank sample can be one of two types: (a) sample bottles are filled with deionized water and inserted into the normal set of water samples for analysis by the laboratory; or (b) sample bottles are filled with deionized water and the preservatives that are normally used with the natural water samples. Trip blank sample bottles are labeled in a way that does not reveal their status to the laboratory.

Field Equipment Blank Sample: A field equipment blank sample consists of deionized water run through decontaminated equipment to detect any residual contamination that may be remaining on sampling equipment. The water is collected in one or more of the normal sample bottles and submitted for laboratory analysis. The field equipment blank sample bottles are labeled in a way that does not reveal their status to the laboratory.

Standard Reference Sample: Standard reference samples are certified liquids with known concentrations of selected constituents that are prepared by an agency or private laboratory. These samples are submitted to the laboratory at the same time as the natural samples. Although the laboratory may be able to recognize the standard reference samples, it would not know the acceptable concentration range for each constituent. Accuracy statements about the analysis can be generated by comparing laboratory results to the acceptable range of each constituent provided by the supplier of the blind standard reference samples.

The need for decontamination in the field is minimized by using disposable equipment and drawing samples directly from the water sources, where possible. All non-disposable sampling equipment that contacts sample media will be decontaminated between sites in order to avoid cross-contamination during the field sampling process. The following pieces of equipment require decontamination: field water quality meters and probes; containers used for transferring samples (e.g. buckets); and non-disposable pumps, hose, pump tubing, or discharge line (tubing associated with the peristaltic pump is replaced for each sample). All probes and transfer containers are first rinsed with deionized or distilled water between samples. If non-disposable parts of filtration equipment come into contact with the water samples, these parts are cleaned between samples with mild soapy water, followed by a deionized or distilled water rinse.

5.2 LABORATORY QUALITY CONTROL

Laboratories are requested to provide the following information to support analytical results for each parameter:

- Sample preparation method reference
- Analytical method reference
- Method detection limit (MDL)
- Reporting or practical quantitation limit (PQL)
- Units of measure
- Sample collection and analysis dates
- Chain-of-custody record initiated by the sampler
- Sample condition upon receipt, including temperature
- Adherence to designated holding time
- Method blank results
- Laboratory duplicate results and relative percent difference
- Laboratory control standard recovery

- Matrix spike (MS) recovery
- Matrix spike duplicate (MSD) recovery
- Initial and continuing calibration checks

Laboratories are requested to meet and document certain certification, licensing, accreditation, and/or auditing requirements, such as adherence to EPA requirements and/or ISO Standard 17025. The laboratories are also requested to provide documentation for their quality control programs. Both internal and external quality control programs are required to ensure production of analytical data of known quality and validity, and to provide water quality for inter-laboratory comparisons. Criteria for acceptance of laboratory data with respect to precision and accuracy include the following:

Laboratory Method Blank Sample: No target analytes should be detected in laboratory blanks. The method blank is processed through the entire analytical procedure in a manner identical to the natural samples. Under certain conditions, corrective action will be performed by the laboratory to identify and eliminate the source(s) of contamination and samples shall be re-digested and analyzed, as appropriate. If eliminating the blank contamination is not possible, all impacted analytes in the sample batch will be qualified in accordance with EPA guidance for the Contract Laboratory Program (CLP) (EPA 2004a, 2004b).

Laboratory Matrix Spike Sample: The laboratory shall use both pre-digestion and, when warranted, post-digestion matrix spike samples for inorganic analytes, and matrix spike/matrix spike duplicate (MS/MSD) samples for organic analytes to evaluate potential sample matrix interferences. The laboratory shall conform to sample frequencies, control limits, and data qualifiers specified in EPA guidance for the CLP (EPA 2004a, 2004b).

Certified Reference Materials or Laboratory Control Sample: These samples contain certified concentrations of the analytes of interest, as determined through replicate analyses by a reputable certifying agency using two independent measurement techniques for verification. Control limits on analyte percent recoveries are lab-specific, and are stated in each laboratory's Quality Control Manual. As a general requirement, laboratory control limits should meet or exceed those specified by the EPA for the CLP (EPA 2004a, 2004b).

Laboratory Analytical Duplicate Sample: Agreement between analytical results for laboratory duplicate samples is evaluated using the relative percent difference (RPD) between the two results. In accordance with EPA CLP guidelines EPA 2004a, 2004b) a RPD of 20 percent or less is considered an acceptable control limit without data qualification if concentrations of both samples are $\geq$5x the PQL. If results are <5x the PQL, the PQL will be the control limit.

The RPD is defined by the following equation:

$$RPD = [(\text{sample} - \text{duplicate value}) \div [(\text{sample} + \text{duplicate value}) \div 2]] \times 100$$

Continuing Calibration Checks: Calibration check solutions traceable to a recognized organization are inserted as part of the sample stream on a routine basis. Source of the calibration check solution shall be independent from the standards used for calibration. Calibration check solutions used for the continuing calibration checks will contain all analytes of interest.

Participation in Inter-Laboratory Comparison: These exercises provide a tool for continuous improvement of laboratory measurements by helping the analysts identify and resolve problems of methodology and/or quality control. Results of these exercises are also used to evaluate both the individual and collective performance of the participating analytical laboratories on a continuing basis, and to insure that ongoing measurements are meeting standards. The participating laboratories should initiate corrective action if their performance in the comparison exercises falls below certain pre-determined minimal standards.

5.3 DATABASE AND REPORTING

Laboratories report analytical data in paper and electronic formats (database spreadsheet and PDF). Paper copies are placed in appropriate project files, whereas electronic field and laboratory data are stored in a computer database specific for the project. The laboratory method detection limit (MDL) is used to define the analytical limit or sensitivity of detectability. The Code of Federal Regulations (40 CFR Part 136, 1993) provides the following definition:

> The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Normally, the MDL is set at three times the standard deviation, or the t-distribution times the standard deviation, of a minimum of seven replicate measurements of a given spiking concentration. Values at the MDL may not reflect a signal much above zero, and therefore, are quantitatively not very meaningful.

The practical quantitation limit (PQL) is considered the lowest concentration that can be reliably measured within specified limits of precision and accuracy during routine laboratory operating conditions. The PQL is determined either through the use of inter-laboratory study data, or through the use of a multiplier of 5 to 10 times the MDL. Using these definitions, measurements below an MDL are not believable, measurements between the MDL and PQL are semi-quantifiable, and measurements above the PQL have a high degree of confidence.

Some laboratories use the term reporting limit (RL), which is a limit imposed upon the reporting laboratory by a client or regulatory agency. The reporting limit typically is associated with either the MDL or PQL.

Concentrations of chemicals that exceed the MDL but do not exceed the PQL are often reported as "estimates". A value reported by the laboratory that is less than the detection limit, which is either the MDL or PQL depending on the needs of the end-user, is an estimated concentration. For statistical purposes, non-detect values most commonly are represented as one-half the detection limit. The EPA (2006) specifies guidelines for evaluating data that includes values below the detection limit. The suggested procedures depend upon the amount of data below the detection limit.

5.4 DATA REVIEW

The objective of data validation is to identify any unreliable or invalid field and laboratory measurements, and qualify data for interpretive use. Data validation is performed using EPA guidelines for organics and inorganics (EPA 2004a, 2004b) and QC criteria in interval laboratory procedures. The following steps are used to validate the laboratory analytical data:

- Chain-of-custody forms and laboratory reports are checked to verify that samples were analyzed for the requested parameters, using the required preservatives, and within specified holding times (i.e., time between sample collection and laboratory analysis). Results from samples that do not satisfy holding time and/or preservation requirements are noted or flagged.

- Laboratory sample receipt forms are reviewed to determine if sample coolers were received with an internal temperature 1 to 4°C. With the exception of preserved sample bottles for metals analysis, sample containers that are received above the recommended temperature are noted or flagged.

- Whenever a sample has both total and dissolved metal concentrations reported, the dissolved values should be equal to or less than the total values. Results from samples with dissolved metal concentrations greater than corresponding total values are noted or flagged.

- Percent recoveries calculated by the laboratory for control samples and matrix spikes are reviewed to verify that they are within acceptable limits (80 to120 percent for laboratory control samples; 75 to 125 percent for matrix spike samples). Laboratory-specified limits may be more stringent than these acceptable limits based on parameter type and concentration. If recoveries are outside the limits, the results are noted or flagged as estimated for all natural samples in the analytical batch, and action should be taken by the laboratory to improve accuracy of analytical results.

- Standard reference sample results are compared to the acceptable range of each constituent provided by the supplier of the blind standard reference samples. Any constituents outside the acceptable range are noted or flagged as estimated for all natural samples in the analytical batch.

- Relative percent difference (RPD) values are calculated for laboratory and field duplicate or split samples to determine if they are less than or equal to the acceptable control limit of 20 percent. If concentrations of both samples (natural and associated duplicate) are <5X the PQL, the PQL will be the control limit, rather than the 20 percent control limit. When the RPD control limits are exceeded, data will be noted or flagged as estimated for all natural samples in the analytical batch, and action should be taken by the laboratory to improve precision of analytical results.

- For laboratory and field blank samples, any parameter detected above the laboratory reporting limit (i.e. PQL) will be noted or flagged as estimated for all natural samples in the analytical batch.

- Field measurements (e.g., stream flow, depth to water, pH, turbidity, specific conductance, temperature) are compared to previous data for accuracy. Anomalous or suspect values are noted and an explanation provided.

- All data are reviewed promptly for potential transcription errors, reporting limit discrepancies, data omissions, and suspect or anomalous values. Such problems are noted and reported to the proper personnel to take appropriate corrective action.

Once field and laboratory data have been reviewed and validated according to the steps described above, final qualified results are entered into the project database, along with field measurements and other sample collection information. Flagged or noted data are those results that do not meet acceptance criteria without qualification; flags are letter codes that alert the reviewer to these quality control considerations. With the exception of letter code "R" (rejected), all letter codes indicate the parameter(s) are considered "estimated". The R-designation is determined by the end-user of the data based on a review of all other data qualifier results in the validated database.

Common data validation flagging letter codes are presented in the following table.

<	The parameter was analyzed for but not detected at the practical quantitation limit (PQL) used for the method.
H	The required holding time for laboratory analysis was exceeded. Only parameters that do not meet the holding time for particular sample(s) will be flagged as "H".
F%	Field duplicate analysis has parameter concentration exceeding acceptable limits (relative percent difference determination). For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JF%".
F	Field duplicate analysis has parameter concentration exceeding acceptable limits (PQL determination). For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JF".
L%	Laboratory duplicate analysis has parameter concentration exceeding acceptable limits (relative percent difference determination). For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JL%".

L	Laboratory duplicate analysis has parameter concentration exceeding acceptable limits (PQL determination). For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JL".
M%	Laboratory matrix spike recovery has parameter concentration outside acceptable range. For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JM%".
B	Laboratory method blank or field blank has parameter concentration detected above PQL. For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JB".
S	Standard reference has parameter concentration outside acceptable range. For any parameters that do not meet this criterion, all same parameters for all samples in the analytical batch will be flagged as estimated "JS".
T	Total concentration for a parameter is lower than the corresponding dissolved concentration. Paired values where the total concentration is lower than the dissolved concentration will be flagged as "T".
J	The associated parameter value is an estimated quantity.
R	The associated parameter value is unusable (rejected).

If the water quality database is ever subject to statistical analysis, the rejected (R-flagged) data are not used. Duplicate samples are not included in the statistical analysis. Samples with reported values below the laboratory detection limit are calculated statistically using the value of the detection limit, or alternatively, using one-half the detection limit value, whichever is deemed appropriate.

In reporting the water resources monitoring program results, it is important to recognize and characterize uncertainties associated with the results, recognizing that each sampling or monitoring program will have different "noise" sources and uncertainties. Data limitations can include the following:

- Missing values
- Sampling frequency that changes over the period of record
- Multiple observations within one sampling period
- Uncertainty in measurement procedures
- Laboratory analytical methods and/or detection limits that change over the period of record
- Small sample sizes
- Outliers
- Lack of quality control procedures and data validation
- Problems related to data presentation and/or transcription

The process of minimizing and documenting error or noise control consists primarily of QA/QC programs developed for both sample collection and laboratory analysis, together with data interpretation and handling procedures. Professional judgment is required and used to assess the impact of field QC on the overall quality and usability of the field data. Knowing limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered.

6.0 SCHEDULE

A master schedule for all PAPA-related environmental activities to be completed in 2009 is included in the "Project Administration Plan" (Geomatrix 2009c). The following tentative schedule is developed for the four general tasks described above in Section 4:

Task 1 – Compile/Review Available Information and Supplement Project Database

Compilation of additional information will begin in February 2009. The project database will be updated as information becomes available. The PAPA-Wide Potential PHC Sources Matrix and Site-Specific Potential PHC Source Matrix will be issued for BDE review by late June/early July 2009. Matrices will need to be finalized by mid-July 2009 to ensure adequate time for SAP preparation and review prior to the 2009 field season.

Task 2 – Prepare and Execute Sampling and Analysis Plans

Sampling and Analysis Plans specified in Section 4.2 will be prepared in May-July 2009. Draft copies of each SAP will be issued to the BDE for review as soon as possible to ensure adequate time is available for execution of the plan during the 2009 field season. SAPs will be executed during the period August-September 2009.

Task 3 – Assess Drilling, Pump Installation, and Sampling Practices

Interviews of water well contractors, pump contractors, and SCCD sampling personnel will be initiated in April 2009. Observations of drilling, pump installation, and sampling practices will be an ongoing effort during the 2009 field season. The ability to observe drilling and installation of a new industrial water supply well is restricted by the moratorium on new water wells per the 2008 ROD (BLM 2008). However, the moratorium does not apply to State or private land, and Geomatrix will work with the Operators to identify opportunities to observe installation of any new industrial water wells in the PAPA.

Task 4 – Prepare Technical Report

The Low-Level Petroleum Hydrocarbon Compound Evaluation Report describing results of this study will be prepared in October-November 2009.

7.0 PERSONNEL

The following key personnel from Geomatrix will complete the eight tasks described in this Plan of Study for Low-Level PHC:

- Steve Wright (Helena) and K. Bill Clark (Missoula) – project study and task managers
- Steve Wright (Helena) & Adam Perine (Missoula) – field task managers
- Tom Hakonson & Carrie Hatch (Pinedale); Adam Johnson, Willy Welzenbach, and Meryl Storb (Missoula) – field staff
- Kevin Van Hook (Houston) – Quality Assurance and Quality Control project officer

Additional information about the project team is contained in the "Project Administration Plan" (Geomatrix 2009c). All personnel who participate in field activities will be properly trained in the site-specific health and safety issues. During the period of field activities, weekly site meetings and/or conference calls will be conducted to discuss progress completed the previous week, and planned activities for the upcoming week.

8.0 REFERENCES

American Public Health Association, American Water Works Association, and Water Environment Federation (APHA et al.), 1992 (or most recent version). Standard Methods for the Examination of Waters and Wastewaters, 18th Edition. Washington D.C.

American Society for Testing and Materials (ASTM), 1996. Annual Book of ASTM Standards. Philadelphia, PA.

ASTM Standard D4448-01, 1985. Standard Guide for Sampling Groundwater Monitoring Wells.

Code of Federal Regulations (CFR), 1993. CFR 40 Part 136, Appendix B, pp 554-555. U.S. Government, Washington D.C.

Geomatrix, Inc. (Geomatrix or AMEC Geomatrix), 2008a. Final Interim Groundwater/Aquifer Pollution Prevention, Mitigation, and Monitoring Plan. Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming. Prepared for U.S. Department of Interior, Bureau of Land Management, Pinedale Field Office, Wyoming Department of Environmental Quality, Water Quality Division, U.S. Environmental Protection Agency, Region 8, Shell Rocky Mountain Production, Questar Market Resources, and Ultra Resources, Inc. December.

Geomatrix, 2008b. Final Hydrogeologic Conceptual Model, Pinedale Anticline Project Area, Sublette County, Wyoming. March.

Geomatrix, 2009a. Draft Plan of Study for Credible/Suitable Well Determination. Interim Plan, PAPA ROD, Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming.

Geomatrix, 2009b. Draft Plan of Study for Hydrogelogic Data Gaps. Interim Plan, PAPA ROD, Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming.

Geomatrix, 2009c. Draft Project Administration Plan. Interim Groundwater/Aquifer Pollution Prevention, Mitigation and Monitoring Plan, Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming.

HydroGeo, Inc., 2004. Groundwater Monitoring Protocol Manual, Pinedale Anticline Project. October 2004.

Microseeps, 2008. Analytical Method AM20GAx, Standard Operating Procedure for Analysis of Biodegradation Indicator Gases, Microseeps, Inc., Revision 9.0, November 21, 2008.

Sublette County Conservation District (SCCD), 2008. Summary of Pinedale Chemical and Field Data 2000-2008. September 10, 2008.

S.S. Papadopulos & Associates, Inc., 2008. Phase II Hydrogeologic Characterization of the Mamm Creek Field Area, Garfield County, Colorado. September 2008.

U.S. Department of Interior, Bureau of Land Management (BLM), 2000. Record of Decision for the Final Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming, Pinedale Field Office, Pinedale, Wyoming. EIS-00-018. July.

U.S. Department of Interior, Bureau of Land Management (BLM), 2008. Record of Decision for the Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming. September 12.

U.S. Environmental Protection Agency (EPA), 2006. Data Quality Assessment: Statistical Methods for Practitioners. EPA QA/G-9S. EPA/240/B-06/003. February 2006.

EPA, 2004a. Draft Final, EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. OSWER 9240.1-45, EPA 540-R-04-004. July 2004.

EPA, 2004b. Draft, EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review. OSWER 9240.1-44, EPA 540-R-04-001. June 2004.

EPA, 2002. Guidance on Environmental Data Verification and Data Validation. EPA QA/G-8. EPA/240/R-02/004. November 2002.

U.S. Geological Survey (USGS), 2009. USGS Surface-Water Monthly Statistics for Wyoming. http://waterdata.usgs.gov/wy/nwis.

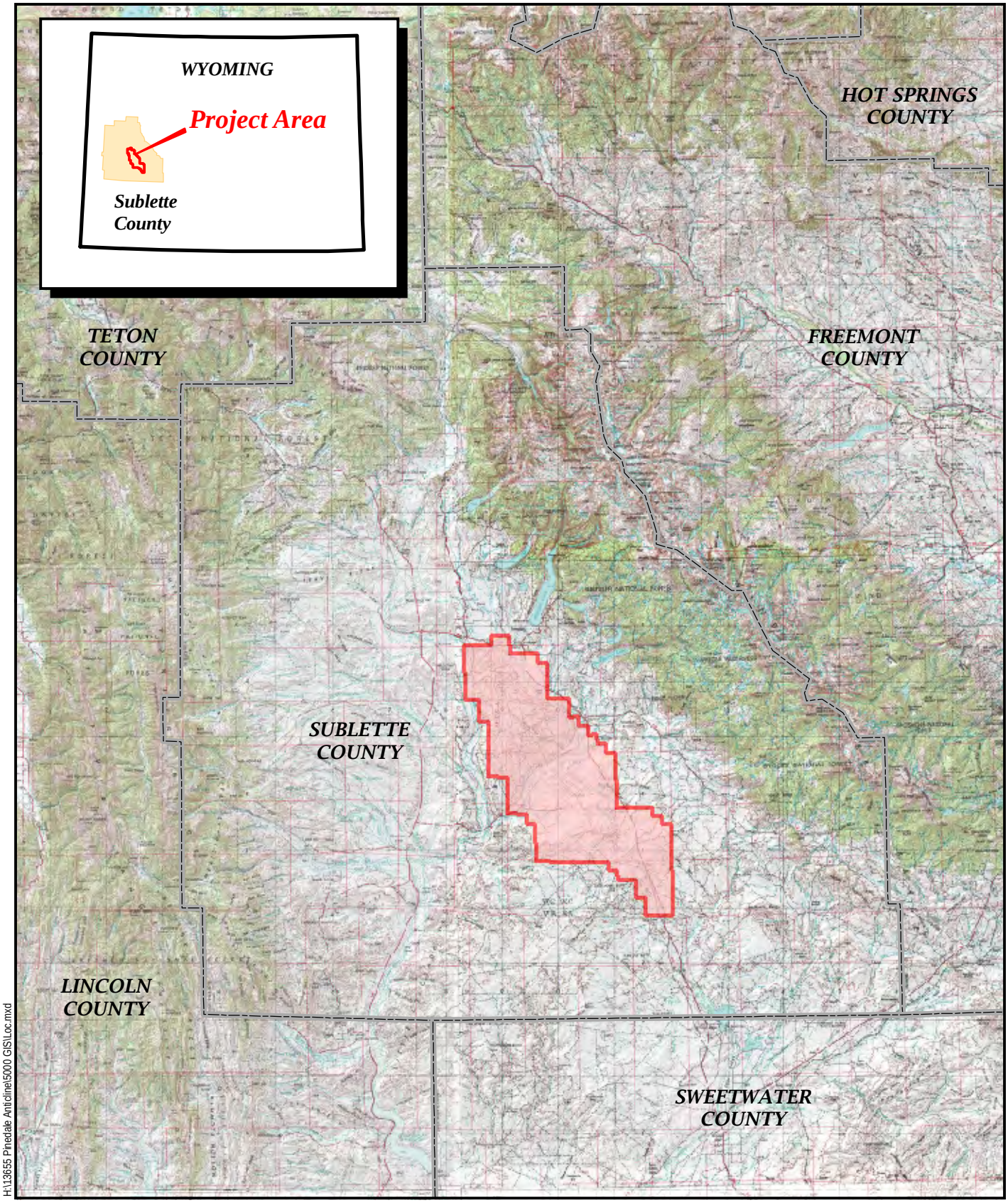
URS, 2006. Phase I Hydrogeologic Characterization of the Mamm Creek Field Area in Garfield County. Prepared for Garfield County, Colorado. March 23, 2006

Wyoming Department of Environmental Quality (DEQ), 2006. Letter from J.F. Wagner to Shell Rock Mountain Production, Pinedale, Wyoming. October 27.

Wyoming Water Quality Rules and Regulations (WQR&R), 2009. Chapter 11, Part G – Well Construction.

APPENDIX A

FIGURES



Source: 250K WYGISC, BLM

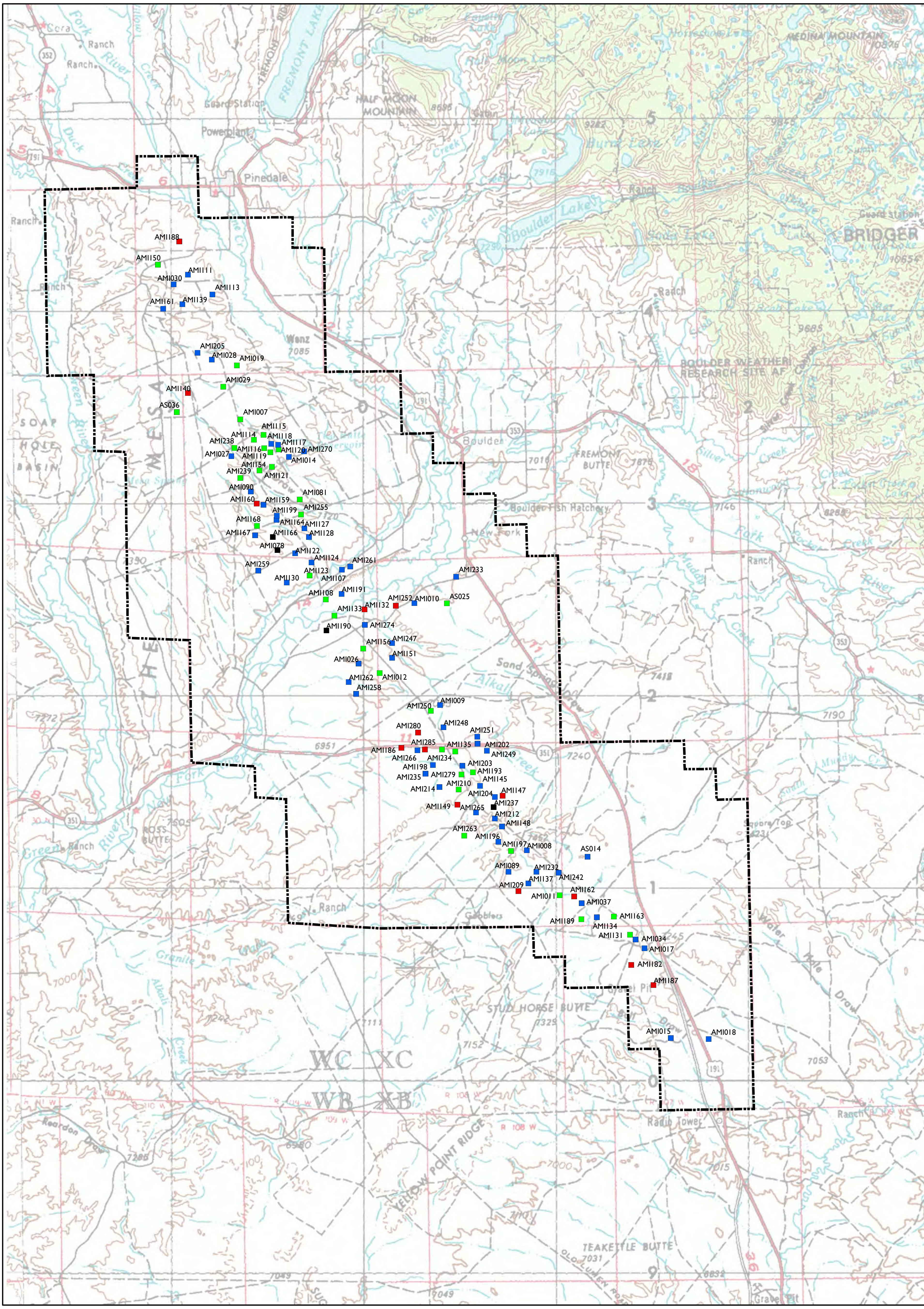
N

0 15
Miles

Project Area

AMEC Geomatrix

Project Location Map
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 1



Source: 100K WYGISC, BLM

Note: Data were collected between September 2006 and August 2008.

Five wells were sampled but are not depicted due to a lack of location information. These include South Mesa 14-12, Mesa 5-26, Rainbow 13-29, Riverside 12-3 Warbonnet 12-4 and Stud Horse Butte 7-23.

N

Miles

0 1.5 3

AMEC Geomatrix

Detected

- Wells in the DEQ Voluntary Remediation Program
- Location where Water Quality Standard was exceeded
- Location where at least one PHC constituent was detected
- Location where PHC were analyzed but not detected
- Project Area

AMI015 - Well Identification

Wells Containing Measurable Petroleum Hydrocarbons
Low Level PHC Plan of Study
Pinedale Anticline Project Area
Sublette County, Wyoming
FIGURE 2

APPENDIX B

TABLES

Table 1
Summary of Information for Inventoried Wells
Interim Plan for PAPA ROD

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AD001	Townsend No.1	P9230P	---	AD	596382.6131	4725358.205	6915.25	5/30/1965	105	---	---	---	---	---	---	---	---
AD002	Mocroft #1	P9605P	---	AD	594135.664	4740411.803	7069.05	7/1/1962	95	---	---	NO	---	---	FALSE	---	---
AD003	Mocroft #2	P9606P	---	AD	---	---	---	12/31/1914	65	---	---	NO	5	---	---	---	---
AD004	Mocroft #3	P9607P	---	AD	594101.8182	4740341.777	7059.26	12/31/1959	65	---	---	YES	6	2-100	TRUE	90	100
AD006	Mocroft Windmill No.1	P38439W	---	AD	594101.8591	4740424.001	7067.59	11/3/1977	92	---	---	YES	8	---	FALSE	---	---
AD007	Possibles #1	P43263W	---	AD	595874.0188	4724353.34	6851.31	7/15/1978	70	---	---	NO	6	0-70	FALSE	---	---
AD008	Dabb #1	P68111W	---	AD	---	---	---	7/1/1985	134	---	---	YES	6	---	FALSE	---	---
AD009	NERD Farm #1	P107024W	---	AD	597236.83	4725358.578	6886.98	10/10/1997	145	---	---	YES	6	0-145	FALSE	---	---
AD014	Chidsey #1	P64890W	---	AD	602169.321	4727718.068	6941.73	---	141	---	---	---	---	---	---	---	---
AD016	Schell #1	P66630W	---	AD	595289.5	4722561	6892.00	---	43	---	---	---	---	---	---	---	---
AD017	The Watering Hole #1	P44818W	---	AD	595164	4722522	---	---	56	---	---	---	---	---	---	---	---
AD018	Edwards #1	P98297W	---	AD	595273	4722143	6857.00	---	180	---	---	---	---	---	---	---	---
AD020	Jeremy #!	P63795W	---	AD	595310	4721849	6877.00	---	132	---	---	---	---	---	---	---	---
AD021	Christina Rae #1	P61393W	---	AD	595130	4721785	6881.00	---	220	---	---	---	---	---	---	---	---
AD022	Watersdown #1	P99291W	---	AD	595145	4722012	---	---	120	---	---	---	---	---	---	---	---
AD033	Bloom #4	P11404P	---	AD	590653	4746473	---	---	130	---	---	---	---	---	---	---	---
AD034	Wanner #1	P15466P	---	AD	590362	4746397	7174.00	8/14/1965	90	---	---	---	---	---	---	---	---
AD035	Vance #2	P87074W	---	AD	590080.8287	4746465.385	7161.63	---	200	---	---	---	---	---	---	---	---
AD036	Koch #1	P48453W	---	AD	590137.2571	4746464.882	7156.29	---	165	---	---	---	---	---	---	---	---
AD037	Delmue #1	P52276W	---	AD	590081.765	4746470.476	7152.21	---	126	---	---	---	---	---	---	---	---
AD038	Susan #1	P96672W	---	AD	590055.416	4746382.117	7149.44	---	100	---	---	---	---	---	---	---	---
AD039	Mortenson #1	P61788W	---	AD	590187.048	4746370.174	7157.24	---	157	---	---	---	---	---	---	---	---
AD040	Bryant #1	P72862W	---	AD	590261.962	4745985.924	7158.40	---	87	---	---	---	---	---	---	---	---
AD041	Burrough 1 (deepened)	P61066W	---	AD	590196.834	4745996.805	7142.69	---	52	---	---	---	---	---	---	---	---
AD042	Cole #5	P84291W	---	AD	---	---	---	---	120	---	---	---	---	---	---	---	---
AD044	Hay #1	P56040W	---	AD	590846.766	4745712.754	7170.28	---	150	---	---	---	---	---	---	---	---
AD045	Grossman #1	P46371W	---	AD	590936	4745688	---	---	152	---	---	---	---	---	---	---	---
AD046	Trombly #1	P80163W	---	AD	591151	4745038	---	---	185	---	---	---	---	---	---	---	---
AD047	Stevens #1	P102716W	---	AD	591087	4745288	---	---	105	---	---	---	---	---	---	---	---
AD050	Isaacs #1	P3380P	---	AD	589475	4746483	7251.00	---	81	---	---	---	---	---	---	---	---
AD052	Dunning #2	P33396W	---	AD	589783.44	4746469.732	7175.59	---	12	---	---	---	---	---	---	---	---
AD053	Dunning #1	P10329P	---	AD	589781.5	4746469	7253.50	---	90	---	---	---	---	---	---	---	---
AD054	Davis #1	P78005W	---	AD	589748.9568	4746534.703	7149.11	---	51	---	---	---	---	---	---	---	---
AD056	Roberts Well #1	P13825W	---	AD	589699.409	4746476.967	7152.72	---	90	---	---	---	---	---	---	---	---
AD057	Wood #1	P64294W	---	AD	589647.421	4745841.086	7194.47	---	283	---	---	---	---	---	---	---	---
AD058	Kenyon #1	P13940W	---	AD	589714.973	4746481.784	7157.37	---	96	---	---	---	---	---	---	---	---
AD059	Clark #1	P5276P	---	AD	---	---	---	---	120	---	---	---	---	---	---	---	---
AD060	Marys #1	P102181W	---	AD	588832.401	4746064.647	7166.04	---	75	---	---	---	---	---	---	---	---
AD062	Licking 1	P98395W	---	AD	---	---	---	---	120	---	---	---	---	---	---	---	---
AD063	Brown #1	P57161W	---	AD	590797.412	4745442.47	7174.00	---	112	---	---	---	---	---	---	---	---
AD084	Max #1	P45131W	---	AD	591522.46	4744593.953	7154.70	---	142	---	---	---	---	---	---	---	---
AD085	Dave #1	P94486W	---	AD	591797.568	4744879.055	7111.45	---	96	---	---	---	---	---	---	---	---
AD086	LaMere 99	P119088W	---	AD	592290.09	4744462.745	7080.49	---	110	---	---	---	---	---	---	---	---
AD087	Leslie Well #1	P109008W	---	AD	591869.4167	4744330.973	7101.83	---	110	---	---	---	---	---	---	---	---
AD089	Abercrombie	P81127W	---	AD	592402.1652	4744088.098	7109.16	---	68	---	---	---	---	---	---	---	---
AD090	Steege #1	P99486W	---	AD	592245.4913	4743499.653	7114.19	6/30/1995	125	---	---	YES	6	---	FALSE	---	---
AD091	Brown #1	P45364W	---	AD	592751.4871	4743573.145	7107.65	---	73	---	---	---	---	---	---	---	---
AD124	McGinnis #1	P99888W	---	AD	---	---	---	---	100	---	---	---	---	---	---	---	---
AD129	Thompson 4	P70929W	---	AD	---	---	---	---	287	---	---	---	---	---	---	---	---
AD134	Steele #1	P19016P	---	AD	590326.688	4747250.618	7156.26	---	104	---	---	---	---	---	---	---	---
AD135	Hoke #1	P99090W	---	AD	590714.605	4746669.238	7163.05	---	80	---	---	---	---	---	---	---	---
AD136	Andy	P55174W	---	AD	590472.344	4745842.587	7177.38	---	110	---	---	---	---	---	---	---	---
AD137	Palubiak #1	P54407W	---	AD	---	---	---	---	168	---	---	---	---	---	---	---	---
AD140	Dale Jensen	No Permit	---	AD	589840.5	4746481.5	7202.50	---	---	---	---	---	---	---	---	---	---
AD142	Ruland	No Permit	---	AD	589574	4746539	7267.00	---	---	---	---	---	---	---	---	---	---
AD145	Corbisier	No Permit	---	AD	589513.4114	4745877.282	7184.77	---	---	---	---	---	---	---	---	---	---
AD149	Swinger's Green 2nd, Lot 2 Well	P143763W	---	AD	591261	4745369	---	---	100	---	---	---	---	---	---	---	---
AD150	T Bone # 1	P144627W	---	AD	589639.5	4746558.5	7220.50	---	65	---	---	---	---	---	---	---	---
AD151	D.C. # 1	P140037W	---	AD	589183	4745933	---	---	303	---	---	---	---	---	---	---	---
AD157	Blooming Ranch #1	P161459W	---	AD	590752.5	4746930.5	7195.50	---	---	---	---	---	---	---	---	---	---
AD174	McMillen II	P158836W	---	AD	---	---	---	---	160	---	---	---	---	---	---	---	---
AD175	Dew Well #1	P158770W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD192	Washburn #1	P163069W	---	AD	592234	4744161.333	7165.67	---	---	---	---	---	---	---	---	---	---
AD193	Sullivans	P61602W	---	AD	595832	4722179	6883.00	---	---	---	---	---	---	---	---	---	---
AD194	Chief #1	P170712W	---	AD	589508	4746003	---	---	---	---	---	---	---	---	---	---	---
AD195	Industrial Well #4	P163557W	---	AD	588819	4745478	7257.00	---	---	---	---	---	---	---	---	---	---
AD196	PBC #1	P162580W	---	AD	588968	4746344	---	---	---	---	---	---	---	---	---	---	---

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AD197	Williams #1	39/3/192W	---	AD	595596	4722083	---	---	---	---	---	---	---	---	---	---	---
AD198	PFAFF 1	39/3/311W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD199	WATER HOLE #31	39/9/338W	---	AD	589506	4746478	---	---	---	---	---	---	---	---	---	---	---
AD200	FAIRWAY LOOP WELL #3	P163561W	---	AD	591348	4745282	---	---	---	---	---	---	---	---	---	---	---
AD201	ESPENSCHEID #1	P164742W	---	AD	591248	4745323	---	---	---	---	---	---	---	---	---	---	---
AD202	CONWAY HAWKS WELL #1	P85838W	---	AD	591470	4745154	---	---	60	---	---	---	---	---	---	---	---
AD204	DELGADO #1	P62079W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD205	JAZ #1	P106546W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD206	SWINGER'S GREEN #1	P109394W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD207	JAMIE #1	P89326W	---	AD	592080	4745285	---	---	---	---	---	---	---	---	---	---	---
AD208	PHILLIPS #1-94	P95598W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD209	AGOSTINI II	P95764W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD210	LAINEY'S WISH # 1	P130732W	---	AD	592117	4745207	---	---	---	---	---	---	---	---	---	---	---
AD211	AGOSTINI III	P144354W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD212	WALSH #1	P154809W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD213	CORWIN 2	P170960W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD214	33 RANCH # 2	P134273W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD215	CHAMBERS #1	39/4/270W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD216	DC-10	40/3/108W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD217	DC-5	40/1/108	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD218	DC-8	40/2/108W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
AD219	STEPP BY STEPP #1	39/4/201W	---	AD	---	---	---	---	---	---	---	---	---	---	---	---	---
ADS003	Chidsey #2	P60515W	---	ADS	600270.5	4725932.5	6910.05	5/21/1982	84	---	---	YES	6	0-84	FALSE	---	---
ADS004	Jensen No.2	P62550W	---	ADS	598980.598	4724391.003	6864.74	11/25/1982	155	---	---	YES	10	0-155	---	---	---
ADS006	Sheffy Well #1	P11186P	---	ADS	---	---	---	---	155	---	---	---	---	---	---	---	---
ADS007	Gosar #1	P9622P	---	ADS	589850.7945	4746537.952	7155.22	---	160	---	---	---	---	---	---	---	---
ADS008	Elwood Meyers #1	P53464W	---	ADS	589926.752	4745867.638	7194.69	---	360	---	---	---	---	---	---	---	---
ADS009	Sid's Well #1	P126569W	---	ADS	---	---	---	---	---	---	---	---	---	---	---	---	---
ADS011	Kramer #1	P115665W	---	ADS	591857.9769	4744032.464	7129.95	---	120	---	---	---	---	---	---	---	---
ADS012	Almquist #1	P74394W	---	ADS	591999.5375	4743511.372	7130.52	---	100	---	---	---	---	---	---	---	---
ADS028	Irwin #1	P52783W	---	ADS	---	---	---	---	125	---	---	---	---	---	---	---	---
ADS029	Snow #1	P98998W	---	ADS	592541.4732	4743918.893	7094.67	---	100	---	---	---	---	---	---	---	---
ADS030	John Scott	No Permit	---	ADS	599997.866	4727058.459	6899.87	---	---	---	---	---	---	---	---	---	---
ADS035	SKW #1	P154075W	---	ADS	589390	4746521	7170.00	---	120	---	---	---	---	---	---	---	---
ADS038	33 RANCH #1	P101518W	---	ADS	---	---	---	---	---	---	---	---	---	---	---	---	---
1	Rellstab #1	P122411W	---	---	589768.01	4746561.85	7150.00	---	100	---	---	---	---	---	---	---	---
AMI001	Enl. Wagon Wheel No.1	P85754W	---	AMI	---	---	---	---	2500	---	---	NO	7	0-2500	---	---	---
AMI002	Enl. Wagon Wheel No.2	P85755W	---	AMI	---	---	---	5/22/1971	5200	---	---	YES	10	0-5200	FALSE	---	---
AMI003	Blue Rim #4	P29128W	---	AMI	---	---	---	---	306	---	---	NO	8	0-303	FALSE	---	---
AMI004	Blue Rim #8	P29129W	---	AMI	---	---	---	---	306	---	---	NO	8	0-304	FALSE	---	---
AMI007	Mesa Water Well NO 15-8	P138175W	---	AMI	593639	4734334	7491.33	---	813	---	---	NO	6	1-813	FALSE	---	---
AMI008	Warbonnet 9-23	P107612W	---	AMI	608519.676	4711943.293	7347.53	10/7/1997	753	---	---	NO	6	1-753	FALSE	---	---
AMI009	Lizard Head 13-28	P107650W	---	AMI	604013.14	4719499.451	7002.18	10/8/1997	553	---	---	NO	6	1-553	TRUE	455	470
AMI010	Lizard Head 11-8	P107746	---	AMI	602671.348	4724792.46	6992.00	10/24/1997	413	---	---	NO	6	1-413	FALSE	---	---
AMI011	Falcon #1-36W	P134656W	---	AMI	610234	4709611.667	7297.67	---	733	---	---	NO	10	1-20	FALSE	---	---
AMI012	Pinedale Federal #13-19W	P135459W	---	AMI	600871	4721145.333	6992.33	---	493	---	---	NO	6	1-493	TRUE	425	440
AMI014	Mesa Water Well NO 3-22	P138174W	---	AMI	596163.5	4732386	7452.50	---	772	---	---	NO	6	2-772	TRUE	750	772
AMI017	Antelope 15-4 WSW	P167531W	---	AMI	614636.4735	4706866.346	7155.71	---	712	---	---	---	---	---	---	---	---
AMI018	Antelope 15-23 WSW	P167532W	---	AMI	617960.7814	4702144.021	7112.20	---	650	---	---	NO	6	2-650	FALSE	---	---
AMI019	Stewart Point 11-34	P116193W	---	AMI	593450.3333	4737141	7529.67	7/6/1999	930	---	---	NO	6	2-910	TRUE	890	930
AMI020	Mocroft 11-22	P117255W	---	AMI	593702.4431	4740740.263	7082.81	8/6/1999	292	---	---	NO	6	1-292	TRUE	265	292
AMI023	Mocroft 1-21	P117259W	---	AMI	592811.809	4741631.835	7098.29	8/8/1999	292	---	---	NO	6	1-292	TRUE	270	292
AMI026	New Fork Unit #11-24W	P132627W	---	AMI	599787.7062	4721647.79	6948.58	2/24/2001	585	---	---	---	---	---	FALSE	---	---
AMI027	Mesa 3-20	P126623W	---	AMI	593166.25	4732419.25	7465.00	---	900	---	---	NO	6	0-940	FALSE	---	---
AMI028	Stewart Point 11-33	P126624W	---	AMI	592152	4737436.333	7559.00	---	980	---	---	NO	6	0-980	FALSE	---	---
AMI029	Mesa 13-5	P126625W	---	AMI	592745.5	4736017	7530.00	8/13/2000	940	---	---	NO	6	0-940	TRUE	930	940
AMI030	STEWART POINT WATER WELL #05-20	P145957W	---	AMI	590174.1446	4741351.406	7346.55	---	745	---	---	---	---	---	TRUE	695	745
AMI033	Highway #11	P131814W	---	AMI	615774.266	4708010.91	7229.52	---	700	---	---	---	---	---	TRUE	685	700
AMI034	Antelope #11-4W	P131008W	---	AMI	614170.7537	4707304.305	7159.18	12/30/2000	700	---	---	---	---	---	FALSE	---	---
AMI037	Rainbow #7-31	P131661W	---	AMI	611363.711	4709188.365	7322.03	1/7/2001	765	---	---	---	---	---	FALSE	---	---
AMI038	Warbonnet 13-19	P107467W	---	AMI	600882	4711721	7228.00	9/28/1997	753	---	---	---	---	---	---	---	---
AMI043	Mesa Lovatt Draw 15-8	P107747W	---	AMI	593611.6748	4724720.826	7022.35	11/11/1997	490	---	---	---	---	---	TRUE	425	490
AMI047	Crosswinds #1	P96037W	---	AMI	591152.9754	4746557.397	7142.95	---	90	---	---	---	---	---	---	---	---
AMI054	Grove #1	P93035W	---	AMI	591232.9636	4746556.674	7148.13	---	80	---	---	---	---	---	---	---	---
AMI061	NFIDW #5	P67302W	---	AMI	589970.7722	4746556.491	7156.34	5/29/1984	15	---	---	NO	4	0-15	TRUE	11	15
AMI062	Raridan #1	P98051W	---	AMI	---	---	---	---	150	---	---	---	---	---	---	---	---
AMI063	Penton #1	P85685W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI064	Dew Lumber #1	P7352W	---	AMI	588751.3596	4745840.726	7179.49	---	210	---	---	---	---	---	---	---	---
AMI065	Dew Lumber #2	P43819W	---	AMI	588662.532	4745742.476	7192.57	---	147	---	---	---	---	---	---	---	---
AMI066	Flugel #2	P86975W	---	AMI	---	---	---	---	148	---	---	---	---	---	---	---	---
AMI067	Williams #1	P89287W	---	AMI	---	---	---	---	120	---	---	---	---	---	---	---	---
AMI068	KOA #1	P39515W	---	AMI	---	---	---	---	402	---	---	---	---	---	---	---	---

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AMI069	Schriver #1	P23266W	---	AMI	---	---	0.00	---	160	---	---	---	---	---	---	---	---
AMI074	NFIDW #4	P67301W	---	AMI	590313.3848	4747346.357	7163.34	5/29/1984	30	---	---	NO	4	0-30	TRUE	5	30
AMI075	Driggs #2	P69137W	---	AMI	591300	4746650	7339.00	---	68	---	---	---	---	---	---	---	---
AMI076	Pinedale Shop #1	P70736W	---	AMI	591299.6741	4746653.413	7160.74	---	200	---	---	---	---	---	---	---	---
AMI077	Mesa 2-28D Water Well	P133241W	---	AMI	595698.619	4730804.951	7169.09	3/29/2001	512	---	---	NO	9	0-512	TRUE	497	510
AMI078	Pinedale 1-4	P137015W	---	AMI	595563.7177	4727534.608	7108.06	---	610	---	---	---	---	---	TRUE	592	610
AMI079	Pinedale 2-2	P155230W	---	AMI	597970.2658	4727443.886	6962.36	7/29/2001	410	---	---	---	---	---	TRUE	386	410
AMI080	Gannet 13-16	No permit	---	AMI	591754.881	4741965.915	7184.79	---	---	---	---	---	---	---	---	---	---
AMI081	Mesa 7-27-32-109	P134220W	---	AMI	596727.9667	4730172.371	7146.16	4/28/2001	645	---	---	---	---	---	FALSE	---	---
AMI089	Warbonnet 6-26	P137014W	---	AMI	607577	4710841.5	7388.00	7/15/2001	630	---	---	---	---	---	TRUE	610	630
AMI090	Mesa 4-28-32-109W	P138432W	---	AMI	594187	4730577	7447.00	---	903	---	---	---	---	---	TRUE	760	780
AMI092	SCOTT WELL #1	39/3/502W	---	AMI	---	---	---	---	210	---	---	---	---	---	---	---	---
AMI094	Mesa Unit # 10-21D # 2	P138390W	---	AMI	595723	4731589.333	7461.00	---	900	---	---	---	---	---	---	---	---
AMI097	Mesa 8-28 Water Well	P138669W	---	AMI	595576	4730299	7243.50	---	---	---	---	---	---	---	---	---	---
AMI098	Mesa 7-28 Water Well	P138920W	---	AMI	595282	4730245	7325.50	---	715	---	---	---	---	---	---	---	---
AMI099	Paradise Ditch State 36-13 Water Well	P134281W	---	AMI	599305	4727663	7036.50	---	290	---	---	---	---	---	---	---	---
AMI107	Riverside 9-2	P155229W	---	AMI	598917.33	4726522	6948.33	---	310	---	---	---	---	---	TRUE	274	310
AMI108	Jensen # 11-11W	P138431W	PA	AMI	598074	4724990.667	6893.00	---	---	---	---	---	---	---	FALSE	---	---
AMI109	State 36-1 Water Well	P135460W	---	AMI	600237.6667	4718930	7005.33	---	450	---	---	---	---	---	---	---	---
AMI111	Stewart Point 15-17 WSW	P144088W	---	AMI	590908.6667	4741852.667	7273.00	---	940	---	---	---	---	---	TRUE	922	940
AMI113	Stewart Point 11-21 WSW	P144091W	---	AMI	592178.3333	4740822	7202.33	---	980	---	---	---	---	---	TRUE	785	980
AMI114	Mesa 6-16 Water Source Well	P139429W	---	AMI	594834	4733535	7465.00	---	1000	---	---	---	---	---	TRUE	980	1000
AMI115	Mesa 12-16 Water Source Well	P139428W	---	AMI	594336.6667	4733274.333	7477.33	---	1000	---	---	---	---	---	TRUE	940	1000
AMI116	Mesa 14-16 Water Source Well	P141309W	---	AMI	594866.3333	4732833.667	7471.67	---	930	---	---	---	---	---	TRUE	902	930
AMI117	Mesa 9-16 Water Source Well	P141307W	---	AMI	595596	4733018	7356.25	---	750	---	---	---	---	---	TRUE	741	750
AMI118	Mesa 10-16 Water Source Well	P141308W	---	AMI	595240.3333	4733065	7457.33	---	900	---	---	---	---	---	TRUE	855	900
AMI119	Mesa 15-16 Water Source Well	P139427W	---	AMI	595191	4732631	7458.00	---	1000	---	---	---	---	---	TRUE	840	1000
AMI120	Mesa 16-16 Water Source Well	P141310W	---	AMI	595623	4732765	7475.00	---	950	---	---	---	---	---	TRUE	914	950
AMI121	Mesa 7-21 Water Source Well	P162527W	---	AMI	595268	4731870.333	7462.33	---	---	---	---	---	---	---	TRUE	972	990
AMI122	Riverside 3-3	P150530W	---	AMI	596480	4727379	7100.00	---	570	---	---	---	---	---	TRUE	561	570
AMI123	Riverside 16-3	P146039W	---	AMI	597243	4726220.667	6989.33	---	310	---	---	---	---	---	TRUE	275	310
AMI124	Riverside 8-3	P150384W	---	AMI	597340	4726900	7023.00	---	520	---	---	---	---	---	FALSE	---	---
AMI127	Mesa 7-34	P144541W	---	AMI	596970	4728664	7151.00	---	510	---	---	---	---	---	TRUE	503	510
AMI128	Mesa 9-34	P144540W	---	AMI	597207.3333	4728224	7081.00	---	410	---	---	---	---	---	TRUE	390	410
AMI130	Riverside 4-10	P144027W	---	AMI	596054.6667	4725846.667	7027.00	---	350	---	---	---	---	---	FALSE	---	---
AMI131	Antelope 5-4 (WW)	P146982W	---	AMI	613875.3333	4707570.333	7221.50	---	---	---	---	---	---	---	---	---	---
AMI132	Riverside 15-12 Water Well	P140566W	---	AMI	600093	4724471	6970.00	---	410	---	---	---	---	---	---	---	---
AMI133	Riverside 2-14W	P159448W	---	AMI	598533.5	4724129.75	6926.00	---	---	---	---	---	---	---	FALSE	---	---
AMI134	Rainbow 13-32W	P140800W	---	AMI	612149.6667	4708466.667	7339.67	---	760	---	---	---	---	---	---	---	---
AMI135	Warbonnet 7-4 Water Well	P140569W	---	AMI	604808	4717084	7149.00	---	470	---	---	---	---	---	---	---	---
AMI136	Warbonnet 13-24	P141738W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI137	Warbonnet 9-26	P141737W	---	AMI	608594	4710224	7331.00	---	570	---	---	---	---	---	TRUE	555	570
AMI139	Stewart Point 14-20 WSW	P138913W	---	AMI	590630	4740324	7496.50	---	1000	---	---	---	---	---	TRUE	972	1000
AMI140	North Mesa 4-7-32-109W	P136063W	---	AMI	590917	4735697.5	7531.00	---	1040	---	---	---	---	---	FALSE	---	---
AMI145	Warbonnet 11-10	P147314W	---	AMI	606084.6667	4715291	7227.33	---	820	---	---	---	---	---	FALSE	---	---
AMI146	Antelope 11-10D	P147485W	---	AMI	615649	4705688.5	7214.00	---	680	---	---	---	---	---	FALSE	---	---
AMI147	Warbonnet 13-11	P150186W	PA	AMI	607260.5	4714771.5	7330.00	---	650	---	---	---	---	---	TRUE	629	650
AMI148	Warbonnet 13-14	P147821W	---	AMI	607238	4713182	7438.50	---	863	---	---	---	---	---	FALSE	---	---
AMI149	Blue Rim State # 2	P150200W	---	AMI	604921	4714320	7417.00	---	---	---	---	---	---	---	TRUE	673	710
AMI150	Stewart Point 16-18D Water Source Well	P150487W	---	AMI	589360.5	4742356.25	7328.00	---	980	---	---	---	---	---	FALSE	---	---
AMI151	Boulder 7-19 Water Well	P145790W	---	AMI	601514.3333	4721941.333	7026.67	---	390	---	---	---	---	---	TRUE	361	390
AMI154	Mesa 11-21 WSW	P147528W	---	AMI	594631	4731683.333	7361.00	---	910	---	---	---	---	---	TRUE	848	910
AMI156	Riverside 2-24	P150521W	---	AMI	600027.5	4722417.5	6989.00	---	700	---	---	---	---	---	FALSE	---	---
AMI157	Mesa 1-28D Well # 2	P138391W	---	AMI	595703	4730817	7177.00	---	645	---	---	---	---	---	---	---	---
AMI158	Enl. Mesa 1-28D	P143295W	---	AMI	---	---	---	---	645	---	---	---	---	---	---	---	---
AMI159	Mesa 11-28-32-109 W	P134221W	---	AMI	594838.75	4729884.75	7436.00	---	865	---	---	---	---	---	FALSE	---	---
AMI160	MESA 12-28	P173005W	---	AMI	594484	4729951.5	7440.00	---	---	---	---	---	---	---	FALSE	---	---
AMI161	Stewart Point 5-29D Water Source Well	P150488W	---	AMI	589625.6667	4740079.667	7739.33	---	1210	---	---	---	---	---	TRUE	1098	1123
AMI162	Rainbow 3-31 (WW)	P146981W	---	AMI	610988.6667	4709558.333	7288.33	---	---	---	---	---	---	---	---	---	---
AMI163	Rainbow 15-32 (WW)	P149067W	---	AMI	613042.3333	4708497.333	7287.67	---	---	---	---	---	---	---	---	---	---
AMI164	Mesa 1-33	P146979W	---	AMI	595516	4729115	7228.00	---	590	---	---	---	---	---	TRUE	577	590
AMI165	Stewart Point 4-33 WSW	P139248W	---	AMI	591926.5	4738294	7537.00	---	1043	---	---	---	---	---	TRUE	985	1043
AMI166	Mesa 10-33	P150192W	---	AMI	595326	4728220	7276.00	---	790	---	---	---	---	---	FALSE	---	---
AMI167	Mesa 12-33	P148359W	---	AMI	594413	4728309.333	7421.33	---	1000	---	---	---	---	---	FALSE	---	---
AMI168	Mesa 5-33	P148375W	---	AMI	594497	4728790	7434.00	---	940	---	---	---	---	---	FALSE	---	---
AMI169	Mesa 5-35	P145208W	---	AMI	597765	4728499	7149.00	---	450	---	---	---	---	---	---	---	---
AMI173	SAND DRAW 7-11 WATER WELL	P167536W	---	AMI	---	---	---	---	715	---	---	---	---	---	---	---	---
AMI181	MESA 2-35	P151114W	---	AMI	598368.5	4728932	7108.50	---	---	---	---	---	---	---	---	---	---
AMI182	HIGHWAY #7 WATER WELL	P151470W	---	AMI	613929	4705998.5	7292.50	---	610	---	---	---	---	---	TRUE	594	610
AMI183	MESA 11-22	P151650W	---	AMI	596507.5	4731346	7343.00	---	---	---	---	---	---	---	---	---	---
AMI184	MESA 6-18	P151651W	---	AMI	591563	4733651.5	7509.00	---	---	---	---	---	---	---	---	---	---
AMI186	WARBONNET 8-6	P152074W	---	AMI	602004.8333	4717275.333	7051.50	---	---	---	---	---	---	---	FALSE	---	---

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AMI187	ANTELOPE 1-16-29-107	P171606W	---	AMI	615101	4704954	7279.50	---	---	---	---	---	---	---	---	---	---
AMI188	NORTH PINEDALE 14-8	P152076W	---	AMI	590465.5	4743574.5	7298.00	---	---	---	---	---	---	---	FALSE	---	---
AMI189	RAINBOW 15-31 (WW)	P152351W	---	AMI	611347	4708388.667	7317.00	---	---	---	---	---	---	---	---	---	---
AMI190	RIVERSIDE 11-34	P152871W	---	AMI	598100	4723371.5	6963.00	---	510	---	---	---	---	---	---	---	---
AMI191	VIBLE 1-11D	P152931W	---	AMI	598894.5	4725265.5	6897.00	---	460	---	---	---	---	---	FALSE	---	---
AMI192	RAINBOW 13-3	P153150W	---	AMI	610541	4710085.333	7300.67	---	650	---	---	---	---	---	TRUE	647	650
AMI193	WARBONNET 4-10	P153812W	---	AMI	605719	4716002.5	7184.00	---	510	---	---	---	---	---	FALSE	---	---
AMI194	LOVATT DRAW STATE 36-4	P153851W	---	AMI	599263	4728810	7046.50	---	710	---	---	---	---	---	---	---	---
AMI196	WARBONNET #8-22	P154029W	---	AMI	607031.6667	4712393.667	7378.33	---	---	---	---	---	---	---	---	---	---
AMI197	WARBONNET 11-23	P154030W	PA	AMI	607698.6667	4711907.667	7405.67	---	710	---	---	---	---	---	TRUE	698	710
AMI198	WARBONNET 16-5	P175196W	---	AMI	603643.3333	4716368	7081.67	---	390	---	---	---	---	---	FALSE	---	---
AMI199	MESA 16-28	P154055W	---	AMI	595538.5	4729321	7238.50	---	---	---	---	---	---	---	---	---	---
AMI201	RIVERSIDE 13-12	P154228W	---	AMI	599291	4724391.5	6929.00	---	450	---	---	---	---	---	TRUE	441	450
AMI202	WARBONNET 3-3	P154552W	---	AMI	605967.3333	4717487.333	7273.67	---	910	---	---	---	---	---	FALSE	---	---
AMI203	ULTRA - WARNONNET 16-4	P154558W	---	AMI	605175	4716335.25	7152.75	---	570	---	---	---	---	---	TRUE	537	570
AMI204	WARBONNET 16-10	P154822W	---	AMI	606864.5	4714712.5	7347.00	---	710	---	---	---	---	---	TRUE	702	710
AMI205	WELL	P154968W	---	AMI	591413	4737791	7554.00	---	---	---	---	---	---	---	---	---	---
AMI206	WARBONNET 5-9	P154981W	PA	AMI	604140.5	4715605	7164.00	---	---	---	---	---	---	---	---	---	---
AMI209	WARBONNET 15-26	P155127W	---	AMI	608089.6667	4709815.333	7318.00	---	800	---	---	---	---	---	FALSE	---	---
AMI210	WARBONNET 10-9D	P155128W	---	AMI	604986.5	4715099	7186.00	---	710	---	---	---	---	---	TRUE	682	710
AMI211	Gannet 11-16	P155331W	---	AMI	591995	4742427	7214.67	---	---	---	---	---	---	---	---	---	---
AMI212	WARBONNET 9-15	P155520W	---	AMI	606854.6667	4713605.333	7415.33	---	730	---	---	---	---	---	TRUE	710	730
AMI213	PETROGULF STATE 36-9	P156828W	---	AMI	600494.3333	4718477.333	7048.67	---	---	---	---	---	---	---	---	---	---
AMI214	WARBONNET 12-9	P157396W	---	AMI	603987.6667	4715226.333	7108.67	---	---	---	---	---	---	---	FALSE	---	---
AMI216	Mesa Unit well #2	P55085W	---	AMI	594844	4733532	7496.00	---	---	---	---	---	---	---	---	---	---
AMI228	Rainbow 16-30 Water Well	P158825W	---	AMI	611871	4710041	7329.33	---	---	---	---	---	---	---	---	---	---
AMI230	Mesa 3-27	P158916W	---	AMI	596415	4730674.5	7201.00	---	---	---	---	---	---	---	---	---	---
AMI231	Riverside 10-13	P159471W	---	AMI	600213	4723295.25	7013.00	---	710	---	---	---	---	---	TRUE	701	710
AMI232	Warbonnet 5-25	P160863W	PA	AMI	609020.6667	4710841	7335.33	---	710	---	---	---	---	---	FALSE	---	---
AMI233	Boulder 15-4	P161093W	---	AMI	604844.3333	4726158.667	7011.67	---	410	---	---	---	---	---	TRUE	403	410
AMI234	Warbonnet 5-4	P161262W	PA	AMI	604116	4717176	7139.67	---	450	---	---	---	---	---	FALSE	---	---
AMI235	Warbonnet 2-8	P161333W	---	AMI	603261.75	4715923.5	7109.50	---	350	---	---	---	---	---	FALSE	---	---
AMI236	NERD Farms Yard Well	P161385W	---	AMI	597467	4726205.5	7046.33	---	410	---	---	---	---	---	---	---	---
AMI237	Warbonnet 7-15D	P162197W	---	AMI	606794.75	4714189.25	7387.25	---	750	---	---	---	---	---	FALSE	---	---
AMI238	Mesa 12-17 Water Source Well	P162525W	---	AMI	593324	4732850.5	7477.00	---	---	---	---	---	---	---	FALSE	---	---
AMI239	Mesa 15-20 Water Source Well	P162526W	---	AMI	593637	4731285	7459.00	---	---	---	---	---	---	---	FALSE	---	---
AMI240	Stewart Point 6-17	P162528W	---	AMI	590018	4742748	7283.00	---	1000	---	---	---	---	---	---	---	---
AMI242	Warbonnet 8-25	P162587W	---	AMI	610177	4710788	7319.00	---	670	---	---	---	---	---	TRUE	658	670
AMI245	Mesa 9-22 CD	P163495W	---	AMI	597191	4731509	7188.00	---	---	---	---	---	---	---	---	---	---
AMI247	Boulder 15-18	P163504W	---	AMI	601516.5	4722714.5	6985.50	---	530	---	---	---	---	---	TRUE	518	530
AMI248	Boulder 12A-33	P163669W	---	AMI	604184	4718338.5	7191.00	---	450	---	---	---	---	---	FALSE	---	---
AMI249	Warbonnet 2D-3D	P163881W	---	AMI	606437	4717116	7276.50	---	950	---	---	---	---	---	FALSE	---	---
AMI250	Boulder 1-32	P169651W	---	AMI	603532.5	4719193.5	7093.50	---	---	---	---	---	---	---	FALSE	---	---
AMI251	BOULDER 14-34	P164892W	---	AMI	605942	4717848.5	7196.00	---	950	---	---	---	---	---	TRUE	937	950
AMI252	Boulder 15D-7D	P168749W	---	AMI	601714	4724650	7016.67	---	450	---	---	---	---	---	TRUE	408	450
AMI253	Boulder 6-32	P169908W	---	AMI	602823	4718699	7091.00	---	510	---	---	---	---	---	FALSE	---	---
AMI254	JONAH FIELD OFFICE	38/8/100W	---	AMI	617383	4701075	7101.00	---	---	---	---	---	---	---	---	---	---
AMI255	Mesa 15B-27D	P168351W	---	AMI	596781	4729400	7183.00	---	600	---	---	---	---	---	FALSE	---	---
AMI257	Mesa 7C-35D	P170383W	---	AMI	598614	4728154	7046.50	---	660	---	---	---	---	---	FALSE	---	---
AMI258	Riverside 11-25	P169298W	---	AMI	599654.5	4720081.5	7036.50	---	---	---	---	---	---	---	FALSE	---	---
AMI259	Riverside 13-4 Water Well	P165690W	---	AMI	594575	4726479	7051.50	---	720	---	---	---	---	---	FALSE	---	---
AMI261	Riverside 4D-1D	P167596W	---	AMI	599348	4726693.333	6958.67	---	510	---	---	---	---	---	FALSE	---	---
AMI262	Riverside 4D-25D	P168966W	---	AMI	599273	4720687	6999.00	---	---	---	---	---	---	---	FALSE	---	---
AMI263	Warbonnet 1-21	P168967W	PA	AMI	605276	4712711	7283.00	---	750	---	---	---	---	---	TRUE	742	750
AMI264	Warbonnet 1B-10D	P170670W	---	AMI	606785	4715887	7226.00	---	---	---	---	---	---	---	---	---	---
AMI265	Warbonnet 5D-15D	P164137W	---	AMI	605880	4713906	7324.00	---	790	---	---	---	---	---	TRUE	763	790
AMI266	Warbonnet 6-5	P164446W	---	AMI	602835.5	4717143	7091.50	---	390	---	---	---	---	---	TRUE	371	390
AMI267	Warbonnet 8-10	P164447W	---	AMI	606794	4715900	7270.00	---	940	---	---	---	---	---	TRUE	840	940
AMI269	Warbonnet 8-8	P163590W	---	AMI	603659	4715508	7135.00	---	---	---	---	---	---	---	---	---	---
AMI270	2 Buttes 16-15 CD	P169139W	---	AMI	596946	4732673.5	7309.00	---	---	---	---	---	---	---	---	---	---
AMI272	Mesa 7-34 Water Well	P170950W	---	AMI	597087	4728606	7188.00	---	---	---	---	---	---	---	---	---	---
AMI274	RIVERSIDE 7-13	38/1/589W	---	AMI	600101	4723671	6999.00	---	---	---	---	---	---	---	FALSE	---	---
AMI276	Riverside 4-2	P174022W	---	AMI	597725	4727140	7025.00	---	400	---	---	---	---	---	TRUE	384	400
AMI279	Warbonnet 1-9	39/10/363W	---	AMI	605122	4715896	7196.00	---	---	---	---	---	---	---	---	---	---
AMI280	BOULDER 14-32	39/3/172W	---	AMI	602876	4718055	7064.00	---	---	---	---	---	---	---	FALSE	---	---
AMI285	WARBONNET 7-5	39/9/363W	---	AMI	603230	4717182	7091.00	---	---	---	---	---	---	---	FALSE	---	---
AMI290	Jonah #1	P173791W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI291	Warbonnet 4-9	P173792W	---	AMI	603926	4716053	7110.00	---	600	---	---	---	---	---	TRUE	571	600
AMI292	KELSON #1	P94914W	---	AMI	591446	4745289	7157.00	---	66	---	---	---	---	---	---	---	---
AMI293	WELL #1	P158696W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI294	MESA 10-21D, #2	P166917W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI295	WHITE WATER #4	P170547W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AMI296	MESA 13-26	40/5/61W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI297	RAINBOW 13-29 WATER WELL	39/7/508W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI298	RAINBOW 8-31	39/2/540W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI299	RIVERSIDE 12-3	39/2/550W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI300	SOUTH MESA 12-14 IDW	39/5/508W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI301	WARBONNET 11-4 WW	39/4/502W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI302	MESA 5-26	39/1/550W	---	AMI	---	---	---	---	---	---	---	---	---	---	---	---	---
AMI304	Jensen 11-11 (new)	39/4/172W	---	AMI	598106	4724944	---	---	---	---	---	---	6	1-600	---	---	---
AS001	Blue Rim Well 4084	P8520W	---	AS	604542	4712412	7301.00	5/2/1972	600	---	---	YES	6	1-325	TRUE	570	600
AS002	Mesa Horse Well	P9348P	---	AS	594558	4727234	---	6/21/1965	325	---	---	NO	8	1-70	---	---	---
AS003	Mud Hole Well #630	P9349P	---	AS	615788.9445	4706255.175	7111.68	9/15/1966	70	---	---	NO	6	1-199	---	---	---
AS004	Lander Well # 583	P9352P	---	AS	---	---	---	6/30/1967	238	---	---	NO	8	1-70	TRUE	215	237
AS005	Mud Hole Well #629	P9353P	---	AS	615845.6278	4706239.24	7095.75	9/1/1966	70	---	---	NO	6	1-199	---	---	---
AS006	Steele-Hittle Square Top Well	P9354P	---	AS	613135.5505	4709314.033	7287.45	10/14/1966	233	---	---	NO	6	1-195	TRUE	200	230
AS007	MT. Airy Well #19	P9357P	---	AS	593234.2283	4736460.006	7394.23	12/23/1960	343	---	---	NO	6	1-99	TRUE	300	343
AS008	Mesa Well #106	P9359P	---	AS	594204.4575	4734078.198	7356.26	8/2/1941	150	---	---	NO	6	1-146	FALSE	---	---
AS010	Buckhorn Well #307	P9367P	---	AS	612923.3405	4707354.97	7195.62	4/11/1948	200	---	---	NO	6	1-55	FALSE	---	---
AS011	Mud Hole Well #69	P9369P	---	AS	616812.1615	4705675.667	7093.10	7/6/1963	102	---	---	NO	6	1-490	FALSE	---	---
AS013	Mount Airy-2 #4694	P59933W	---	AS	589798.3333	4738412	7651.00	8/19/1983	490	---	---	NO	5	0-227	FALSE	---	---
AS014	N.W. Squaretop	P68609W	---	AS	611680.6822	4711603.523	7351.62	10/21/1985	227	---	---	YES	6	0-190	TRUE	216	226
AS015	Water Hole Draw	P71946W	---	AS	617131.9322	4707969.359	7254.19	3/18/1986	190	---	---	NO	6	2-35	TRUE	175	185
AS016	Mocroft #4	P75830W	---	AS	594340.1843	4740320.315	7049.12	11/14/1987	35	---	---	NO	6	0-192	FALSE	---	---
AS019	Clark Bloom Well	P89321W	---	AS	589199.5	4744629.5	7403.00	7/16/1994	192	---	---	YES	---	---	FALSE	---	---
AS025	East Fork Well #580	P9345P	---	AS	604360.031	4724770.116	6985.31	---	200	---	---	---	---	---	---	---	---
AS028	Cut-Off Spring 4111	P23521W	---	AS	597317	4721046	6921.00	---	4	---	---	---	---	---	---	---	---
AS029	Bertram #1	P76369W	---	AS	---	---	---	---	60	---	---	---	---	---	---	---	---
AS030	Olson #4	P7549P	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AS035	East Mesa Well #1	P8525W	---	AS	599732	4732692	7071.00	---	160	---	---	---	---	---	---	---	---
AS036	Middle Mesa Well #509 (deepened)	P9372P	---	AS	590341.25	4734704.5	7520.33	---	425	---	---	---	---	---	---	---	---
AS039	Clark #2	P5277P	---	AS	588743.4153	4746235.737	7161.43	---	176	---	---	---	---	---	---	---	---
AS046	Bloom #3	P11403P	---	AS	590673.2883	4746732.981	7149.35	---	120	---	---	---	---	---	---	---	---
AS047	Bloomfield #2	P83512W	---	AS	590755.5783	4746807.451	7158.16	---	52	---	---	---	---	---	---	---	---
AS053	JONAH 1-11 CP	P155228W	---	AS	---	---	---	---	300	---	---	---	---	---	---	---	---
AS054	RAMSEY #1	P156052W	---	AS	590651	4746716	7219.00	---	100	---	---	---	---	---	---	---	---
AS063	Stockwell #5	P163558W	---	AS	590620.5	4747376	7195.50	---	---	---	---	---	---	---	---	---	---
AS065	SAND SPRINGS NO. 13	P172914W	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AS066	SAND SPRINGS NO. 10	P172911W	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AS067	SAND SPRINGS NO. 11	P172912W	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AS068	SAND SPRINGS NO. 12	P172913W	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AS069	WILSON SCOTT FAMILY NO. 1 WELL	39/2/459W	---	AS	---	---	---	---	---	---	---	---	---	---	---	---	---
AD005	Westman #1	P10620P	---	AD	597271.228	4725314.807	6876.43	23968	50	---	---	---	---	---	---	---	---
AD048	---	P9388P	---	AD	589604.8851	4746452.186	7189.27	---	95	---	---	---	---	---	---	---	---
AD049	Davis #1	P9384P	---	AD	589743	4746538	7181.00	---	100	---	---	---	---	---	---	---	---
AD106	---	P100175W	---	AD	595922.6052	4740662.691	7101.73	---	90	---	---	---	---	---	---	---	---
AD115	---	P22472W	---	AD	597509.2774	4739408.613	7054.84	---	100	---	---	---	---	---	---	---	---
AD118	---	P41674W	---	AD	595914.2347	4740157.15	7073.04	---	259	---	---	---	---	---	---	---	---
AD119	---	P93195W	---	AD	595671.5448	4739976.19	7046.23	---	85	---	---	---	---	---	---	---	---
AD123	---	P109683W	---	AD	595206.6907	4739641.123	7028.53	---	70	---	---	---	---	---	---	---	---
AD143	---	Rellstab	---	AD	589768.4118	4746543.656	7131.86	---	---	---	---	---	---	---	---	---	---
AD147	---	Feltner	---	AD	589922.5889	4746482.777	7145.24	---	---	---	---	---	---	---	---	---	---
ADS015	---	P105464W	---	ADS	594987.7774	4742305.953	7127.63	---	125	---	---	---	---	---	---	---	---
ADS016	---	P111503W	---	ADS	594961.906	4742190.365	7110.34	---	115	---	---	---	---	---	---	---	---
ADS017	---	P91168W	---	ADS	595361.2397	4741079.948	7100.33	---	105	---	---	---	---	---	---	---	---
ADS018	---	P37928W	---	ADS	596073.5804	4740276.34	7089.14	---	70	---	---	---	---	---	---	---	---
ADS026	---	P109514W	---	ADS	595756.8724	4740033.736	7064.03	---	100	---	---	---	---	---	---	---	---
ADS027	---	P13213W	---	ADS	595567.9629	4739722.469	7053.06	---	100	---	---	---	---	---	---	---	---
AMI005	New Fork Unit 13-10	P130850W	---	AMI	605688.037	4714841.037	7217.78	---	755	---	---	---	---	---	FALSE	295	640
AMI013	Stewart Point 3-28	P138176W	---	AMI	592097.3116	4739940.519	7211.35	---	593	---	---	---	---	---	FALSE	220	555
AMI015	Antelope #14-22	P141914W	---	AMI	616002	4702192	7147.00	---	710	---	---	---	---	---	FALSE	555	705
AMI016	Sherlock Federal 15-8	P111580W	PA	AMI	590812.968	4743542.753	7183.26	36058	670	---	---	---	---	---	FALSE	110	635
AMI025	Gannett #5-15	P120975W	---	AMI	591672.537	4742707.931	7142.85	---	500	---	---	---	---	---	---	---	---
AMI031	---	P128546W	---	AMI	591251.3633	4738782.311	7504.02	---	1040	---	---	---	---	---	---	---	---
AMI032	Mesa 10-21D	P129042W	---	AMI	595601.5166	4731607.068	7427.05	36789	750	---	---	---	---	---	---	---	---
AMI035	---	P130658W	---	AMI	614631.5388	4706007.668	7176.21	---	---	---	---	---	---	---	---	---	---
AMI036	---	P72773W	---	AMI	595341.6641	4740955.252	7098.99	---	226	---	---	---	---	---	---	---	---
AMI071	---	P60647W	---	AMI	597760.8155	4739086.149	7050.25	---	118	---	---	---	---	---	---	---	---
AMI082	Vible #1	Vible #1	---	AMI	598894.5	4725265.5	6867.39	---	---	---	---	---	---	---	---	---	---
AMI083	Jensen #1	P61704W	---	AMI	597663.5852	4725370.643	6882.45	---	146	---	---	---	---	---	FALSE	---	---
AMI268	---	P168906W	---	AMI	615103	4704953	7283.00	---	---	---	---	---	---	---	---	---	---
AMI275	Warbonnet 5-9	38/10/563W	---	AMI	604138	4715601	7112.00	---	450	---	---	---	---	---	TRUE	435	450
AS009	---	P9365P	---	AS	608136.2718	4712310.75	7344.47	18079	375	---	---	---	---	---	---	---	---
AS034	---	P71948W	---	AS	600489	4734297	7123.00	---	131	---	---	---	---	---	---	---	---

SCCD Well ID	Well Name	Permit Number	Well Status [1]	Type [2]	Easting [3]	Northing [3]	Reference Elevation [3]	Date Drilled	Total Depth	Type of Seal	Depth of Seal	Multiple Casings	Casing Diameter	Casing Depth	Perforated (P) or Screened (S)	Start of Perforated or Screened Interval	Bottom of Perforated or Screened Interval
AS045	Wilson #2	P53956W	---	AS	590629.816	4747390.528	7159.01	---	59	---	---	---	---	---	---	---	---
AS048	---	Well	---	AS	610262.2119	4709689.163	7244.35	---	---	---	---	---	---	---	---	---	---
AS050	---	---	---	AS	608284	4721465	7125.00	---	---	---	---	---	---	---	---	---	---
AS051	---	---	---	AS	608284	4703548	7192.00	---	---	---	---	---	---	---	---	---	---
AS061	Scott Stock Well	---	---	AS	600402.5	4725849.5	6902.50	---	---	---	---	---	---	---	---	---	---
AS062	Old Cow Camp Well	---	---	AS	599701	4718142	6987.00	---	---	---	---	---	---	---	---	---	---
AS064	---	---	---	AS	587297	4741489	7354.00	---	---	---	---	---	---	---	---	---	---

Notes:
1 - A = active; PA = plugged and abandoned; UNK = unknown
2 - AMI = miscellaneous/industrial; AD = domestic; AS = stock; ADS = domestic/stock
3 - Value based on SCCD location/elevation information. All locations will be surveyed to a common datum by a professional land surveyor.
"---" - information not available
Source: SCCD September 10, 2008

TABLE 2
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI006	1/19/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.13**	NM
AMI008	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.12**	NM
AMI009	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.11**	NM
AMI010	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.12**	NM
AMI015	1/16/2007	< 1	**31**	< 1	NM	NM	< 3	< 0.1	**0.91**	NM
AMI017	12/13/2006	< 1	**99.2**	< 1	NM	NM	< 10	< 0.5	< 0.5	NM
AMI026	2/14/2007	< 1	**2.53**	< 1	< 2	< 1	< 3	< 0.05	< 0.25	NM
AMI026	11/16/2006	< 0.5	**5.8**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI026	2/14/2007	< 0.5	**2.4**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI027	11/8/2007	**1.2**	< 0.5	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI028	2/21/2007	< 1	**3.8**	< 2	NM	NM	< 2	< 0.02	< 0.5	NM
AMI028	11/6/2007	< 0.5	**3.5**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI030	2/14/2007	NM	NM	NM	NM	NM	NM	**0.028**	< 0.5	NM
AMI030	11/9/2007	< 0.5	**0.56**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI034	11/15/2006	< 0.5	**1.6**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI037	2/13/2007	< 1	**1.35**	< 1	< 2	< 1	< 3	< 0.05	< 0.25	NM
AMI037	11/16/2006	< 0.5	**5.8**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI037	2/13/2007	< 0.5	**1.3**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI078	1/16/2007	< 1	**22**	< 1	NM	NM	< 3	< 0.1	**5.2**	NM
AMI078	11/28/2007	< 0.5	**19**	< 0.5	**0.61**	< 0.5	NM	**0.08**	< 1	NM
AMI089	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.17**	NM
AMI090	2/15/2007	< 0.5	< 0.5	< 0.5	**1.6**	< 0.5	NM	< 0.036	< 1	NM

TABLE 2 Continued
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI090	11/14/2006	< 0.5	**0.66**	< 0.5	**4.8**	< 0.5	NM	**0.107**	< 2.4	NM
AMI107	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.3**	NM
AMI113	11/8/2007	< 0.5	**0.78**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI117	11/16/2007	< 0.5	**1.9**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI118	11/16/2007	< 0.5	**2**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI122	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.12**	NM
AMI124	10/26/2007	< 0.5	**0.55**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI127	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.25**	NM
AMI128	1/16/2007	< 1	**67**	< 1	NM	NM	< 3	< 0.1	**0.13**	NM
AMI130	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.66**	NM
AMI131	12/14/2006	ND	**1.2**	ND	NM	NM	ND	ND	ND	NM
AMI132	1/16/2007	< 1	**16**	< 1	NM	NM	< 3	< 0.1	**0.16**	NM
AMI132	7/24/2008	**7600**	**34000**	**1600**	**17000**	**3300**	NM	**143**	**210**	NM
AMI132	7/24/2008	**6400**	**34000**	**2500**	**25000**	**4900**	NM	**241**	**380**	NM
AMI132	7/8/2008	**0.76**	**100**	**1.8**	**8.9**	**4.4**	NM	**0.346**	**8.8**	NM
AMI132	7/8/2008	**0.58**	**68**	**1.3**	**6.5**	**3.2**	NM	**0.247**	**4.3**	NM
AMI134	11/6/2007	< 0.5	< 0.5	< 0.5	**1.3**	< 0.5	NM	< 0.036	< 1	NM
AMI134	11/16/2006	< 0.5	**3.2**	**0.52**	**7.3**	**1.7**	NM	< 0.036	< 2.4	NM
AMI134	2/13/2007	< 0.5	**0.96**	< 0.5	**2.8**	**0.54**	NM	< 0.036	< 1	NM
AMI137	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.1**	NM
AMI140	9/7/2006	NM	NM	NM	NM	NM	NM	NM	NM	**456**
AMI140	7/16/2007	< 0.5	< 0.5	< 0.5	**1.6**	< 0.5	NM	< 0.036	< 1	NM

TABLE 2 Continued
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI140	9/7/2006	**290**	**4400**	**1200**	**16000**	**3000**	**19000**	**46**	NM	NM
AMI140	9/18/2006	**21**	**640**	**240**	**2300**	**560**	**2800**	**8.42**	NM	ND
AMI140	10/25/2006	**6.9**	**83**	**14**	NM	NM	**325**	NM	NM	NM
AMI145	11/6/2007	**0.57**	**4.3**	< 0.5	**0.72**	< 0.5	NM	< 0.036	< 1	NM
AMI147	1/19/2007	< 1	**43**	< 1	NM	NM	< 3	< 0.1	**230**	NM
AMI148	2/12/2007	< 1	**10.6**	< 1	< 2	< 1	< 3	< 0.05	< 0.25	NM
AMI148	2/12/2007	< 0.5	**8.6**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI148	11/16/2006	< 0.5	**1.9**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI149	11/5/2007	**5.2**	**13**	ND	ND	ND	NM	**0.051**	ND	ND
AMI149	11/5/2007	**4.8**	**13**	ND	ND	ND	NM	**0.052**	ND	ND
AMI151	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.52**	NM
AMI159	11/14/2006	< 0.5	**0.62**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI160	11/13/2006	< 0.5	**69**	< 0.5	**0.85**	< 0.5	NM	**0.103**	**7.4**	NM
AMI160	2/14/2007	< 0.5	**8.5**	< 0.5	**0.97**	< 0.5	NM	< 0.036	**3.4**	NM
AMI160	10/26/2007	< 0.5	**0.95**	< 0.5	**2.1**	< 0.5	NM	< 0.036	< 1	NM
AMI160	7/3/2008	**1.3**	**0.98**	4.6	**57**	**10**	NM	**0.208**	ND	NM
AMI161	11/8/2007	< 0.5	**0.77**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI162	6/27/2008	NM	NM	NM	NM	NM	NM	ND	**1.4**	NM
AMI164	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.12**	NM
AMI166	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**1.7**	NM
AMI167	11/13/2006	< 0.5	**17**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI182	1/1/2007	**5.9**	< 0.5	< 0.5	< 0.5	< 0.5	NM	< 1	**0.052**	NM

TABLE 2 Continued
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI186	7/16/2007	< 0.5	< 0.5	< 0.5	0.55	< 0.5	NM	< 0.036	< 1	NM
AMI186	11/6/2007	< 0.5	45	< 0.5	3.7	1	NM	< 0.204	1.8	NM
AMI186	9/29/2006	3.4	27	3.8	54	12	66	0.358	NM	22
AMI186	10/4/2006	0.5	2.4	0.5	3.6	0.75	4.35	ND	NM	ND
AMI187	6/8/2007	25	1.3	ND	ND	ND	NM	0.078	NM	53
AMI187	5/10/2007	2.9	ND	ND	ND	ND	NM	ND	NM	70
AMI188	7/16/2007	< 0.5	1.7	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI188	10/26/2007	< 0.5	0.92	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI188	11/17/2006	6.6	63	1.7	17	4.3	NM	0.12	< 2.4	NM
AMI188	2/12/2007	5.58	58	1.53	14	3.44	17.7	0.209	0.31	NM
AMI188	2/12/2007	5	48	1.3	13	3.3	NM	0.094	< 1	NM
AMI190	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	7.6	NM
AMI190	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	7.4	NM
AMI190	12/11/2007	< 0.5	4.4	< 0.5	< 0.5	< 0.5	NM	0.08	< 1	NM
AMI191	11/13/2006	< 0.5	1.4	< 0.5	1.6	< 0.5	NM	< 0.036	< 2.4	NM
AMI196	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	0.15	NM
AMI198	1/18/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	0.13	NM
AMI198	7/18/2008	1	1	ND	0.94	ND	NM	ND	ND	NM
AMI199	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	0.4	NM
AMI202	1/16/2007	< 1	140	< 1	NM	NM	< 3	0.24	0.7	NM
AMI203	1/18/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	0.6	NM
AMI204	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	0.95	NM

TABLE 2 Continued
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI205	11/6/2007	< 0.5	**0.7**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI209	6/10/2008	NM	NM	NM	NM	NM	NM	**0.169**	**2**	NM
AMI209	7/3/2008	ND	**85**	ND	**2.2**	**0.52**	NM	**0.311**	ND	NM
AMI209	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.11**	NM
AMI212	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.4**	NM
AMI214	11/16/2006	**1**	**0.76**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 2.4	NM
AMI214	11/6/2007	**0.59**	**1.7**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM
AMI232	1/18/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.13**	NM
AMI233	7/18/2008	ND	**2.3**	ND	ND	ND	NM	**0.28**	ND	NM
AMI233	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	**0.17**	< 0.1	NM
AMI235	8/23/2006	NM	NM	NM	NM	NM	NM	NM	NM	**21**
AMI235	10/13/2006	ND	**1.8**	ND	ND	ND	NM	ND	NM	ND
AMI235	10/30/2006	ND	**1**	ND	ND	ND	NM	ND	NM	ND
AMI235	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.46**	NM
AMI237	6/1/2007	**85**	**95**	**2.4**	**18**	**2.5**	NM	**0.696**	NM	ND
AMI237	6/25/2007	**77**	**92**	**2.4**	**18**	**2.4**	NM	**0.648**	NM	< 5
AMI237	1/18/2007	**52**	**93**	**2**	NM	NM	**18**	**0.33**	< 0.1	NM
AMI242	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.29**	NM
AMI247	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.53**	NM
AMI248	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.18**	NM
AMI249	1/18/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.21**	NM
AMI251	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.23**	NM

TABLE 2 Continued
Summary of Water Wells with One or More PHC Detections [1]
Interim Plan for PAPA ROD

Well Id	Date	Benzene (ug/L)	Toluene (ug/L)	Ethyl-benzene (ug/L)	m+p-Xylenes (ug/L)	o-Xylene (ug/L)	Xylenes (total) (ug/L)	GRO (mg/L)	DRO (mg/L)	Non Polar Materials (SGT_HEM) (mg/L)
DEQ Water Quality Standard		5	1000	700	10000	10000	10000	7.3	1.1[A], 10[B]	NE
AMI252	7/11/2006	NM	NM	NM	NM	NM	NM	NM	NM	**20**
AMI252	1/16/2007	< 1	**110**	< 1	NM	NM	< 3	**0.35**	**2.8**	NM
AMI252	1/16/2007	< 1	**110**	< 1	NM	NM	< 3	**0.31**	**4**	NM
AMI258	11/13/2006	< 0.5	< 0.5	< 0.5	**1**	< 0.5	NM	< 0.036	< 2.4	NM
AMI258	2/13/2007	< 0.5	**11**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	< 1	NM
AMI258	10/30/2007	< 0.5	**2.3**	**1.2**	**8.1**	**3.9**	NM	**D 0.122**	< 1	NM
AMI259	11/17/2006	< 0.5	**3.8**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	< 1	NM
AMI259	2/14/2007	< 0.5	**1.9**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	< 1	NM
AMI262	1/16/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.1**	NM
AMI265	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	**0.12**	**0.34**	NM
AMI266	1/17/2007	< 1	< 5	< 1	NM	NM	< 3	< 0.1	**0.14**	NM
AMI270	11/9/2006	ND	**1.6**	ND	ND	ND	NM	ND	NM	NM
AMI274	2/13/2007	< 0.5	**2.7**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	< 1	NM
AMI274	11/13/2006	< 0.5	**1.3**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	< 2.4	NM
AMI280	11/13/2006	< 0.5	**12**	< 0.5	< 0.5	< 0.5	NM	D < 0.036	**3.9**	NM
AMI285	10/30/2007	**28**	**25**	**0.63**	**5.2**	< 0.5	NM	**D 0.193**	< 1	NM
AMI285	11/26/2007	**3**	**2.4**	< 0.5	**0.55**	< 0.5	NM	**D 0.074**	< 1	NM
AS014	7/3/2008	ND	**13**	ND	ND	ND	NM	ND	ND	NM
AS014	8/1/2008	ND	**0.84**	ND	ND	ND	NM	ND	ND	NM
AS014	8/1/2008	ND	**0.79**	ND	ND	ND	NM	ND	ND	NM
South Mesa 14-12	10/26/2007	< 0.5	**0.58**	< 0.5	< 0.5	< 0.5	NM	< 0.036	< 1	NM

Table 2 Notes:

1 – Data include SCCD records through August 2008 and Geomatrix records through December 2007

ND - Not Detected; NM – Not Measured; NR – Not Reported

DEQ – Wyoming Department of Environmental Quality

µg/L – micrograms per liter; mg/L – milligrams per liter

A - Applicable cleanup level for TPH-DRO is 1.1 mg/L if BTEX, naphthalene, and/or 2-methylnaphthalene exceed cleanup levels.

B - If BTEX, naphthalene and/or 2-methylnaphthalene are below cleanup levels and no free product is present, the applicable cleanup level for TPH-DRO is 10 mg/L.

Shading indicates concentration exceeds DEQ groundwater standard or action level.

TABLE 3
Media-Specific Parameters for Laboratory Analysis
Interim Plan for PAPA ROD

Parameter [1]	Analytical Method or Equivalent	Laboratory Reporting Limit [2,3]	Preservation Method [4]	Holding Time	Container Type & Size [5]
Groundwater Parameters					
Methane	AM20GAx[6]	0.025 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
Ethane	AM20GAx[6]	0.025 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
Ethene	AM20GAx[6]	0.05 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
Iso-butane	AM20GAx[6]	0.05 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
n-butane	AM20GAx[6]	0.05 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
Propane	AM20GAx[6]	0.05 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
Propene	AM20GAx[6]	0.05 µg/l	<6 °C, TSP (pH >10)	14 days	G, 4 - 40 mL VOA [7]
TPH-GRO	EPA Method 8015	1 mg/L	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
TPH-DRO	EPA Method 8015	0.2 mg/L	<4°C, HCL (pH<2)	14 days	AG, 2 - 1L
Benzene	EPA Method 8021	0.5 µg/l	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
Toluene	EPA Method 8021	0.5 µg/l	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
Ethylbenzene	EPA Method 8021	0.5 µg/l	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
Total xylenes	EPA Method 8021	1.5 µg/l	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
VOC	EPA Method 8260	1-20 µg/l	<4°C, HCL (pH<2)	14 days	G, 3-40 mL VOA
SVOC	EPA Method 8270	10-100 µg/l	<4°C, Na-thio	7 days	AG, 2 - 1L
Well Headspace Parameters					
Oxygen	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Nitrogen	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Carbon Dioxide	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Methane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Ethane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Propane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Isobutane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Normal Butane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Isopentane	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Hexanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Benzene	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Heptanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Toluene	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Octanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Nonanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L

TABLE 3
Media-Specific Parameters for Laboratory Analysis
Interim Plan for PAPA ROD

Parameter [1]	Analytical Method or Equivalent	Laboratory Reporting Limit	Preservation Method	Holding Time	Container Type & Size [2]
Decanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Undecanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Dodecanes	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Tridecanes Plus	IntertekEGA [8]	0.01 Mole%	None	14 days	Summa Canister, 1 L
Well Headspace Stable Isotope Analysis of Methane					
Carbon (^{13}C) isotope	IntertekEGA [9]	-1000 ‰ [10]	None	14 days	Summa Canister, 1 L
Hydrogen (D) isotope	IntertekEGA [9]	-1000 ‰ [10]	None	14 days	Summa Canister, 1 L

Note:
1 – TPH = total petroleum hydrocarbons; DRO = diesel range organics; GRO = gasoline range organics; VOC = volatile organic compounds; SVOC = semi-volatile organic compounds.
2 – Stated laboratory reporting limits are method detection limits or practical quantitation limits and are minimum requirements for project; reporting limits for for dissolved gases in groundwater per Microseeps, Inc.; reporting limits for well headspace gases and stable Isotopes per Intertek Westport Technology Center
3 – mg/l = milligrams per liter; µg/l = micrograms per liter; µmhos/cm = micromhos per centimeter; s.u. = standard units.
4 – C = degrees Celsius; TSP = trisodium phosphate; HCL = hydrochloric acid; Na-thio = sodium thiosulfate
5 – Container types and sizes are abbreviated as: VOA = volatile organic analysis vials; G = glass; A = amber; L = liter; ml = milliliters.
6 – Analytical Method AM20GAx, Standard Operating Procedure for Analysis of Biodegradation Indicator Gases, Microseeps, Inc., Revision 9.0, November 21, 2008
7 - Container is a 40-ml glass VOA vial with a proprietary septa designed to retain light hydrocarbons and exclude atmospheric gases.
8 – Intertek Westport Technology Center, internal laboratory procedure for extended gas analysis
9 – Intertek Westport Technology Center, internal laboratory procedure for stable isotope analysis
10 – Reporting limits in parts per thousand calculated versus a standard. -1000 ‰ indicates no isotope present is present, 0 would indicate concentration is equivalent to standard concentration.

TABLE 4
Precision, Accuracy, and Completeness Goals
Interim Plan for PAPA ROD

Measurement Parameter	Precision	Accuracy	Completeness
Field Water Quality Parameters (pH, temperature, specific conductance)	± 20% (compare to lab data, where applicable)	Variable (depends on parameter)	90%
Laboratory Analysis (inorganic common ions in water)	±20% RPD [1]	80 – 120% [2] 75 – 125% [2]	95% [3]
Laboratory Analysis (PHC in water)	±20% RPD [1]	80 – 120% [2] 75 – 125% [2]	95% [3]
Laboratory Analysis (dissolved gases in water)	no analytes in method blanks; ±20% RPD [1]	70-130% [2] 75-125% [2]	95% [3]
Laboratory Analysis (extended gases in headspace)	±20% RPD [1]	±3% compared to calibration standard	95% [3]
Laboratory Analysis (stable isotopes of methane in headspace)	±20% RPD [1]	≤0.09‰	95% [3]

Note:
1 – Refer to Section 3.4; RPD = relative percent difference.
2 – Refer to Section 3.5
3 – Refer to Section 3.6

APPENDIX C

MATRICES

APPENDIX C-1
PAPA-Wide Potential Source Screening Matrix
Interim Plan for PAPA ROD

Source	Source Type	Location[1]	Source Depth (ft)	Potentially Affected HSU	General Description	Indicators	Target Analytes
Petrogulf State 1-36 WDW	Class II Injection Well	T31N R109W S36	5721	Regional Wasatch; Fort Union Fm.	Produced Water	High TDS High Salinity BTEX	TDS, common ions, HCO3, BTEX

Note:

1 - Locations relative to NAD 83 UTM Zone 12N coordinate system.

APPENDIX C-2
Location-Specific Analyte Screening Matrix
Interim Plan for PAPA ROD

Well Name	Well ID	Well Location[1]	Associated Potential Sources	Potential Source Location	Potential Source Rank	Rank Justification[2]	Target Analytes

Notes:

1 - Locations relative to NAD 83 UTM Zone 12N coordinate system.

2 - based on direction, distance, depth, and mobility of indicator parameters.

APPENDIX D

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE

FIELD FORMS

SOP-1

All pertinent field investigation and sampling information shall be recorded on a field form during each day of the field effort and at each sample site. The field crew leader shall be responsible for ensuring that sufficient detail is recorded on the field forms. No general rules can specify the extent of information that must be entered on the field form. However, field forms shall contain sufficient information such that someone could reconstruct all field activities without relying on the memory of the field crew. All entries shall be made in indelible ink weather conditions permitting. Each day's or site's entries will be initialed and dated at the end by the author.

At a minimum, entries on the field sheet or in field notebook shall include:

- Date and time of starting work and weather conditions.
- Names of field crew leader and team members.
- Project name and type.
- Description of site conditions and any unusual circumstances.
- Location of sample site, including map reference, if relevant.
- Details of actual work effort, particularly any deviations from the field work plan or standard operating procedures.
- Field observations.
- Any field measurements made (e.g., PID readings, pH, temperature).

For sampling efforts, specific details for each sample should be recorded using Geomatrix standardized field forms. Surface water and groundwater field forms contain fill-in-the-blank type information in order that all pertinent information shall be recorded. In addition to the items listed above, the following information is recorded on field forms during sampling efforts:

- Time and date samples were collected.
- Number and type (natural, duplicate, QA/QC) of samples collected.
- Analysis requested.
- Preservative added to samples.
- Sampling method, particularly deviations from standard operating procedures.

Strict custody procedures shall be maintained with the field forms. Field forms shall remain with the field team at all times while being used in the field. Upon completion of the field effort, photocopies of the original field forms will be made and used as working documents; original field forms shall be filed in an appropriately secure manner.

STANDARD OPERATING PROCEDURE

EQUIPMENT DECONTAMINATION

SOP-2

The purpose of this section is to describe general decontamination procedures for field equipment. Decontamination will be performed on all nondedicated and non-disposable sampling equipment that may contact potentially contaminated media. Field personnel must wear disposable latex or nitrile gloves while decontaminating equipment at the project site. Change gloves between every sample. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

Table A-1 lists equipment and liquids necessary to decontaminate field equipment.

The following should be done in order to complete thorough decontamination:

1. Set up the decontamination zone upwind from the sampling area to reduce the chances of windborne contamination.

2. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.

3. The general decontamination sequence for field equipment includes: wash with Liquinox or an equivalent degreasing detergent; deionized water rinse; 10% dilute nitric acid rinse; rinse with deionized water three times.

4. Rinse equipment with methanol in place of the nitric rinse if sampling for organic contamination. Follow with a deionized water rinse.

5. Decontaminated equipment that is used for sampling organics should be wrapped in aluminum foil if not used immediately.

6. Clean the outside of sample container after filling sample container.

Alternatively, field equipment can be decontaminated by steam cleaning, rinsing with 10% dilute nitric acid, and rinsing with deionized water.

All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner. Handling and disposal procedures for the rinse and wash water will be specified in the project work plan.

TABLE A-1. EQUIPMENT LIST FOR DECONTAMINATION

5-gallon plastic tubs	Liquinox (soap)
5-gallon plastic water container	Hard bristle brushes
5-gallon carboy DI water	Garbage bags
1-gallon cube of 10% HNO_3	Latex gloves
1-gallon container or spray bottle of 10% Methanol or pesticide grade acetone for organics	Spray bottles
	Paper towels, aluminum foil

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF GROUNDWATER LEVEL

SOP-5

1. Calibrate the water level meter to a steel tape prior to each sampling event. Note any corrections to water level meter measurements on field forms.

2. Verify the water level meter is operating correctly prior to leaving for the field by placing probe in water to test the buzzer and light. Repair as necessary. Make certain the mater and extra batteries are in the carrying case.

3. Measure all wells (monitoring and domestic) from the top of the well casing in the north quadrant or from a designated measuring point, as appropriate. Measure and record the distance from the measuring point to ground level. Make sure the measuring point is labeled on the well, so future measurements can be made from the same location.

4. Measure the depth to water from the measuring point to the nearest hundredth of a foot. Record measurements on the appropriate field forms. Also record the presence/absence of free product on the field forms.

5. Decontaminate the water level meter between each measurement following the procedures in SOP-2.

6. If free product is known or suspected to be present in a well, an oil-water level indicator should be used to measure the depth to water and the thickness of free product in the well.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF ELECTRIC OR SPECIFIC CONDUCTANCE (EC/SC)

SOP-6

INSTRUMENT CALIBRATION

1. The meter shall be calibrated prior to each sampling event following the manufacturer's recommendations. If the instrument is a multi-parameter meter, follow the instructions for measurement of electric or specific conductance from the manual.

2. Prior to conducting field measurements, verify the meter automatically corrects for temperature variations. If the meter does not, apply the appropriate temperature correction to the field measurements.

FIELD PROCEDURE

1. Rinse a decontaminated glass beaker with approximately 50 milliliters of sample water three times.

2. Place approximately 150 ml. of sample in the decontaminated beaker.

3. Rinse the conductivity or multi-parameter probe with deionized water and place it in the beaker of sample water.

4. Immerse the probe in sample and move it around to displace any air bubbles. The probe should not touch the sides of the beaker. Record the conductivity reading taking note of the scale of the reading, microseimens/centimeter (µs/cm), micromhos/centimeter (µmhos/cm), or milliseimens/centimeter (ms/cm). If the reading is being taken in-situ or using a flow-through cell, wait until the reading stabilizes and record it on the sample field form.

7. Remove the probe from sample and rinse it with deionized water. Store the probe following the manufacturer's recommendations.

STANDARD OPERATING PROCEDURE

FIELD MEASUREMENT OF pH

SOP-7

INSTRUMENT CALIBRATION

1. The meter shall be calibrated prior to each field day following the manufacturer's recommendations. The two point standard method should be used for calibration. If instrument is a multi-parameter meter, follow the instructions for measurement of pH from the manual.

2. The calibration of the pH meter should be checked periodically throughout the field day, especially when air temperatures change more than 5 degrees. To check the calibration, place the probe in 7.0 pH buffer solution. If the measured value differs from the expected value by more than 0.1 pH units, recalibrate the meter according to the manufacturer's instructions.

FIELD PROCEDURES

1. Rinse a decontaminated glass beaker with approximately 50 milliliters of sample water three times.

3. Rinse the pH electrode with deionized water.

4. Check the meter using a 7.0 pH buffer. Re-calibrate the meter if the reading is not within 0.1 pH standard units (s.u.).

5. Fill the beaker with sample water.

6. Immerse the probe in the sample and agitate it to provide thorough mixing. Continue to agitate until the reading has stabilized. Read the pH to the nearest 0.1 s.u. If the reading is being taken in-situ or using a flow-through cell, wait until the reading stabilizes and record it.

7. Record the sample pH on the field measurement form. Note any problems such as erratic readings. If previous readings are available, compare the current measurement to previous reading to check that the current reading is within reasonable limits.

8. Rinse probe with deionized water and store according to the manufacturer's instructions.

STANDARD OPERATING PROCEDURE

FIELD SAMPLE FILTRATION

SOP-10

1. Filtration equipment will include disposable 0.45 micron filters.

2. To avoid the need for decontamination, use disposable tubing with a peristaltic pump or disposable bailers and a hand-vacuum pump.

3. Fill pre-preserved, laboratory supplied sample containers with filtered sample and cap. Invert sample container several times to insure complete sample-preservative mixing.

4. Place sample container into cooler; package and ship accordance with SOP-15.

5. If extremely turbid sample water is obtained, pre-filter the sample using 3.0 or 5.0 micron filter paper followed by 0.45 micron filtration.

6. Decontaminate, if necessary, all equipment in accordance with SOP-2 following use.

STANDARD OPERATING PROCEDURE

GROUNDWATER SAMPLING

SOP-11

EQUIPMENT:

Five gallon bucket graduated in gallons	pH meter/thermometer
Coolers and ice	Specific conductance meter
Sample bottles	Bailer(s)
Preservatives	Bailer rope or Teflon reel
Filter apparatus	Field sampling forms
Decontamination equipment & fluids	Indelible marker
Water level meter	Stop watch
Purge/sampling pump(s)	Generator
Discharge hose	Fuel

All sampling equipment shall be inspected for damage and repaired if necessary, prior to arriving on-site.

GENERAL PROCEDURE – PURGING

Purging must be performed on all wells prior to sample collection. If required by the project workplan, the stability of pH, specific conductivity, and temperature will be evaluated. A minimum of three casing volumes shall be purged from the well prior to sample collection. The volume of water present in each well shall be computed using the length of water column and monitoring well inside diameter. The total volume of water in the well (gallons) can be approximated using the following formula (depth and water level measurements in feet; borehole diameter in inches):

$$(1/25)\ (\text{Total Depth - Measured Water Level})\ (\text{Casing Diameter})^2 = \text{gallons}$$

Several general methods are used for well purging. Well purging may be achieved using bailers, bladder pumps and submersible pumps. The specific pumping method shall be chosen based on depth to groundwater, diameter of well, existing well configuration and contaminant(s) of concern. Specific conductance, pH, temperature, and purge volume values will be entered on the Field Sampling Forms. If sampling for hydrocarbon compounds, wells shall be checked for the presence of free product prior to purging and sampling.

Field parameters will be measured periodically during well purging at a minimum of once per casing volume purged. The well is ready for sampling when either or both of the following conditions are met: 1) measured field parameters stabilize within plus or minus five percent over three successive readings or, 2) three to five casing volumes have been evacuated from the well.

If the recovery of a low-yield well exceeds two hours after purging, the sample shall be extracted as soon as sufficient volume is available in the well. At no time will a monitoring well be pumped dry if the recharge rate causes formation water to cascade down the well casing causing an accelerated loss of volatiles and change in pH.

COLLECTING WATER QUALITY SAMPLES

1. Generally, wells shall be sampled from the least contaminated to the most contaminated, if known. Open well and measure water level (SOP-5).

2. Decontaminate sampling equipment following the procedures outlined in SOP-2.

3. Label each sample container with project number, sample location, well owner, date, military time, sampler's initials, preservative, and analysis required.

4. Don clean latex or nitrile gloves immediately prior to obtaining the sample.

5. Sampling Monitoring Wells
    a. Obtain the sample from the well using a disposable polyethylene bailer, a decontaminated stainless steel or Teflon bailer, or pump tubing, as appropriate. When using a bailer, take care to minimize degassing or contamination of the sample by submerging and withdrawing the bailer slowly to avoid splashing. Do not place the bailer on the ground.

6. Sample Domestic Wells
    a. Turn-on household fixture (preferably an outside faucet without a hose connected) that is on the well-side of any household water conditioning device.
    b. Using the above equation, calculate the volume of water to be evacuated. Measure the discharge rate from the faucet in a graduated 5 gallon bucket, or other suitable container, to compute the rate of discharge. Calculate the time needed to evacuate the predicted volume from the well. Record all measurements and calculations on the field forms.
    c. Samples should be collected directly from hydrant or faucet and prior to entry of the water through any water conditioning devices. Do not collect samples through rubber hoses. Aerators or screens (if present) should be removed from faucets prior to sample collection.

7. If sampling for dissolved metals, field filter sample according to SOP-10.

8. Transfer sample water directly into sample bottles, maintaining a slow linear flow with as little aeration as possible. Samples will be preserved as described in the table below.

Parameter	Number	Container	Preservation	Maximum Holding Time Extraction/ Analysis
VOCs	2	40 ml glass	4°C & HCL	14 days to analysis
SVOCs	1	1 liter glass	4°C	7 days/40days from extraction to analysis
Metals	1	500 ml HDPE	4°C & HNO_3	6 months to analysis,, Hg 28 days to analysis
Nutrients	1	500 ml HDPE	4°C & H_2SO_4	Varies – contact laboratory for additional information
Common Ions	1	1 liter HDPE	4°C	7 days/40 days from extraction to analysis

9. For volatile analyses add preservative to sample vial and fill vials at the rate of 100 milliliters per minute (24 seconds for 40 milliliter vial) or less. Fill each sample vial completely so the water forms a convex meniscus at the top to ensure no air space exists in the vial after it has been capped. After filling, immediately cap, invert, and gently tap the vial to check for trapped air. If air bubbles are present, un-cap vial, add more sample water and repeat procedure. If air bubbles are still present, discard the vial.

10. Complete the necessary shipping and handling paperwork, and record all pertinent information on Field Sampling Form in accordance with SOP-1.

STANDARD OPERATING PROCEDURE 12

COLLECTING VAPOR AND WATER SAMPLES WHEN COMBUSTIBLE GAS CONCENTRATIONS IN WATER WELL CASING EXCEED LOWER EXPLOSIVE LIMIT

Ultra Resources, Inc.

Pinedale Anticline Production Area, Sublette County, Wyoming

PURPOSE

The purpose of this Standard Procedure is to ensure a safe environment for the collection of environmental data (e.g. static water level measurements, water samples, well casing headspace samples) from water supply wells where a combustible atmosphere may be present.

ASSUMPTIONS

It is assumed that combustible conditions are most likely to occur near the top of the well casing where gas or vapors are mixing with ambient atmospheric air. It is further assumed that conditions within the well casing below the depth of atmospheric influence are oxygen deficient, and that by sealing off the wellhead from ambient atmospheric influences, explosive conditions will not exist within the casing or at land surface around the wellhead. These assumptions will be tested in the field using a combustible gas indicator (CGI).

NECESSARY EQUIPMENT

The following equipment/supplies will be necessary to implement the SCCD groundwater sampling procedure.

1. Well cap (PVC, expandable j-plug, or similar) sized to form an airtight seal with the steel well casing and fitted with:

    a. A monitoring port for a CGI with a five-foot length of polyethylene (PE) tubing affixed to the inside, for the purpose of monitoring explosive conditions inside the well casing;

    b. A 5/8-inch diameter port through which water level meter and nylon bailer cord can pass.

2. Nylon bailer cord

3. Disposable PE bailer

4. A combination combustible gas indicator and oxygen concentration meter (the type that accommodates a sampling line or probe will be necessary) that is calibrated at the beginning of each work shift in accordance with manufacturer's instructions (calibrated for both flammable gas and oxygen concentration)

5. Compressed nitrogen or carbon dioxide gas cylinders (standard K-size) , regulator, and air hose (enough to reach within 10 feet of the static water level)

The following equipment/supplies will be necessary to implement the low-flow sampling procedures described in the Bladder Pump SOP and to collect samples of well head gas.

1. Well cap (PVC, expandable j-plug, or similar) sized to form an airtight seal with the steel well casing and fitted with:

    a. A monitoring port for a CGI with a five-foot length of polyethylene (PE) tubing affixed to the inside, for the purpose of monitoring explosive conditions inside the well casing;

b. Three ports for ¼-inch inside diameter (3/8-inch outside diameter) PE tubing to connect bladder pump air line **(BPair Port)**, bladder pump water discharge tubing **(BPwater Port)** and well head gas sample collection **(WHGas Port)** tubing (to within 3ft of the static water level).

c. A port through which water level meter probe can pass **(Access Port)**.

2. Bladder pump and PE pump tubing (1/4-inch ID x 3/8-inch OD)

3. ¼ inch PE tubing if sampling for expanded gas and/or stable isotopes (1/4-inch ID x 3/8-inch OD)

4. A combination combustible gas indicator and oxygen concentration meter (the type that accommodates a sampling line or probe will be necessary) that is calibrated at the beginning of each work shift in accordance with manufacturer's instructions (calibrated for both flammable gas and oxygen concentration)

5. Summa canisters (1-L preferred) for collecting vapor samples

6. Intrinsically safe air pump to evacuate PE tubing

7. Flexible tubing to connect CGI and Summa canisters to monitoring/sampling ports

8. Zip ties to secure tubing together

9. Compressed nitrogen or carbon dioxide gas cylinders (standard K-size), regulator, and air hose (enough to reach within 10 feet of the static water level)

PROCEDURE

- Survey workspace at and around the well head with CGI. If readings are ≥20% of the LEL, additional sampling activities should not be performed until the source the combustible vapors are identified and mitigated.

- Install the well cap fitted with ***monitoring/sampling ports*** and PE **monitoring** drop tubing on the wellhead. Prior to installation, suspend a disposable PE bailer attached to the nylon cord from the underside of the cap by passing the bailer cord through the 5/8-inch diameter ***access port*** in the cap (SCCS method) or alternatively suspend an electronic water level monitoring probe through the ***access port***.

- After installing the well cap, survey the work space around the wellhead for potentially explosive conditions. While it is safe to proceed if CGI readings are ≤20% of the LEL, the source of CGI readings in the 1% to 20% range should be investigated and mitigated, if possible, since appreciable vapors should not be escaping from the well casing with the cap attached. Investigation and mitigation are beyond the scope of this procedure, and should be performed by the Operator.

- Connect the CGI to the ***monitoring port*** with the 5 foot-long flexible tubing and measure for potentially explosive conditions within the well casing. Allow sufficient running time for the tubing to be completely purged to ensure the atmosphere within the well casing is being monitored.

- If conditions within the well casing measured through the ***monitoring port*** are ≤20% of the LEL, proceed with collecting the groundwater sample by lowering the bailer via the nylon cord passing through the 5/8-inch ***access port*** in the well cap (SCCD method) or lower the water level meter probe and determine the depth to water.

- If conditions within the well casing, as indicated by readings from the CGI attached to the monitoring port, are >20% of the LEL, **STOP WORK**. The well casing will have to be inerted before a groundwater sample can be safely collected (again, it is assumed that readings >20% of the LEL are due to mixing of

vapors emanating from the well with ambient air around the wellhead). Remove the well cap to allow vapors to dissipate as the well is being inerted. Discharge nitrogen or carbon dioxide gas from a hose as it is being lowered into the well to a depth of approximately 30 feet. After inerting is completed, remove the hose from the well and reinstall the well cap. Monitor continuously for potentially explosive conditions with the CGI. Proceed with groundwater sampling once CGI readings remain ≤20% of the LEL for at least 10 minutes.

- Attach ¼-inch ID PE tubing for headspace gas sampling to the bladder pump tubing using zip ties so that the bottom of the tubing will be located 3 feet above the static water level after lowering the bladder pump to the target pumping depth.

- Lower the bladder pump to the target pumping depth and connect the tubing to the BPair, BPwater, WHGas ports on the underside of the well cap and replace the well cap.

- If conditions within the well casing, as indicated by readings from the CGI attached to the monitoring port, are >20% of the LEL, **STOP WORK**. The well casing will have to be inerted before a groundwater sample can be safely collected (again, it is assumed that readings >20% of the LEL are due to mixing of vapors emanating from the well with ambient air around the wellhead). Remove the well cap to allow vapors to dissipate as the well is being inerted. Discharge nitrogen or carbon dioxide gas from a hose as it is being lowered into the well to a depth of approximately 30 feet. After inerting is completed, remove the hose from the well and reinstall the well cap. Monitor continuously for potentially explosive conditions with the CGI. Proceed with groundwater sampling once CGI readings remain ≤20% of the LEL for at least 10 minutes.

- Connect the air pump to the ***WHGas port*** and purge the sample tubing for sufficient period of time to purge air from the tubing (1.25 times the tubing volume). Purge time will depend on pumping rate. Record the actual pumping rate and time on the well sampling form or logbook. Take care not excessively purge the tubing.

- Disconnect the air pump and connect the Summa canisters to ***sample port***. Collect vapor samples in accordance with laboratory instructions.

- Perform groundwater purging and sampling using the bailer (SCCD method) or following the Bladder Pump SOP.

- Monitor the well casing continuously with the CGI during groundwater sample collection to ensure readings remain below 20% of the LEL. If necessary, repeat the inerting process.

- Depth to water measurements can be made after sampling by inserting an electric water level meter probe through the 5/8-inch port, provided that CGI readings remain ≤20% LEL.

STANDARD OPERATING PROCEDURE

QUALITY CONTROL SAMPLES

SOP-14

Quality Control (QC) samples are submitted along with natural samples to provide supporting laboratory data to validate laboratory results. QC samples are submitted blind with the exception of matrix spikes and trip blanks, and do not have any unique identifying codes that would enable the lab or others to bias these samples in any way. Usually, the time or sampling location is modified in a way which will separate blank and standard samples from the rest of the sample train. QC samples are identified only on field forms and in field notebooks. The following codes are typically used:

N	Natural Sample	Soil, water, air, or other of interest material from a field site
SP	Split Sample	A portion of a natural sample collected for independent analysis; used in calculating laboratory precision
D	Duplicate Sample	Two samples taken from the same media under similar conditions; also used to calculate precision
FB	Field Blank	Deionized water collected in sample bottle; used to detect contamination introduced during the sampling process.
RB	Rinseate Blank	Deionized water run through or over decontaminated equipment; used to verify the effectiveness of equipment decontamination procedures
MS/MSD	Matrix Spike/ Matrix Spike Duplicate	Certified materials of known concentration; used to assess laboratory precision and accuracy
TB	Trip Blank	Inert material (deionized water or diatomaceous earth) included in sample cooler; sent by the lab, the sample is used to detect any contamination or cross-contamination during handling and transportation.

In general, selected QC samples will be inserted into the sample train within a group of twenty samples. QC samples will be prepared in the field with the exception of trip blanks and matrix spike/matrix spike duplicate samples. Trip blanks will be supplied by the laboratory and will accompany each sample cooler containing samples for analysis of volatile organic compounds. Matrix spike and matrix spike duplicates will be generated by submitting three duplicate samples from the same sample to the laboratory. The laboratory will then spike two of the three samples with known concentrations of select target compounds. After the laboratory has spiked the matrix spike and matrix spike

duplicate samples, they are subject to the same laboratory procedures and analyses as all other samples collected during the investigation.

QC sample collection frequencies are presented in the table below. Each field crew leader will be responsible for all QC samples prepared by that crew.

QC Sample	Purpose	Collection Frequency
Field Duplicate	Measure analytical precision.	1 per every 20 samples
Matrix Spike/Matrix Spike Duplicate	Measure analytical accuracy.	1 per every 20 samples
Equipment rinse blanks	Evaluate effectiveness of equipment decontamination and sample handling procedures.	1 per sampling event per media
Field Blank	Assess possible cross-contamination of samples due to ambient conditions during sample collection.	1 per sampling event
Trip Blanks	Evaluate sample preservation, packing, shipping, and storage.	1 per cooler containing samples with volatile constituents

Methods for computing data validation statements can be found in EPA documents or obtained from Geomatrix.

STANDARD OPERATING PROCEDURE

SAMPLE DOCUMENTATION

SOP -15

Sample documentation is an important step to ensure the laboratory, project manager, and field personnel are informed on the status of field samples. Depending on the specifics required for each project, a number of forms will need to be filled out. Most sample documentation forms are preprinted carbonless triplicates, enabling copies to be filled or mailed from labs or offices. The forms will be completed by field personnel, who have custody of the samples. The office copy will be kept in the project file and subsequent copies sent to the laboratory, or other designated parties.

Responsibility for completing the forms will be with each field crew leader. It is important the field crew leader is certain field personnel are familiar with the completion process for filling out forms, and the expected information is included.

Potential documents to be completed clearly in indelible ink for each sample generated include:

- Field Form
- Chain-of-Custody
- Custody Seal

STANDARD OPERATING PROCEDURE

SAMPLE PACKAGE AND SHIPPING

SOP-16

All environmental samples collected should be packaged and shipped using the following procedures:

PACKAGING

1. Label all sample containers with indelible ink (on the side, not on the cap or lid). Place labeled sample bottles in a high quality cooler containing an adequate amount of ice (inside sealed Ziploc bags) and/or frozen blue ice (appropriate for the season) to maintain a temperature of 4°C or less inside the cooler. Ensure the cooler drain plug is taped shut.

2. Place the samples in an upright position and wrap the samples with absorbent, cushioning material for stability during transport. Samples should not be loose; the cooler should be able to withstand tough handling during shipment without sample breakage.

3. Fill out the appropriate shipping forms, and place the paperwork in a Ziploc bag and tape it to the inside lid of the shipping container. Shipping forms usually consist of a chain-of-custody form, which documents the samples included in the shipment and specifies the laboratory analyses for each sample. If more than one cooler is used per chain of custody, put a photocopy in the other coolers and mark them as a copy.

4. Close and seal the cooler using strapping tape.

5. Place completed sample custody seals on the cooler such that the seals will be broken when the cooler is opened. Secure the custody seals on the cooler with clear strapping tape.

6. Secure the shipping label with address, phone number, and return address clearly visible.

SHIPPING HAZARDOUS MATERIALS/WASTE

Hazardous materials need to be shipped using procedures specified under Federal Law. Samples need to be shipped in Ziploc bags or paint cans filled with packing material, depending on the level of hazard. Special package labeling may be needed. Consult the project manager for specific shipping procedures.

STANDARD OPERATING PROCEDURE

SAMPLE CHAIN-OF-CUSTODY

SOP-18

A chain-of-custody form will be generated for all samples collected in the field for laboratory analysis. The sampler may use Geomatrix' chain-of-custody form (example attached) or a chain-of-custody form provided by the laboratory.

FIELD EQUIPMENT

- Indelible ink pen
- Chain-of-custody forms
- Custody seals

PROCEDURES

Sample custody records must be maintained from the time of sample collection until the time of sample delivery to the analytical laboratory and should accompany the sample through analysis and final disposition. The information to be included on the chain-of-custody form will include, but is not limited to:

- Project number/site name
- Sampler's name and signature
- Date and time of sample collection
- Unique sample identification number or name
- Number of containers
- Sample media (e.g., soil, water, vapor, etc.)
- Sample preservative (if applicable)
- Requested analysis
- Comments or special instructions to the laboratory

Each sample will be assigned a unique sample identification number or name. The information on the chain-of-custody form, including the sample identification number or name, must correspond to the information recorded by the sampler on the field forms (refer to SOP 1) and the label on the sample container.

A sample is considered under a person's control when it is in their possession such that tampering is prevented. This includes placing the samples in an area of controlled access such as building, or locking the samples in a vehicle. When custody of a sample is relinquished by the sampler, the sampler will sign and date the chain-of-custody form and note the time that custody was relinquished. The person receiving custody of the sample will also sign and date the form and note the time that the sample was accepted into custody. Samples will be shipped to the analytical laboratory following the

procedures in SOP 15. If an overnight shipping service is used to transport the samples to the laboratory, custody of the samples will be relinquished to the shipping service. The shipping service will not sign the chain-of-custody form; however, the samples can be tracked while in the custody of the shipping service.

More than one sample may be included on a chain-of-custody form, as long as all of the samples are for the same project. Copies of the chain-of-custody form will be maintained in the project file

STANDARD OPERATING PROCEDURE 20

LOW-FLOW SAMPLING OF GROUNDWATER WITH A BLADDER PUMP

This document describes the procedures to be used for operation of bladder pumps with pressurized gases, both from a safety and effectiveness point of view. These procedures are applicable to wells where combustible gas indicator (CGI) readings are greater than 20 percent of the lower explosive limit (LEL) at the wellhead. Additional procedures outlined in the document entitled *Standard Procedure – Collecting Vapor and Water Samples when Combustible Gas Concentrations in Water Well Casing Exceed the Lower Explosive Limit* must also be followed.

EQUIPMENT LIST

	Water level indicator
	Physical parameter meter (e.g. YSI 556 MPS)
	Bladder pump
	Replacement bladder
	Replacement O-rings
	Tubing (new) for 1" pump 1/4" OD, 0.17" ID
	Tubing (new) for 2" pump 3/8" OD, 1/4" ID
	Tubing (new) for head space gas/vapor sampling (if applicable) 3/8" OD, 1/4" ID
	Intrinsically safe air pump for head space gas/vapor sampling (if applicable)
	Pressurized gas cylinder (air or nitrogen) with pressure regulator
	Straps for supporting pressurized gas cylinder
	Controller (e.g. Geocontrol2) including associated pressure hoses/fittings from pressurized gas cylinder and to bladder pump gas line, as well as electricity source
	Groundwater Sampling containers
	Summa cansisters (1-L preferred) for head space gas/vapor sampling (if applicable)
	Combination combustible gas indicator and oxygen concentration meter (the type that accommodates a sampling line or probe will be necessary) that is calibrated at the beginning of each work shift in accordance with manufacturer's instructions (Also need calibration standard gas for both flammable gas and oxygen concentration)
	Alligator clamps
	Filters
	Decontamination supplies (2 gallons of tap water and 1 gallon of deionized water per well, Alconox or similar detergent)

MOBILIZATION TO SAMPLING SITE

Nitrogen tanks must be strapped to vehicle in a vertical position during transport. Once at the well location, strap one tank to the well, also in a vertical position.

CONNECTING PRESSURIZED TANK TO REGULATOR

At the sampling location, check the cylinder and line pressure of the pressurized gas, as follows. Attach the regulator to the cylinder, and check that the cylinder-regulator connection is firmly seated prior to opening the cylinder valve, and that the outer coupling on the regulator is in place to allow pressure to build within the regulator. Open the cylinder valve.

The controller and bladder pumps have pressure limitations, and can fail if limits specified by the manufacturer are exceeded. Set the in-line pressure regulator prior to the controller at a pressure that meets manufacturer's recommendations. For accurate readings of adjusted line pressures, close the cylinder valve, slowly loosen the

cylinder-regulator connection to bleed out pressure, adjust the regulator control knob/screw, re-attach the cylinder-regulator connection, and open the cylinder valve. Do this for each adjustment until the desired line pressure is reached. Close the cylinder valve when correct pressure is confirmed.

ASSEMBLING PUMP SYSTEM

Measure water level prior to placing the pump or tubing in the well. Identify the desired sampling depth. Attach air and water lines to the bladder pump, mark each line on a portion of the line that will remain above ground surface, and note factory markings regarding tubing length at the pump (if present). Consult the plan of study to determine if headspace gas/vapor and dissolved gas in groundwater sampling is required at the well. If required, use the following headspace gas/vapor procedures. The procedures outlined below only apply to wells outlined in the Plan of Study where previous CGI monitoring resulted in the LEL<10%.

HEADSPACE GAS/VAPOR SAMPLING PROCEDURES

Survey workspace at and around the well head with CGI. If readings are ≥20% of the LEL, additional sampling activities should be performed using until the source the combustible vapors are identified and mitigated. If readings are between 10 and 20% of the LEL then initiate the requirements contained in *Standard Procedure – Collecting Vapor and Water Samples when Combustible Gas Concentrations in Water Well Casing Exceed the Lower Explosive Limit.*

Attach ¼-inch ID PE tubing for headspace gas sampling to the bladder pump tubing using zip ties so that the bottom of the tubing will be located 3 feet above the static water level after lowering the bladder pump to the target pumping depth. Lower the bladder pump to the target pumping depth and secure the tubing to the well casing with alligator clamps.

Connect the air pump to the ***WHGas port*** and purge the sample tubing for sufficient period of time to purge air from the tubing (1.25 times the tubing volume). Purge time will depend on pumping rate. Record the actual pumping rate and time on the well sampling form or logbook. Take care not excessively purge the tubing.

Disconnect the air pump and connect the Summa canisters to ***sample port***. Collect vapor samples in accordance with laboratory instructions. Continue with the Purging and Sampling procedures.

PURGING AND SAMPLING

Lower the pump to the desired depth, with confirmation by reading the factory markings on the tubing (if present), or by lowering a water level indicator until it encounters the pump.

Connect the controller to a power source, then verify that the valve to the pressurized gas cylinder is closed, and attach all hoses and fittings. Determine the target line pressure based on the guideline below:

Line pressure to pump (psi) = Depth to groundwater (ft) * 0.5 + 10

(i.e. to pump out of a well where the depth to water is 100 ft, set the line pressure at 60 psi)

Slightly more pressure may be needed to overcome friction losses if your pump intake is deep in the water, and/or if you run lines along the ground surface horizontally for a long distance. However, use extra pressure sparingly and gradually, as you can collapse the bladder so that the natural water pressure will not re-open it.

The following is a list of effective final target line pressures and cycle intervals for a Geotech Environmental Control 2 controller used for the indicated depth to water:

Static Water Depth (ft)	Air Line Pressure (psi)	Air Line Charge Time (sec)	Air Line Exhaust Time (sec)
70	50	15*	10
210	130	7	20
65	45	15*	7
65	50	5	5
70	55	9	5
250	165	12	20
85	85	5	10

* Integral air compressor used with AMEC Geomatrix controller Geocontrol Pro. Pressurized nitrogen not used.

Once the pump and tubing are in the well, record the time and depth to water immediately prior to purging.

Open the valve to the pressurized gas cylinder, and turn on the controller. The initial settings of the controller should conform to those listed in the table above, with the exception that, at the start of purging, the controller pressure gauge should be set at less than half the final target pressure. This avoids collapsing the bladder when there is not yet a column of water in the line from the pump to the surface. Confirm that the pump is working by placing the end of the water line in clean water, and observing air bubbling from the line. Gradually increase the line pressure as a taller column of water fills from the pump to the surface.

Record time, depth to water, and normal water quality parameters listed on the attached Well Sampling and/or Development Record at approximately 5 minute intervals during purging. Physical parameters should stabilize and the depth to water should stabilize in order for the low flow sampling method to be used. The ASTM low flow method D 6771-02 will be used to perform purging and sampling of groundwater. In summary, the well should not be drawn down more than one quarter of the length from the top of the well screen to the pump intake (if achievable), and sequential physical parameter readings should be within approximately 5%, depending on the parameter.

At the end of purging the discharge water should be directed into a container and notations regarding effervescence shall made as follows:

- None – no gas bubbles are observed
- Slight – can observe and count the number of bubbles
- Medium – can't count the number of bubbles but it is less than the Strong description.
- Strong – bubbles are observed similar to water just starting to boil.

Sample directly from the end of the tubing into sampling containers, attaching any necessary filters directly to the end of the tubing (i.e. filtering can be done during sampling, rather than from temporary containers, because the water line is pressurized). Consult the plan of study to determine if dissolved gas sampling is required. If so, the 40 mL VOA vials fitted with proprietary septum lids (provided by Microseeps) for dissolved gas analysis the vials should be filled last by placing the discharge tubing near the bottom of the vial until a mound of water forms on top of the vial. Slowly remove the tubing and carefully seal with the septum lid. Invert and check for bubbles. If bubbles are present a second attempt can be made to fill the vial but it may not be possible to seal the vial without bubbles (due to dissolved gas and not air). In this case make a note of which sample contained bubbles and submit the samples for analysis.

When all sampling containers are filled, turn off the controller and gently remove the tubing and pump from the well. Tubing over 100 ft. in length should be rolled onto a clean spool and marked with the well number for reuse, taking care to leave both ends of the tubing accessible. Once the tubing and pump are removed, immediately measure the post-sampling depth to water.

DECONTAMINATION

For tubing that will be reused, run clean water through the tubing using low pressure with the bladder pump, then store the spool of tubing in a clean bag or box.

For the pump itself, use new tubing and perform the following soap and water decontamination procedure. Rinse the exterior of the pump with soapy water. Attach short air and water lines. Run soapy water through the pump for approximately 10 cycles of the pump. Do the same exterior rinse and pumping in clean tap water, then rinse the exterior of the pump with deionized water and turn the pump upside-down to dump out water from inside the pump. The pump is now ready for purging and sampling a new well.

Slowly bleed out line pressure by loosening the cylinder-regulator fitting, then disconnect all other tubing and fittings.

EQUIPMENT STORAGE

At the end of a sampling event, the pump should be further decontaminated by unscrewing both ends and performing a triple rinse (soapy water, tap water, deionized water) for the pump ends, bladder, and metal tube surrounding the bladder. O-rings at both ends of the bladder pump should be inspected and replaced if any cracks or other problems are observed, and the bladder itself should be inspected and replaced, if necessary. Protect the pump in a cardboard tube or box, and stow the pump, controller, and tubing carefully in a single area.

APPENDIX E

STANDARD FIELD FORMS

DAILY FIELD RECORD

GEOMATRIX

Project and Task Number:	Date:
Project Name:	Field Activity:
Location:	Weather:

PERSONNEL: Name	Company	Time In	Time Out

PERSONAL SAFETY CHECKLIST

	Steel-toed Boots		Hard Hat		Other:_____
	Rubber Gloves		Safety Goggles		Other:_____

TIME	DESCRIPTION OF WORK PERFORMED

FIELD PREPARATION CHECKLIST

PROJECT NAME: PROJECT #:

		FIELD PREPARATION AND FOLLOW-UP
		Telephone Calls
		Client/Site Contact:
		Regulatory Agency:
		USA Contact:
		Private Utility Locator:
		Other:
		Additional Numbers or Notes
		Geomatrix:
		Rick Morrow:
		Francis Sefwi:
		Paul Dawson:
		Driver:
		Hospital/Clinic:
		SGS Lab:
		Other:
		Site Walk Information
		Mark borings/excavations
		Obtain utility maps or plans
		Access Issues:
		keys or keypad security code #
		time constraints on work (hours/days)
		limited by power lines, structures, soft ground
		Water or electrical source at site
		Traffic control requirements
		Other:
		Documents to Prepare
		Geomatrix work plan
		Geomatrix Health and Safety Plan
		Subcontractor cost estimates
		Subcontractor work order
		Other:
		Permits
		County Drilling Permit
		Encroachment Permit
		Grading Permit
		Other:
		Analytical Laboratory
		Lab:
		Laboratory Service Request
		Bottle order: sample containers & (circle)
		duplicate or split samples
		trip, atmospheric, or temperature blanks
		equipment, pump, or rinsate samples
		cleaning water
		Sample courier or shipment (airbill label, insurance)
		Other:

		FIELD EQUIPMENT AND REFERENCES
		Equipment
		Geomatrix equipment order
		Water Level Indicator
		Measuring Tape
		Pump
		Tubing
		Hose
		Transducer
		Lap Top Computer
		Personal Protective Equipment
		See health and safety on back
		Hard hat and steel toed boots (leather/rubber)
		Rain gear
		Safety glasses and vest
		Ear protection
		Drinking water
		Sun screen
		Other:
		Additional Personal Items
		Cellular phone
		Camera (digital, disposable)
		Clipboard
		Calculator
		Clock or wrist watch
		Tape measure
		Scale and protractor
		Satellite phone
		Spray water bottle
		Other:
		References and Forms
		H & S Plan, permits, subcontractor WO
		Previous field documents (reports, etc)
		Site location map and site plan
		Work plan or sampling plan
		Telephone contact list
		Unified soil classification tables
		Munsell color charts
		Geomatrix forms (circle): daily field records;
		boring, well, or trench logs;
		development records; well construction
		summary, water-level monitoring, chain-or-
		custody, sample control log, drum inventory
		Other:

FIELD PREPARATION CHECKLIST

PROJECT NAME: PROJECT #:

		Waste Generated				Follow-Up Tasks
		Soil (soil bin, drums, stockpiled on plastic)				Surveyor
		Water (drums, Baker™ tank)				DWR Forms for well installations
		Sample for disposal				Other:
		Coordinate storage location at site and disposal				

WATER LEVEL MONITORING RECORD

Geomatrix

Project Name: _____ Project and Task Number: _____

Date: _____ Measured by: _____ Instrument Used: _____

Note: For you convenience, the following abbreviations may be used.

P = Pumping I = Inaccessible D = Dedicated Pump
ST = Steel Tape ES = Electric Sounder MP = Measuring Point WL = Water Level

Well No.	Time	MP Elevation (meters)	Water Level Below MP (meters)	Water Level Elevation (meters)	Previous Water Level Below MP	Remarks

GEOMATRIX

PHOTOGRAPH LOG

Project Name: _____ **Project No.** _____

_____

_____ **Roll No.** _____

Photo No.	Date	Subject, Location, and Direction of View	Taken by

FIELD INSTRUMENT CALIBRATION SHEET

GEOMATRIX

Project Name: _____ **Project Number:** _____

_____ _____

Date: _____

Equipment Type: _____

Manufacturer: _____

Model Number: _____ **Serial Number:** _____

Calibration (as necessary, minimum twice per day):

Calibration #1 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #2 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #3 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Calibration #4 **Time:** _____

Calibration Standard: _____

Instrument Reading: _____

Date of Last Calibration: _____ Date(s) Instrument Used: _____

Name of person(s) who calibrated instruments: _____

Calibration Standards Used:

(1) _____

(2) _____

(3) _____

(4) _____

Source of Calibration Standards: _____

Misc. Comments:

_____

_____

Calibrated by: _____

CHAIN-OF-CUSTODY RECORD

MIS 10012

PROJECT NAME:			DATE:	PAGE OF
PROJECT NUMBER:	LABORATORY NAME:	CLIENT INFORMATION:	REPORTING REQUIREMENTS:	
RESULTS TO:	LABORATORY ADDRESS:			
TURNAROUND TIME:				
SAMPLE SHIPMENT METHOD:	LABORATORY CONTACT:		GEOTRACKER REQUIRED	YES NO
	LABORATORY PHONE NUMBER:		SITE SPECIFIC GLOBAL ID NO.	

SAMPLERS (SIGNATURE):

ANALYSES

DATE	TIME	SAMPLE NUMBER															CONTAINER TYPE AND SIZE	Soil (S), Water (W), Vapor (V), or Other (O)	Filtered	Preservative Type	Cooled	MS/MSD	No. of Containers	ADDITIONAL COMMENTS

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME	TOTAL NUMBER OF CONTAINERS:	
SIGNATURE:			SIGNATURE:			SAMPLING COMMENTS:	
PRINTED NAME:			PRINTED NAME:				
COMPANY:			COMPANY:				
SIGNATURE:			SIGNATURE:				
PRINTED NAME:			PRINTED NAME:				
COMPANY:			COMPANY:				
SIGNATURE:			SIGNATURE:				
PRINTED NAME:			PRINTED NAME:				
COMPANY:			COMPANY:				

1001 South Higgins Avenue, Building B-1
Missoula, Montana 59801-4144
Tel 406.542.0129 Fax 406.542.0130

Geomatrix

APPENDIX F

HEALTH AND SAFETY PLAN

SITE SPECIFIC HEALTH AND SAFETY PLAN

Approvals		
	Initials	Date
Prepared By		
Approved By		

PROJECT INFORMATION

Date(s) of Field Work: _____
Project Name: _____ Project Number: _____
Client: _____ Site Phone: _____
Site Address: *PAPA, Sublette Co., WY* ☐ Site Plan Attached
Scope of Work: _____

Type of Project: ☒Environmental; ☐Geotechnical; ☐Industrial Process; ☐Other: _____
☒HAZWOPER Project: Training & Medical Surveillance must conform to 29 CFR 1910.120 & Geomatrix Guidelines.
☐Client Specific Requirements (Attached)

KEY CONTACTS

Project Manager: _____ Phone: _____ Cell: _____
Project H&S Manager: _____ Phone: _____ Cell: _____
Site H&S Manager: _____ Phone: _____ Cell: _____
Client Contact: _____ Phone: _____ Cell: _____
Client's Site Contact: _____ Phone: _____ Cell: _____
Corporate Health & Safety Manager: *Don Kubik Jr., CIH* Phone: _____ Cell: _____
Other: _____

Emergency Medical Facility 1: ***Pinedale Medical Clinic***
Address: *619 E Hennick, Pinedale, WY*
Phone Number (general): *307-367-4133* Phone Number (emergency): *911*
☒Emergency Medical Facility Confirmed ☒Map to the hospital is attached

Emergency Medical Facility 2: ***Marbleton-Big Piney Clinic***
Address: *17 W 3rd, Big Piney, WY*
Phone Number (general): *307-276-3306* Phone Number (emergency): *911*
☒Emergency Medical Facility Confirmed ☒Map to the hospital is attached

Emergency Medical Facility 1:
Address:
Phone Number (general): Phone Number (emergency): *911*
☒Emergency Medical Facility Confirmed ☐Map to the hospital is attached

Police: 911 Fire: 911 Paramedic/Ambulance: 911
Poison Control Center: 1-800-222-1222

EMERGENCY PROCEDURES

Medical Emergencies

1. Remove injured or exposed person(s) from immediate danger if possible.
2. Evacuate other on-site personnel to a safe place in an upwind direction until it is safe for work to resume.
3. If serious injury or life-threatening condition exists, call 911 - Paramedics, fire department, police Hospital emergency room Clearly describe location, injury and conditions to dispatcher/hospital. Designate a person to direct emergency equipment to the injured person(s).
4. Provide first aid if necessary. Remove contaminated clothing only if this can be done without endangering the injured person.
5. Call the project manager and/or project health and safety officer.
6. Immediately implement steps to prevent recurrence of the accident.

Accidental Release of Hazardous Materials or Wastes

1. Evacuate all on-site personnel to a safe place in an upwind direction until the PM or PHSO determines that it is safe for work to resume.
2. Immediately instruct a designated person to contact the PM or PHSO.
3. Contain spill, if it is possible and it can be done safely.
4. Initiate cleanup.

General Emergencies

In the case of fire, flood, explosion, or other hazard, work shall be halted and the local police/ fire department shall be notified by calling 911. All on-site personnel will be immediately evacuated to a safe place.

Emergency Equipment Onsite

☒First Aid Kit; ☒Fire Extinguisher; ☒Eye Wash; ☐Other: _____

CHEMICAL HAZARDS

CHEMICAL	EXPOSURE LIMITS		LEL (%)	KNOWN/EXPECTED CONCENTRATIONS	HEALTH HAZARDS
	OSHA	ACGIH			
Benzene	1 ppm S 5 ppm	0.5 ppm	1.2	Unknown	Irritant to resp. system; giddiness, headache, nausea, staggered gait
Toluene	200 ppm	50ppm	1.1	Unknown	Irritation eyes, nose; lassitude (weakness, exhaustion), confusion, euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears); anxiety, muscle fatigue, insomnia; paresthesia; dermatitis; liver, kidney damage
Ethyl benzene	100 ppm	100 ppm S125 ppm	0.8	Unknown	Irritation eyes, skin, mucous membrane; headache; dermatitis; narcosis, coma
Xylenes	100 ppm C 200 ppm	100 ppm	0.9	Unknown	Irritation eyes, skin, nose, throat; dizziness, excitement, drowsiness, incoordination, staggering gait; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis
Naphthalene	10 ppm (50 g/m^3)	10 ppm (50 mg/m^3)	NA	Unknown	Irritation eyes; headache, confusion, excitement, malaise (vague feeling of discomfort); nausea, vomiting, abdominal pain; irritation bladder; profuse sweating; jaundice; hematuria (blood in the urine), renal shutdown; dermatitis, optical neuritis, corneal damage

If not specified, exposure limit is the PEL or the TLV-TWA, Exposure limit preceded by a “S” is a Short Term Exposure Limit and by a “C” is the Ceiling Limit

PHYSICAL HAZARDS:

☐Heat Stress ☒Cold Stress ☒Wet ☒Noise
☒Slip,Trip, & Fall ☒Heavy Equipment ☐Electrical Hazards
☒Underground Hazards: One Call Ticket #083010404_ Date Called: 10/27/08
☐Private Locator Utilized: _____ ☒Overhead Hazards
☒Traffic ☒Excavations/Trenching ☐Confined Space
☒Other: Driving Well Points

BIOLOGICAL HAZARDS:

☐Pathogens: _____ ☐Mold: _____
☐Plants: _____ ☐Insects: _____
☐Other Fauna: _____ ☐Other: _____

SITE CONTROLS:

PERSONAL DECONTAMINATION PROCEDURES:_____

PERSONAL PROTECTIVE EQUIPMENT – R = REQUIRED, A = HAVE AVAILABLE

R Eye Protection: ***R*** Safety Glasses; __ Splash Goggles; __ Face Shield; __Other: _____
R Hard Hat ***R***Steel-Toed Boots __ Chemical Resistant Boots
__ Traffic Safety Vest ***A*** Hearing Protection: *When noise level exceeds 80 dBA*
R Protective Clothing: ☐Tyvek®; ☐Coated Tyvek®; ☐Sarinex; ☒Other: *Flame resistant clothing (FRC)*
R Gloves: ☒Nitrile; ☐PVC; ☐Neoprene; ☒cloth/leather; ☐Other
A Respiratory: ☐Full-Face APR; ☒Half-Face APR
__ Filter: ☒Organic Vapor; ☐Acid Gas; ☐HEPA; ☐Other: _____
R Other: *Hardhat, Safety glasses, hearing protection & steel-toed boots if working around heavy equipment*

If air monitoring in the workers' breathing zone exceeds *XXX ppm* for 60 seconds or longer, upgrade to Level C (APR) or vacate the immediate area.

MONITORING EQUIPMENT

☒Photo Ionization Detector with *10.6* eV lamp ☐Flame Ionization Detector
☐Combustible Gas Indicator ☐Oxygen Meter
☐Detector Tube (Brand: _____) – Tubes: _____
☐Hydrogen Sulfide Meter
☐Passive Dosimeter _____
☐Air Sampling Pump – Filter Media: _____
☐Other: _____
Frequency of monitoring: *While excavating*

TAILGATE SAFETY MEETING

AMEC Geomatrix

Date:

Project Name:

Project Number:

Site Location:
PAPA, Sublette County, Wyoming

Scope of Work for Day:

Lead By:

Name (printed)	Signature

AMEC Geomatrix

JOB SAFETY ANALYSIS

Project Name:		***Project No:***		***Date:***	
Tasks:	1. Vapor Monitoring/Sampling 2. Groundwater Sampling	***Task Location:***	Pinedale Anticline Production Area Sublette Co., WY		
For this Project and Task, this document is a Certification of Hazard Assessment					
Completed by:	Steve Wright	***Reviewed by:***	DK		
Notes:					

Task	Hazard	Risk Control Method
Mobilize to site	Driving accidents	❒ Vehicle should be in good condition and well maintained ❒ Check weather forecast, bring tire chains if warranted ❒ Seat belt will be worn while driving ❒ Driver will be licensed, trained, and medically fit ❒ Driver will be rested and alert ❒ NO CELL PHONE USE WHILE DRIVING ❒ Route to be planned in advance ❒ Driver must not be under the influence of alcohol, drugs, or medication that impairs ability to drive ❒ Park so that first move is forward (i.e. back into space or allow room for driving forward)
Set up work site	Pad traffic	❒ If applicable, coordinate with other work at location ❒ If applicable, notify PIC of work activities and location ❒ Obey all Ultra traffic rules while on site ❒ Wear flame resistant clothing as the outer layer, steel toe boots, long sleeves, pants, hardhat, and safety glasses at all times while on the pad
Measure static water level	Explosion Hazard	❒ Eliminate all potential ignition sources ❒ Monitor ambient air in the aboveground work space with a combustible gas indicator ❒ Seal the top of casing and monitor ambient conditions inside the well casing with a combustible gas indicator ❒ Work may proceed with concentrations up to 20% of the LEL ❒ Stop work if concentrations in aboveground work space meets or exceeds 20% of the LEL ❒ Each location will be explored by hand tool to a depth of approximately 5 feet before power equipment is used.
	Injury from using installation tools (post-pounder, sledge hammer)	❒ Wear hard hat, safety glasses, steel toes, hearing protection, and leather gloves during installation ❒ Use post-pounder to install well points, if possible. ❒ Operate post-pounder using two people ❒ Use installation tools from a position of firm footing ❒ When using post-pounder, do not lift tool higher than the top of the well point on the up-stroke ❒ Keep fingers, hands, arms, and other body parts clear of impact areas. ❒ Inspect all hand tools prior to use. If faulty or inappropriate, do not use until repaired or replaced.
	Pinch points	❒ Watch for pinch points when assembling / installing well casing

AMEC Geomatrix

JOB SAFETY ANALYSIS

Project Name:		***Project No:***		***Date:***	
Tasks:	1. Vapor Monitoring/Sampling 2. Groundwater Sampling	***Task Location:***	Pinedale Anticline Production Area Sublette Co., WY		
For this Project and Task, this document is a Certification of Hazard Assessment					
Completed by:	Steve Wright	***Reviewed by:***	DK		
Notes:					

Task	**Hazard**	**Risk Control Method**
	Slip, trip, and fall	❒ Keep work area clean – including removal of excess cuttings / mud
Sample vapor/gas inside well casing		❒ Keep work areas dry when possible ❒ Stay aware of footing and do not run
	Cold stress	❒ Wear appropriate clothing for Wyoming fall weather conditions – e.g. insulated coveralls, winter gloves, hard hat liner, etc. ❒ Seek warmth out of weather (e.g. inside vehicle), if necessary ❒ Consume adequate amounts of food and beverages
	Working at heights	❒ No work will be conducted at heights greater than 6 feet without fall restraint / arrest safety equipment
	UV exposure	❒ Wear neck to toe clothing and sun block
	Lifting heavy equipment/materials	❒ Do not lift or move heavy equipment without assistance ❒ Use proper lifting techniques. Lift with arms and legs, keep back straight. ❒ If possible, use a powered lift truck, drum cart, or other mechanical means.
Well Point Installation	Underground Utilities	❒ Confirm with Shell that no overhead or underground utilities are present in the monitoring well location(s); ❒ Confirm subsurface utilities with Wyoming One Call – (800) 849-2476
	Injury from using installation tools (post-pounder, sledge hammer)	❒ Wear hard hat, safety glasses, steel toes, hearing protection, and leather gloves during installation ❒ Use post-pounder to install well points, if possible. ❒ Operate post-pounder using two people ❒ Use installation tools from a position of firm footing ❒ When using post-pounder, do not lift tool higher than the top of the well point on the up-stroke ❒ Keep fingers, hands, arms, and other body parts clear of impact areas. ❒ Inspect all hand tools prior to use. If faulty or inappropriate, do not use until repaired or replaced.
	Pinch points	❒ Watch for pinch points when assembling / installing well casing
	Slip, trip, and fall	❒ Keep work area clean – including removal of excess cuttings / mud ❒ Keep work areas dry when possible

AMEC Geomatrix

JOB SAFETY ANALYSIS

Project Name:		***Project No:***		***Date:***	
Tasks:	1. Vapor Monitoring/Sampling 2. Groundwater Sampling	***Task Location:***	Pinedale Anticline Production Area Sublette Co., WY		
For this Project and Task, this document is a Certification of Hazard Assessment					
Completed by:	Steve Wright	***Reviewed by:***	DK		
Notes:					

Task	**Hazard**	**Risk Control Method**
		❒ Stay aware of footing and do not run
	Cold stress	❒ Wear appropriate clothing for Wyoming fall weather conditions – e.g. insulated coveralls, winter gloves, hard hat liner, etc. ❒ Seek warmth out of weather (e.g. inside vehicle), if necessary ❒ Consume adequate amounts of food and beverages
	Working at heights	❒ No work will be conducted at heights greater than 6 feet without fall restraint / arrest safety equipment
	UV exposure	❒ Wear neck to toe clothing and sun block
	Lifting heavy equipment/materials	❒ Do not lift or move heavy equipment without assistance ❒ Use proper lifting techniques. Lift with arms and legs, keep back straight. ❒ If possible, use a powered lift truck, drum cart, or other mechanical means.
Groundwater Sampling and Aquifer Testing	Handling contaminated groundwater and sample preservatives	❒ Coordinate with other work at location ❒ Wear appropriate PPE (e.g. nitrile gloves, safety glasses) ❒ Handle sample containers with preservatives with care to avoid spills/breakage of preservatives. ❒ Have water available to rinse skin in case of accidental contact with preservative.