DOE–EM/GJTAC1830

Office of Environmental Management – Grand Junction

MOAB UTAH UMTRA Project

Moab UMTRA Project
Surface Water/Ground Water Sampling and Analysis Plan

Revision 1

July 2012

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contractor under contract number DE-EM0002067
for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Review and Approval

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In concurrence:

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Revision History

Revision No.	Date	Reason/Basis for Revision
0	November 2009	Initial issue.
1	July 2012	Periodic update.

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Acronyms and Abbreviations

ASTM	ASTM International
BOA	Basic Ordering Agreement
ºC	degrees centigrade
CF	Configuration
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm	centimeter
DO	dissolved oxygen
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ft	feet
GPS	global positioning system
HASP	Health and Safety Plan
IA	interim action
ICPT	Integrated Contractor Purchasing Team
IWP	Integrated Work Plan
µm	micrometer
µmhos/cm	micromhos per centimer
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
L	liter
L/m	liters per minute
mL	milliliters
mL/m	milliliters per minute
mm	millimeters
MSDS	Material Safety Data Sheet
mV	millivolts
NTU	nephelometric turbidity unit
ORP	oxidation reduction potential
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QSAS	DOE Quality Systems for Analytical Services
RIN	report identification number
SOW	statement of work
TAC	Technical Assistance Contractor
UMTRA	Uranium Mill Tailings Remedial Action
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

1.0 Introduction

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site is a former uranium ore-processing facility located approximately 3 miles northwest of the city of Moab in Grand County, Utah. The plant was constructed in 1956 by the Uranium Reduction Company, which operated the mill until 1962 when the assets were sold to the Atlas Minerals Corporation (Atlas). Operations continued under Atlas until 1984. When the processing operations ceased in 1984, the mill had accumulated an estimated 16 million tons of uranium mill tailings in an unlined impoundment in the floodplain of the Colorado River. The tailings pile covers approximately 130 acres, is about ½-mile in diameter, averages about 94 feet (ft) in height above the surface of the Colorado River terrace, and is located about 750 ft west of the Colorado River. Atlas placed an interim cover over the tailings pile as part of the decommissioning activities ongoing between 1988 and 1995. In October 2001, the title of the property and responsibility for remediation of the tailings pile and contaminated ground water beneath the site were transferred to the U.S. Department of Energy (DOE).

Previous investigations, including the *Moab UMTRA Project Ground Water Interim Action Performance Assessment* (DOE-EM/GJTAC1841), indicate that several contaminants have migrated from the tailings pile into the ground water. Of the contaminants identified, ammonia is of greatest significance. DOE studies have identified two plumes of ammonia at the Moab site—a deep plume beneath the tailings pile and a shallow plume between the tailings pile and the Colorado River. Ground water from the shallow ammonia plume has been demonstrated to discharge to the Colorado River and to have a localized impact on surface water quality. Another constituent of concern is dissolved uranium, which also discharges to the river. Degradation of surface water quality is of concern because of potential effects on aquatic species in the area—particularly endangered fish. In its final Biological Opinion issued as part of the DOE *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* (EIS) (DOE/EIS-0355), the U.S. Fish and Wildlife Service (USFWS) identified several actions required by DOE to address concerns regarding endangered fish. Endangered fish species known to inhabit the area include the razorback sucker, humpback chub, and Colorado pikeminnow.

DOE initiated an interim action (IA) to pump contaminated ground water from the shallow plume to an evaporation pond on top of the tailings pile. Another IA includes the injection of diverted Colorado River water into shallow ground water. The goal of this action is to reduce contaminant mass in ground water and to be protective of potential endangered fish habitat in backwater areas of the river until a final remediation action can be implemented. The IA has been in place since summer 2003. In the Final EIS for remediation of the Moab site, DOE has proposed to intercept ground water and control discharge of contaminants to the river until concentrations in the alluvial system are reduced to levels that permit unrestricted discharge to the river.

2.0 Purpose and Scope

The purpose of this Sampling and Analysis Plan is to present all pertinent surface and ground water sampling information in one document. Included in this plan is a summary of the sampling events, sampling protocol and handling, and quality assurance (QA).

Appendix A includes procedures for sample preparation and for the field. Appendix B includes tables of the sample locations for each of the sampling events. Appendix C contains useful datasheets that are used throughout the ground water program, and Appendix D includes a list of required training for ground water personnel. Attachment 1 (provided on the enclosed CD) contains the manufacturers sampling equipment manuals.

3.0 Summary of Sampling Events

The following section describes the sampling events that take place on site.

IA Well Field Performance

The purpose of the monthly sampling event is to obtain well field performance data and chemical analysis. Typically, locations (extraction, remediation, observation wells, well points, and surface water locations) are sampled during injection and extraction operations. Figure 1 shows the IA well field, and Tables B-1 through B-6 (Appendix B) list the wells in the IA well field.

The IA well field was installed beginning in 2003 between the toe of the tailings pile and the Colorado River. Table 1 gives a chronology of the construction of the IA well field. As of 2012, the well field consists of eight extraction wells, 34 injection wells, an infiltration trench, and many monitoring wells.

Table 1. Components of the IA Well Field

Component	Purpose	Year Added
CF1 injection wells	10 GW injection wells at 18 ft bgs	2003
Lined evaporation pond	Manage extracted GW	2003
CF2 injection wells	Four GW injection wells at ~40 ft bgs	2009
CF3 injection wells	10 GW injection wells at 45 ft bgs	2005
CF4 injection wells	10 GW injection wells at 35 ft bgs	2006
CF5 extraction wells	Eight GW extraction near base of pile	2009/2010
Infiltration trench	160-ft perforated horizontal pipe at 10 ft bgs to inject diverted river water	2006

CF = Configuration; ft bgs = feet below ground surface; GW = ground water

Site-Wide Sampling Event
The site-wide sampling event is typically conducted twice a year, during high river flow and base flow conditions. The main purpose of this sampling event is to show any changes in the overall distribution of contaminants at the Moab site and to monitor off-site conditions. Water levels are measured on a site-wide basis every year. Figure 2 shows a site-wide map of observation wells, and Table B-8 (Appendix B) lists the sampling locations.

Biota Monitoring/Sampling
As the river flow decreases after the annual peak runoff, backwater channels form adjacent to the IA well field. These backwater channels may be utilized by several endangered fish species, including the razorback sucker, humpback chub, and Colorado pikeminnow. Biota monitoring takes place in conjunction with the initial action from early July (or when flows decrease to less than 7,000 cubic feet per second [cfs]) to late September, when the young-of-year fish inhabit these channels. Biota monitoring includes collecting real-time ammonia samples from habitat areas. Occasionally, surface water samples may be collected for laboratory analysis. Refer to Section 10.0 for more information on biota monitoring.

4.0 Sampling Protocol

4.1 Ground Water

Ground water samples are collected from a series of extraction wells, remediation wells, observation wells, and well points.

4.1.1 Well Classification
Ground water sampling protocol will vary based on well production during the initial purging. Wells will be classified according to their hydraulic properties or use as shown in Table 2.

Table 2. Well Classification

Classification	Properties/Use
Category I	Wells that produce a minimum of 100 mL/m
Category II	Wells that produce less than 100 mL/m and have an initial water level above the top of the screened interval
Category III	Wells that produce less than 100 mL/m and have an initial water level within the screened interval
Category IV	Domestic and flowing wells

mL/m = milliliters per minute

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Figure 1. IA Well Field

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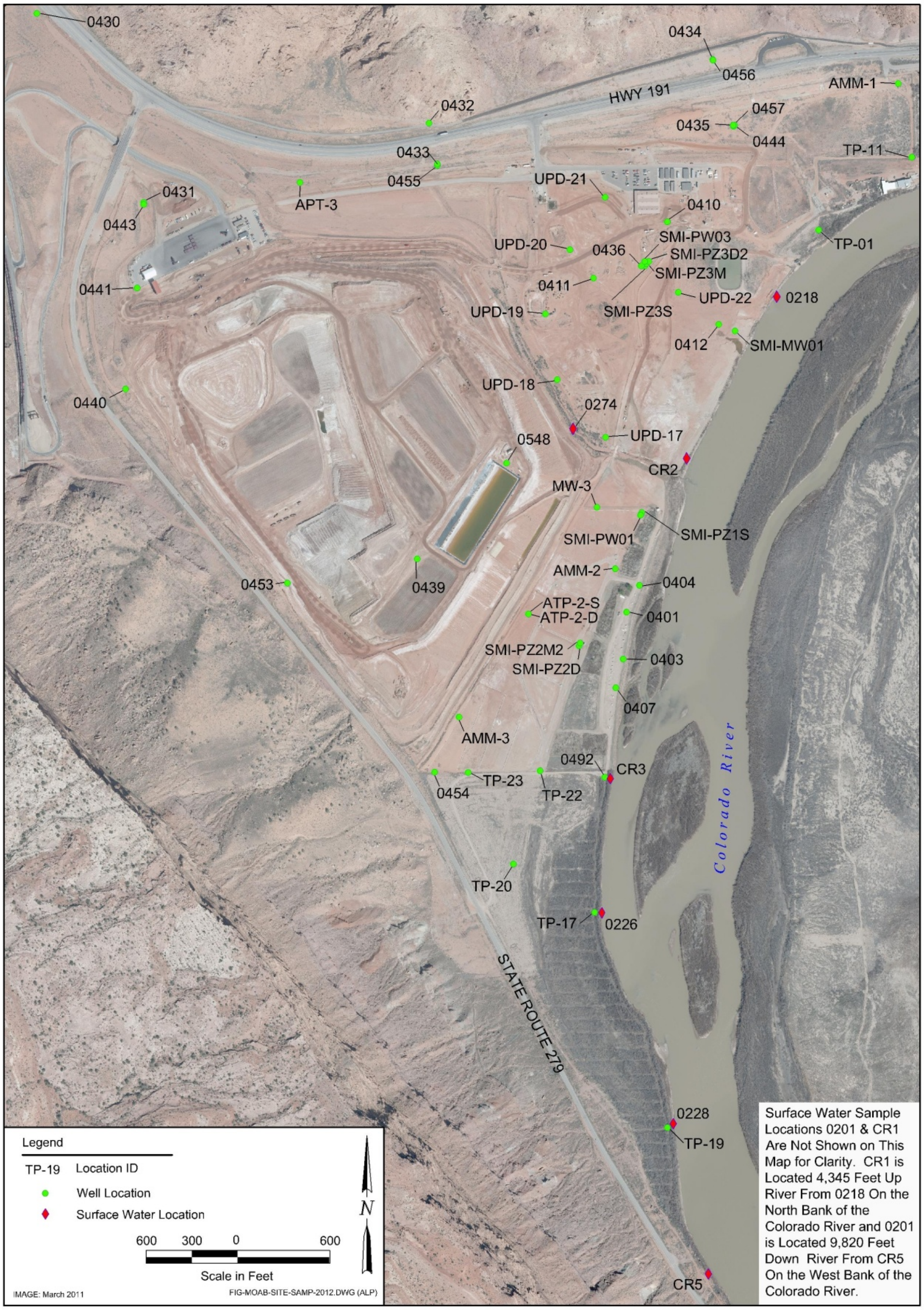

Figure 2. Site-Wide Sampling Locations

4.1.2 Category I Protocol

Purging and sampling of Category I wells is accomplished with a low-flow method that involves pumping at a low-flow rate. In theory, the slow pumping rate allows water to flow directly from the formation to the pump intake. The slow pumping rate results in minimal mixing with the stagnant water column above the pump intake, minimal pumping-induced turbidity, and minimal disturbance of sediment accumulated in the end cap of the well. Using Category I sampling protocol will provide the highest quality sample (Korte, et al., “Application of Low-Flow Purging to the Moab UMTRA Ground Water Project”). Refer to Procedures 6, “General Considerations for the Sampling of Liquids,” and 8, “Standard Practice for Purging of Monitoring Wells,” for specific guidance (Appendix A).

Category I wells will be purged using the following guidelines.

- The intake of the portable pump, dedicated pump, or dedicated tubing should be placed at the desired sampling depth within the screened interval.
- If a portable pump is used, a minimum of 4 hours after installation is required before purging and sampling can commence.

As described in Procedure 7, “Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells” (Appendix A), depth to water will be measured with an electric sounder immediately before purging. The initial pumping rate should not exceed 500 milliliters per minute (mL/m). At the start of pumping, the water level should be monitored continuously to determine if drawdown is occurring. If drawdown is occurring at the initial pumping rate, the pumping rate should be decreased until the drawdown stops or a pump rate of 100 mL/m is obtained. If the water level stabilizes (no further drawdown), then purging and sampling may continue at that flow rate. Water levels in the well will be measured and recorded at regular intervals (a minimum of 3 minutes apart) on the Moab Water Sampling Field Data sheet (Appendix C) during the purging process to document that drawdown was not occurring during the purge (refer to Procedure 1, “Standard Practice for Field Documentation Processes” in Appendix A). If the water level does not stabilize at the minimum flow rate of 100 mL/m, then the well will be classified as a Category II or Category III well. All of the extraction/remediation wells in the well field and most of the observation wells on site are Category I. The well points are considered Category II wells since they typically dewater during the initial purge.

After the start of the low-flow purging process, parameters such as temperature, pH, specific conductance, dissolved oxygen (DO), oxidation reduction potential (ORP), and turbidity will be measured at regular intervals based on volume purged or time, with measurements recorded a minimum of 3 minutes apart. Sample collection will begin as soon as pH, specific conductance, and turbidity measurements stabilize and one pump/tubing volume has been removed. Specific conductance and pH will be considered stable when the three most current consecutive readings are within 10 percent and within 0.2 pH units, respectively. The turbidity measurements should be below 10 nephelometric turbidity units (NTUs) before sample collection, if possible. Criteria for purging a Category I well are summarized in Table 3.

Table 3. Summary of Ground Water Sampling Protocol

Well Classification	Parameter	Purge Criteria
Category I	Purge volume	1 pump/tubing volume
	Flow rate	>100 mL/m and <500 mL/m
	Water level	No drawdown
	pH	± 0.2 pH units
	Specific conductance	± 10 percent
	Turbidity	<10 NTUs
Category II	Purge volume	1 pump/tubing volume
	Flow rate	<500 mL/m
	Water level	None
	pH	None
	Specific conductance	None
	Turbidity	None
Category III	All parameters	No purge required
Category IV	All parameters	No purge required

Purge water will be disposed of according to site-specific or program-specific documents, *Technical Approach for the Management of UMTRA Ground Water Investigation-Derived Wastes* (DOE/AL/62350-109) and the *Moab UMTRA Project Waste Management Plan* (DOE-EM/GJ1633).

4.1.3 Category II Protocol

The following protocol will apply to wells that are classified as Category II. A maximum flow rate of 500 mL/m will be used to purge and sample wells in this category. There are no stabilization or drawdown criteria for Category II wells. Sampling can occur as soon as one pump/tubing volume is removed. Recording water levels and flow rates will be used to initially document that the well is a Category II well using the criteria stated in Sections 4.1.1 and 4.1.2 and in Procedure 1 (Appendix A).

The riverbank well points have a ¾-inch casing, and the water level cannot be monitored during the purge. These locations are sampled under the Type II criteria. See Procedure 11, "Standard Practice for Sampling Well Points," in Appendix A for the well point sampling protocol.

4.1.4 Category III Protocol

The following protocol will apply to wells that are classified as Category III. There are no stabilization, drawdown, or purge volume criteria for Category III wells. If a bailer is used to sample, it must be lowered very slowly into the water column to minimize sampling-related turbidity. Only the first bailer of water will be used for the sample. Subsequent bailers introduced into the water column increase turbidity and reduce sample quality. Because the volume of water will be limited using a bailer, prioritization of analytes will be required. This will require an estimation of sample volume before the sampling event. The volume estimate will be discussed with the site lead, and the analytical laboratory to determine which constituents will be analyzed. If a sufficient volume of water cannot be obtained from the first bailer, then the well cannot be sampled. If there is a sufficient column of water in the well to utilize a dedicated pump or dedicated tubing, then the entire water column available can be sampled. Recording of water levels and flow rates will be used to initially document that the well is a Category III well using the criteria stated in Tables 2 and 3.

Because obtaining a representative sample from a low-producing well (Categories II and III) is problematic, and there is not adequate guidance for sampling wells completed in low permeability formations, there may be site-specific documents that require an alternate method for sampling low-producing wells. This may include purging a well dry and sampling when sufficient recovery has occurred, purging without dewatering the screen, or passive diffusive sampling.

4.1.5 Category IV Protocol

With domestic and flowing wells, it is assumed that formation water continually flows from the well, eliminating stagnant water and the need to purge. These wells will be sampled after collecting the field parameters by filling bottles at the discharge point and filtering if required.

4.2 Surface Water

Surface water sampling will be conducted according to Procedure 10, "Standard Practice for Sampling Surface Water" (Appendix A).

Occasionally, new surface water locations are sampled, and the location data should be collected using a global positioning system (GPS) device and downloaded into SEEPro database. Any departure from collecting a sample at the normal location must be documented on the Moab Water Sampling Field Data Sheet (Appendix C).

If unfiltered surface water samples are collected, the sample may be collected by container immersion as described in Procedure 6, "General Considerations for the Sampling of Liquids" (Appendix A). Refer to Procedure 10 in Appendix A for more information on Moab UMTRA Project surface water sampling.

4.3 Sample Collection

Ground water samples can be collected with a peristaltic pump, bladder pump, submersible pump, inertia pump, or a bailer (Refer to Procedures 6 and 8, "Standard Practice for Purging of Monitoring Wells," in Appendix A). The specific method used for withdrawing water from the well will be determined in the field depending on whether a well has dedicated equipment and the category of the well. Sample collection will be conducted using the same flow rate used during the purging of the well. Refer to Procedure 20, "Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples," in Appendix A.

4.4 Field Measurements and Calibration

General procedures for field measurements are in Procedures 12 through 19 in Appendix A. Table 4 shows current sample analytes and container and preservation requirements. Calibration of field instrumentation will be conducted according to manufacturer's recommendations (Table 5). If calibration acceptance criteria are not met during the operational check, a primary calibration of the affected probe(s) and instruments(s) must be conducted. Probe replacement or cleaning may also be required if the operational acceptance criteria are not met.

Table 4. Current Sample Analytes and Container and Preservation Requirements

Analytical Parameter	Container Type/Size	Preservation	Holding Time
Metals (barium, copper, iron, magnesium, manganese, uranium, selenium)	125 mL HDPE	Filtered* (0.45µm), nitric acid pH<2	6 months
Anions (bromine, chloride, sulfate)	125 mL HDPE	Filtered (0.45µm)	28 days
Total dissolved solids	125 mL HDPE	Filtered (0.45µm), cool 0ºC to 4ºC	7 days
Total suspended solids	125 mL HDPE	Cool 0ºC to 4ºC	7 days
Ammonia	125 mL HDPE	Filtered* (0.45µm), cool 0ºC to 4ºC, sulfuric acid pH<2	28 days

ºC = degrees centigrade; HDPE = high density polyethylene; µm = micrometers; mL = milliliters
*Samples with fewer than 10 NTUs do not require filtering

Table 5. YSI Calibration Requirements

Parameter	Requirement	Frequency	Operational Check Criteria
pH	Three-point calibration	Before start of sampling event	NA
	One-point check	Twice daily	±0.2 pH unit
Specific Conductance	One-point calibration	Before start of sampling event	NA
	One-point operational check	Twice daily	±10% of standard
ORP	One-point calibration	Before start of sampling event	NA
	One-point operational check	Twice daily	±10% of standard
DO	Calibration in water saturated air	Twice daily	NA
Turbidity	Four-point calibration	Every 6 months	NA
	One-point calibration	Twice daily	±10% of standard
Temperature	NA	NA	NA

NA = not applicable

5.0 Sample Identification and Handling Procedures

Each sample will be assigned a site identification number that corresponds to each well or surface sample location. In addition, a unique sample number (virtual ticket number) will be assigned to each sample location (See Procedure 2, "Standard Practice for Sample Labeling," in Appendix A for more details). The true site identification number and the type of quality control (QC) sample will be documented for duplicates and field blanks on the QC Sample Cross-reference Log.

Sample bottles used for sampling will be pre-cleaned to guidelines established by the U.S. Environmental Protection Agency (EPA) in "Specification and Guidance for Contaminant-Free Sample Containers."

To ensure the integrity of the sample, the sampling lead or designee is responsible for the care, packaging, and custody of the samples until they are dispatched to the laboratory. Procedure 3, “Standard Practice for Chain of Custody and Physical Security of Samples,” in Appendix A will be implemented to provide a security and document sample custody.

The sampling lead will be responsible for ensuring that the samples are transferred to the laboratory in sufficient time for the laboratory to complete extraction/analysis before the expiration of sample holding times.

If a commercial carrier sends the packages, receipts and any other shipping-related documents are retained as part of the chain of custody documentation. The laboratory services coordinator will retain carrier and shipping receipts as long as they have value associated with the laboratory sample receiving activities.

Chain of custody records document all transfers of sample possession and show that the samples were in constant custody between collection and analysis. A chain of custody form will accompany samples sent or transported to an analytical laboratory by individuals other than a member of the field sampling team, with a copy retained by the originator.

6.0 Decontamination of Sampling Equipment

Decontamination of nondedicated sampling equipment will be accomplished by rinsing all equipment surfaces with diluted detergent followed by deionized water as described in Procedure 5, “Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites” (Appendix A). Decontamination of nondedicated sampling equipment will be conducted immediately after use at a sampling location. Between sampling or until further use, decontamination equipment will be stored in protective containers or plastic bags (see Section 8.1.2, “Equipment Blanks”).

7.0 Analytical Program

The constituents analyzed at each site are specified in the site-specific environmental planning document. A comprehensive list of analytes, along with the required analytical methods and required detection limits, are listed in the Basic Ordering Agreement (BOA). The analytical methods used for surface water and ground water analyses as specified in Procedure 6 (Appendix A), are typically from the EPA’s *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (SW-846) or *Methods for the Chemical Analysis of Water and Wastes*. Analytes typically requested, along with required detection limits and analytical methods, are shown in Table 6.

Commercial laboratories provide these analytical services in accordance with “DOE Quality Systems for Analytical Services” (QSAS) to ensure data of known documented quality. The QSAS provides specific technical requirements, clarification of DOE requirements, and conforms to DOE Order 414.1D, “Quality Assurance.”

The QSAS is based on EPA's "National Environmental Laboratory Accreditation Conference, Chapter 5, 'Quality Systems,'" and provides a framework for performing, controlling, documenting, and reporting laboratory analyses. Validation of field and analytical data will be accomplished according to the guidance in the *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855).

8.0 Quality Assurance

The objective of sample QA and QC measures is to provide systematic control of the tasks to maximize accuracy, precision, comparability, and completeness. All procedures will be checked for accuracy through internal laboratory QC checks, such as the analysis of blind duplicates, splits, and known standards. Sample preservation will consist of storing the samples in a cooler with ice during field sampling, sample packaging, and shipping.

To maintain evidence of authenticity, the samples collected must be properly identified and easily discernible from other similar samples. A label will be attached to the sample container specifying the sample identification number, location, date collected, time collected, and the sampler's name. Water samples will be kept under custody from the time of collection to the time of analysis. Chain of custody records will be used to list all transfers in the possession of the samples. The chain of custody form will show that the sample was in constant custody between collection and analysis. On opening the container, the receiving laboratory will note the condition of the sample container (e.g., broken bottles, leaking bottles). All sample shipments will be made in compliance with U.S. Department of Transportation regulations (Title 49 Code of Federal Regulations Parts 171-179 [49 CFR 171-179]) governing shipment of hazardous materials and substances. These regulations govern the packaging, documentation, and shipping of hazardous material, substances, and waste. Special care will be taken to ensure the integrity of the sample through proper packaging and shipping.

8.1 Field QA

Field QA procedures include following the standard operating procedures (see Table 6) discussed in this document and collection and analysis of QC samples. The types of QC samples will be submitted to the laboratory under a fictitious identifier.

Table 6. Analytes and Laboratory Techniques

Analyte	Required Detection Limit (mg/L)	Analytical Technique	EPA Analytical Method
Aluminum	0.2	ICP-AES	SW-846 6010B
Ammonia	0.2	MCAWW 350.1	MCAWW 350.1
Ammonium	0.10	Colorimetric	EPA 350.1
Antimony	0.003	ICP-MS	SW-846 6020
Arsenic	0.0001	ICP-MS	SW-846 6020
Barium	0.10	ICP-AES	SW-846 6010B
Beryllium	0.008	ICP-AES	SW-846 6010B
Bromine	0.5	IC	SW-846 9056
Cadmium	0.001	ICP-MS, ICP-AES	SW-846 6020, SW-846 6010B
Calcium	5.0	ICP-AES	SW-846 6010B
Chemical Oxygen Demand	5.0	Colorimetric	EPA 410
Chloride	0.5	IC	SW-846 9056
Chromium	0.002	ICP-MS	SW-846 6020
Cobalt	0.05	ICP-AES	SW-846 6010B
Copper	0.025	ICP-AES	SW-846 6010B
Cyanide	0.005	Colorimetric	NA
Flourine	0.5	IC	SW-846 9056
Gross Alpha	2.0	PC	SW-846 9310
Gross Beta	4.0	PC	SW-846 9310
Iron	0.05	ICP-AES	SW-846 6010B
Mercury	0.001	CVAAS	SW-846 7470
Lithium	0.1	ICP-AES	SW-846 6010B
Lead	0.002	ICP-MS	SW-846 6020
Lead-210	1.0	LSC	NA
Magnesium	5.0	ICP-AES	SW-846 6010B
Manganese	0.005	ICP-AES	SW-846 6010B
Molybdenum	0.003	ICP-MS	SW-846 6020
Nickel	0.04	ICP-AES	SW-846 6010B
Nitrogen Nitrate	0.05	Colorimetric	EPA 353.2
Polychlorinated Biphenyls	0.00025	GC	SW-846 8082
Nitrobenzene	0.00003	HPLC	EPA 8330
Polycyclic Aromatic Hydrocarbon	0.005	HPLC	SW-846 8310
Phosphate	0.5	IC	SW-846 9056
Potassium	5.0	ICP-AES	SW-846 6010B
Radon-226	1.0	RE	EPA 903.1, modified
Radon-228	1.0	PC	SW-846 9320, modified
Selenium	0.001	ICP-MS	SW-846 6020
Semivolatiles	0.01	GC-MS	SW-846 8270C
Silicon Dioxide	0.10	ICP-AES	SW-846 6010B
Silver	0.001	ICP-MS	SW-846 6020
Sodium	5.0	ICP-AES	SW-846 6010B
Strontium	0.2	ICP-AES	SW-846 6010B
Sulfate	1.0	IC	SW-846 9056
Sulfide	0.002	Titrimetry	EPA 376.1
Total Organic Carbon	0.3	IR	EPA 415.1
Technetium-99	1.0	PC	NA

Table 6. Analytes and Laboratory Techniques (continued)

Analyte	Required Detection Limit (mg/L)	Analytical Technique	EPA Analytical Method
Thalium	0.004	ICP-MS	SW-846 6020
Thorium-228, -230, -232	1.0	AS	NA
Tin	0.2	ICP-AES	SW-846 6010B
Total Dissolved Solids	10	Gravimetric	EPA 160.1
Total Petroleum Hydrocarbon	1.0	IR Spectrometry	EPA 418.1
Total Suspended Solids	5.0	Gravimetric	EPA 160.2
Uranium	0.001	ICP-MS	SW-846 6020
Urainum-234, -235, -238	0.1	AS	NA
Vanadium	0.003	ICP-MS	SW-846 6020
Volatile Organic Compounds	0.005	GC-MS	SW-846 8260B
Zinc	0.02	ICP-AES	SW-846 6010B

AS = Alpha Spectrometry; COD = Chemical Oxygen Demand; GC = Gas Chromatography; GC-MS = Gas Chromatograph-Mass Spectrometry; HPLC = High Performance Liquid Chromatography; IC = Ion Chromatography; ICP-AES = Inductively Coupled Plasma-Atomic Emission Spectrometry; ICP-MS = Inductively Coupled Plasma-Mass Spectrometry; IR = Infrared; LSC = Liquid Scintillation Counting; mg/L = milligrams per liter; NA = Not Applicable; PAH = Polynuclear Aromatic Hydrocarbons; PC = Proportional Counting; RE = Radon Emanation

8.1.1 Field Duplicates

Duplicate water samples will be collected in the field on a frequency of one duplicate sample per 20 water samples for each analytical parameter. If fewer than 20 water samples are collected during a sampling event, one field duplicate will be required. Each duplicate will be assigned a virtual ticket number and a sample location number. All of the information should be recorded in the front of the Field Data Book under "Quality Control."

8.1.2 Equipment Blanks

Equipment blanks provide a check for cross-contamination of samples from ineffective equipment decontamination. One equipment blank sample will be prepared in the field for every 20 water samples that are collected with nondedicated equipment. If fewer than 20 (and at least one) samples are collected with nondedicated equipment, then one equipment blank will be required. Equipment blanks will be prepared by collecting a sample of the final deionized (rinsate) water used to decontaminate nondedicated sampling equipment.

8.1.3 Trip Blanks

Trip blanks are not currently collected on the Moab site, but there is a possibility that they may be necessary in the future. Trip blanks will be prepared using organic-free water obtained from a certified source and taken to the field by the sampling team. Trip blank samples will be prepared before the sampling trip when collection of samples for volatile organic compound (VOC) analysis is required. Trip blanks will subsequently be handled as all other water samples collected for analysis of VOCs. Each ice chest in which VOC samples are stored or shipped will have an accompanying trip blank, which will be analyzed for VOCs only.

8.2 Training

Personnel participating in sampling activities and the use of standard operating procedures addressed in this plan will be proficient in the procedures for the work that they perform. The training requirements are listed in Appendix D. It is important to note that the requirements may not be the same for every sampler. Personnel should be notified by the Ground Water Manager of the training requirements before sampling.

8.3 Documentation

The Moab Water Sampling Field Data Form (Appendix C) will be used at each location to record and document sample collection, field measurement data, sampling equipment used, and instrument calibration information. The form will be completed following the protocol specified in Procedure 1 in Appendix A. Deviations from the procedures specified in this plan will be documented as a field variance on the field data form and, as appropriate, in the sampling trip report.

After the completion of a sampling event or period, the sampling lead will prepare a sampling trip report that will document the specifics of the sampling event. Items that will be documented in the report will include:

- Dates of the sampling event.
- Team members.
- Number of locations sampled.
- Water levels and total depth of sample locations.
- Field variances.
- Analytical report identification number(s).
- Equipment problems.
- Required action items.
- Photographs of sample locations (well points and surface water locations).

8.4 Records

Records associated with or generated through ground water and surface water sampling activities include, but are not limited to the following.

- Laboratory Analytical Data Reports
    - Water Sampling Field Data Forms
    - Chain of Custody Sample Forms
    - Sampling Trip Reports
- Analytical Data Validation Summary Reports

After each sampling event, the completed field data forms should be scanned into the virtual server. Once completed, the sampling trip report should be placed in the virtual server so that it is accessible for data validation.

All records will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545) and the *Moab UMTRA Project Records Management Program Plan* (DOE-EM/GJ1462).

9.0 Health and Safety

Information on health and safety is provided in the *Moab UMTRA Project Health and Safety Plan* (HASP) (DOE-EM/GJ1038) and emergency response information is provided in the *Moab UMTRA Project Emergency Response Plan* (DOE-EM/GJ1520). The site-specific HASP has been prepared for the Moab Project in accordance with the requirements of 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." All activities performed in association with the sampling for this task will be performed according to the site-specific health and safety requirements described in the HASP.

Water sampling activities will be conducted according to the health and safety requirements specified in the Ground Water Operations Integrated Work Plan (IWP) (TAC-IWP-2010-03), the Ground Water Sampling, Preservation, Shipment, and Transportation Task Awareness Plan, and the HASP. Task-specific health and safety requirements may also be addressed in health and safety documents such as the *Moab UMTRA Project Radiological Work Permitting Procedure* (DOE-EM/GJRAC1950) and the *Moab UMTRA Project Confined Space Entry Procedure* (DOE-EM/GJ1553). If any required task is not covered in the IWP, contact Health and Safety for guidance on whether a new IWP needs to be created or whether a Field Change Notice should be completed.

10.0 Biota Monitoring

The objectives of the tasks described in this section are to monitor the channel morphology and the ammonia concentration in the backwater habitat areas adjacent to the Moab site. Emphasis is placed on monitoring and diluting concentrations of unionized ammonia in the mixing zone of the Colorado River where suitable habitat may exist. This will be accomplished by incorporating a real-time ammonia meter with the backwater channel observations and introducing freshwater into the backwater channels for ammonia dilution, if necessary.

10.1 Timing

Young-of-year endangered fish are most likely to be present in the river adjacent to the site on the descending limb of the hydrograph of the river. Monitoring will commence after the hydrograph has peaked and descended to approximately 7,000 cfs (as measured at the U.S. Geological Survey Cisco gaging station). If the river flow does not reach 7,000 cfs, monitoring will start on approximately July 10. Monitoring will continue through September 30. By the end of September, young-of-year endangered fish should have reached a size of approximately 40 millimeters (mm) and have the ability to avoid harmful conditions.

10.2 Survey Frequency and Requirements

After the peak spring runoff, a visual survey of the backwater channel morphology should be conducted. This survey should include photographs, documentation of any significant changes from the previous year, and the characteristics of any new habitat areas. Thereafter, a visual survey should be conducted at least once and up to four times a week (depending on the variability of the river flow) for the duration of the monitoring period.

The survey frequency will be dependent on river flow and access, scheduling constraints, and the results of previous surveys. A narrative description is adequate for the survey log.

The main fish of concern are Colorado Pikeminnow, which are known to use the river adjacent to the Moab site. Three other endangered fish cited in the final USFWS Biological Opinion are less well known in the area. Several important habitat characteristics that appear to influence habitat used by pikeminnow have been identified. These include water depth, habitat surface area, water velocity, turbidity, and temperature. The main criteria that have been used in habitat sampling to date are that waters must be at low velocity and fairly shallow. Ideally, pikeminnow prefer backwater areas that are separate from the main river channel and connected on the downstream side. Generally, isolated pools of water would not be considered suitable habitat unless they are sufficiently large and have a probability of reconnecting with the river if flows were to slightly increase. Pools surrounded by saturated sediments that have only recently become disconnected from the river could serve as temporary refuge for young-of-year fish until river flows increase. Pools surrounded by desiccated sediments and evidence of salt precipitation are deemed uninhabitable based on natural processes. These types of features and characteristics should be noted.

During recent sampling events, the areal extent of potentially suitable fish habitat was very limited. River conditions may be such that habitat areas with turbid waters develop. Under these conditions, the presence of dead or dying fish may not be able to be detected visually. If it is determined that habitat is present in sufficient size that it is likely to contain fish, the area can be swept with a dipnet (circular or D-shaped head with $^{1}/_{16}$-inch mesh) to determine the presence of fish. Live fish should be released immediately. Any dead or nearly dead fish should be preserved as described in Section 10.7. Sweeps should be pulled slowly at the sediment/water interface at lengths up to a few meters.

When a suitable habitat area is identified, surface water parameters, including temperature, pH, and conductivity, will be measured and recorded with an YSI XLM 6000, and the area will be photographed and documented. In addition, an ammonia sample may be collected and analyzed with a Hach sensION Ammonia Gas Sensing Combination Electrode (see Attachment 1 on enclosed CD, which contains the probe manual). If the unionized ammonia concentration exceeds background in a habitat area, freshwater will be delivered into the backwater channel through a hose to dilute the contaminants. The ammonia concentration will be monitored during the freshwater introduction to ensure dilution has occurred. If no habitat areas are present, the backwater channels will be photographed and documented as such.

10.3 Location

Site-related contamination is only likely to affect river water quality in areas where the main contaminant plumes discharge to the river. It is anticipated that the survey would consist of observations made in the vicinity of the Moab Wash and along the length of the IA well field. At low flows, it is generally possible to walk along the river bed in this stretch of river. During times of increased river flow when it may not be possible or is not safe to walk along the river bank, observations will only be made from these positions.

This portion of the river is the most likely area in which potentially suitable habitat may develop due to the presence of gravel bars. Conclusions from the *Moab UMTRA Project 2011 Ground Water Program Report* (DOE-EM/GJTAC2041) indicate that the potential habitat area has migrated southward (toward Configuration 4 [CF4]) since the IA commenced in 2005.

10.4 Personnel

The biota monitoring surveys and any required sampling will be conducted by personnel trained in appropriate sampling techniques and methods.

10.5 Fish Sampling Procedures

Fish will be collected that are dead or nearly dead. Fish that are nearly dead are incapable of orienting themselves in low flow waters. The presence of stressed fish should also be noted.

10.6 Collection and Preservation Methods

When dead or dying fish are encountered, the monitoring personnel should collect up to 100 specimens or 10 percent of the estimated total number, whichever is greater. Dead fish larger than 150 mm need not be preserved if they can be photographed (with the entire body filling the photographic frame). Dead or nearly dead fish should be placed in a plastic zippered bag and covered with a 50:50 solution of isopropyl alcohol (available over the counter). Dead or dying fish collection sites should be mapped or located with a GPS and photographs taken. The sample should be labeled with date, time of collection, and closest known existing sample location. The label can consist of information written with pencil on paper placed inside the sample or information written on the zippered plastic bag with a permanent marker; using both methods is preferable. Samples should be stored in a cool place as soon as possible.

10.7 Notification and Identification

As soon as possible on collection of fish samples, the USFWS Ecological Services office should be notified at (801) 975-3330 to make arrangements for fish identification.

10.8 Personnel and Equipment

Sampling will be conducted according to standard sampling protocols and procedures (see Section 4.3). Standard equipment and methods will be employed. If at any time during the monitoring period clarification is needed regarding protocols, collection techniques, or other biota monitoring requirements, the USFWS may be contacted.

10.9 Environmental Compliance

Additional information on environmental compliance, waste management, and emergency response is in the HASP. It is anticipated that the only wastes generated by these survey and sampling activities will be personal protective equipment.

11.0 References

29 CFR 1910.120 (Code of Federal Regulations), "Hazardous Waste Operations and Emergency Response."

49 CFR 171-179 (Code of Federal Regulations), "General Information, Regulations, and Definitions."

DOE (U.S. Department of Energy), "DOE Quality Systems for Analytical Services," 2005.

DOE (U.S. Department of Energy), *Ground Water Operations Integrated Work Plan* (TAC-IWP-2010-03), November 2008.

DOE (U.S. Department of Energy), *Moab UMTRA Project Confined Space Entry* (DOE-EM/GJ1553), April 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Emergency Response Plan* (DOE-EM/GJ1520), September 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Ground Water Interim Action Performance Assessment* (DOE-EM/GJTAC1841), October 2009

DOE (U.S. Department of Energy). *Moab UMTRA Project 2011 Ground Water Program Report* (DOE-EM/GJTAC2041), May 2012.

DOE (U.S. Department of Energy), *Moab UMTRA Project Health and Safety Plan* (DOE-EM/GJ1038), November 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Radiological Work Permitting Procedure* (DOE-EM/GJRAC1950), September 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545), July 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Records Management Program Plan* (DOE-EM/GJ1462), July 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855), September 2011.

DOE (U.S. Department of Energy), *Moab UMTRA Project Waste Management Plan* (DOE-EM/GJ1633), July 2008.

DOE (U.S. Department of Energy), *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement* (DOE/EIS-0355), 2005.

DOE (U.S. Department of Energy), *Technical Approach for the Management of UMTRA Ground Water Investigation-Derived Wastes* (DOE/AL/62350-109), 1994.

DOE (U.S. Department of Energy), DOE Order 414.1D, "Quality Assurance."

EPA (U.S. Environmental Protect ion Agency), "Methods for the Chemical Analysis of Water and Wastes," 1983.

EPA (U.S. Environmental Protect ion Agency), "National Environmental Laboratory Accreditation Conference, Chapter 5, 'Quality Systems,'" July 2004.

EPA (U.S. Environmental Protect ion Agency), "Specification and Guidance for Contaminant-Free Sample Containers," December 1992.

EPA (U.S. Environmental Protect ion Agency), "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)," 1996.

Korte et al., "Application of Low-Flow Purging to the UMTRA Ground Water Project," 2001.

Appendix A.
Sampling Procedures

Procedure 1
Standard Practice for Field Documentation Processes

Scope

This standard practice covers reproducibility, legibility, accuracy, completeness, protection, identification, and error correction of records. The practice describes the control, data entry, content, review, and storage of field documents such as field notebooks, data sheets, and other records.

Terminology

Records – Information or data on a specific subject collected and preserved in writing or other permanent form that has been verified and authenticated as technically complete and correct. Records may include data sheets, logbooks, field notebooks, maps, drawings, and photographs.

Field Data Books – For purposes of this practice, technical record books will refer to log books and field notebooks.

Significance and Use

This practice includes the use of field data sheets for direct data entry.

Documentation of the results produced from performing tasks is necessary to provide adequate evidence of compliance with requirements, provide an adequate basis for design decisions, and document techniques and conditions of sample collection.

General Procedures for Records

All records produced from work performed must meet the following requirements.

- Records must be clear, legible, and reproducible. Black ink is preferred. Reproducible photocopies of penciled documents are acceptable as records.
- Errors will be corrected by lining through the incorrect entry with a single line, making the correction, and initialing and dating the correction. The erroneous information must not be obliterated or erased.
- Records must specify the activity conducted and the method used, if applicable. The signature of the person who performed the work and the date it was performed must appear on each page of a record and on any attached sheets.
- Records must be protected against damage, deterioration, and loss while in the field, during data review, and until they are scanned into the server. Records must be isolated from any source of contamination.
- All data will be reviewed before personnel leave a remote site. The review will ensure no additional sampling or data acquisition is required before departure.
- When the procedure specifies compilation of data sheets, the data must be legible and traceable to the activity, project, and method used. The person completing the data sheet will sign and date the sheet and ensure applicable spaces are completed.

Procedures for Field Data Books

Field data sheets will be bound books. Each book will have the report identification number (RIN), month, and date of the sample event labeled on the front cover.

Issue and Control of Field Data Books

A Field Data Book will be designated for an activity or a person for use on a project. The book will be transmitted to the Ground Water Manager or designee on completion. If a Field Data Book contains information on more than one activity or project, the book will clearly identify the portion associated with each activity or project. Reproducible copies of applicable sections of these books may be submitted to the Ground Water Manager or designee as records.

The person to whom the Field Data Book is issued to shall take the following steps on receipt.

1. Keep the book in their possession during the sampling event
2. Complete the information on the front cover of the Field Data Book
3. Ensure the QC/calibration/and data sheets are legible, correct, and complete before turning the sheets into the Ground Water Manager

Rules for Data Entry

1. Pages shall be kept intact. No page is to be left completely blank or removed from the book.
2. Use pages consecutively. If a page has entries from more than 1 day, each entry shall be signed and dated. If a page or part of a page must be left blank, it must be ruled across, signed, and dated. If entries for a given subject are made on two or more pages that are not consecutive, each page must be cross-referenced to the previous and following entries.
3. Record all data as required by procedures for the activity being performed. Enter all data directly in a Field Data Book when practical.
4. Record instrument numbers or equipment used, if not specified in a referenced procedure.
5. Document all pre-trip and daily instrument calibrations.
6. Record results obtained, observations made, the review of the results; nonconformances and deficiency reports may be included.
7. Record weather or other environmental influences that might affect the results.
8. Document variances from planned activities. A variance is considered to be a deviation from “shall,” “must,” or “will” statements of a procedure.
9. Record the location of the activity, including site and sample location.
10. Sampling entries must include date and time of sample collection and water quality parameters.

Review of Field Data Books

A reviewer will review Field Data Books for content, accuracy, legibility, calculations, error correction, and reproducibility

The reviewer will check for completeness, validity of data, and traceability between each page and the items or activities to which it applies. The reviewer will take action to correct any deficiencies.

Once the reviewer is satisfied with the data on the sheets, he/she must sign and date the bottom of each field data sheet.

Procedure 2
Standard Practice for Sample Labeling

Scope
This procedure addresses labeling requirements and recommended practices for labeling samples that are collected in the field and intended for analysis at a later time. The materials sampled may include solids, such as soils and cores, liquids and sludges, and gases.

This procedure is intended for use with a variety of sample types, including grab samples, equipment blanks, duplicate samples, and split samples.

All samples collected by contractor personnel shall have a sample label and a contractor-generated sample number.

Terminology
Chain of custody form – A form used to document sample custody and receipt. It also may contain other information, such as the sample analyses required and traceability.

Field – Any place where the material for analyses or testing is collected.

Duplicate samples – More than one sample collected from the same source location, but placed in separate containers.

Sample – A portion of material collected from a larger mass that represents the characteristics of that mass or to select and collect a sample.

Sample label – The documentation attached to the sample or sample container and marked with required information about the sample. An example is shown in Figure A-1.

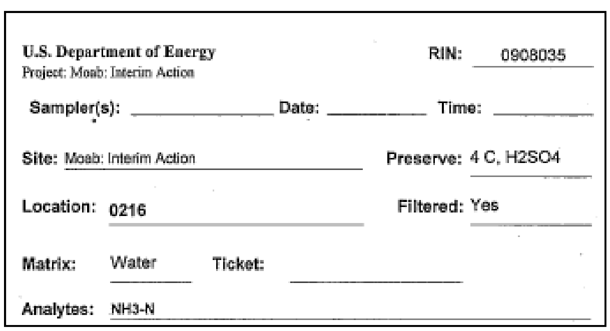
U.S. Department of Energy
Project: Moab: Interim Action
RIN: 0908035
Sampler(s): ______ Date: ______ Time: ______
Site: Moab: Interim Action
Preserve: 4 C, H2SO4
Location: 0216
Filtered: Yes
Matrix: Water
Ticket: ______
Analytes: NH3-N

Figure A-1. Example of a Sample Label

Sample log – A document that lists all samples collected during a field visit or visits. A Chain of Custody Form or spreadsheet of sample locations are examples of sample logs.

Sample number – The unique identification number assigned by the contractor to each sample and attached to or written on the sample label or sample container. The sample number will normally consist of three alpha and three numeric characters.

Significance and Use
All contractor personnel shall use this procedure for sample identification unless an approved alternate procedure is included or referenced in the official project records. Alternate procedures shall include the minimum sample labeling information identified below.

Materials
- Preprinted contractor sample labels with adhesive backing
- Ballpoint pen with reproducible, waterproof ink
- Chain of custody

Procedure for Obtaining Sample Numbers
Sample numbers are created for each sample location. Originally, sample ticket number books were used for each location, but to cut back on paperwork, the site now uses virtual tickets. Each sample location is given a unique set of three letters followed by three numbers. The letters represent the first three letters of the sampling month, and the last three numbers are consecutive. For example, the first sample collected in August would have the virtual ticket number AUG001. This method provides unique sample numbers that may be used to log various sample media; these ticket numbers are used in data validation and QA/QC activities.

Procedure for Using Sample Labels
1. Complete the sample label before attaching it to the sample container.
2. Use reproducible ink to complete the required label information.
3. Normally, the sampler will complete the entire label. If some of the requested information is not relevant, write “NA” for “not applicable” in that space.
4. The minimum information required on the sample label shall include:
   - Sample number (virtual ticket number).
   - Date the sample was collected.
   - Sampler identification (name or initials of the person who collected the sample).
   - Project site (area or property defined in project documents containing one or more sample locations; property may be identified by a number).
   - Sample location (location at which the sample was collected; examples include well numbers, grid locations, or surveyed coordinates).
   - Time at which the sample was collected.
5. Attach the preprinted sample number to the sample label. If the preprinted number is illegible or does not adhere to the label, the sampler may write the sample number on the sample, sample label, or sample container. The sampler also may write the number on tape and attach it to the sample.
6. Maintain a record of sample numbers and other pertinent information on the field data sheet.
7. When needed, protect the completed sample labels from moisture and abrasion by placing a piece of clear plastic tape over the label.

Procedure 3
Standard Practice for Chain of Custody Control and Physical Security of Samples

Scope
This procedure describes the documentation required for tracing sample custody and the requirements for maintaining physical security of samples.

Terminology
Chain of custody record – A Chain of Custody Form (Figure A-2) or equivalent used to document sample custody and receipt.

Custody – To maintain a sample in sight, in immediate possession, or locked under one's personal control.

Custody seals or tags – Adhesive-backed strip fastened to the sample container or the shipping container in such a way as to demonstrate that no tampering with the sample has occurred. Custody seals also may be manufactured in the field by using paper strips and clear plastic tape.

Duplicate samples – More than one sample collected from the same source location, but placed in separate containers.

Physical security – Synonymous with custody, but emphasizes the measures taken to prevent tampering with the samples or sampling process.

Sample – A portion of material collected from a larger mass or to select and collect a sample.

Significance and Use
All contractor personnel shall use this procedure for chain of custody control and physical security of samples unless an approved alternate procedure is included or referenced in the official project records.

Materials
- Chain of Custody/Sample Submittal Form or equivalent (Figure A-2)
- Ballpoint pen with waterproof, reproducible ink
- Custody seals or tags
- Clear plastic tape (normally 2 inches wide)
- Containers and/or enclosures as appropriate to provide physical security of the samples

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Chain of Custody / Sample Submittal Form ~~Page 1 of 10~~ 1

RIN: 0803009 COC: 0803009.1.1

PO #: 24314 Shipping Cost #:

Sampler(s): SB/SG

Project: Moab: Interim Action

Laboratory: Paragon Analytics, Inc.
Address: 225 Commerce Dr.
Ft. Collins, CO 80524

Phone: 970.490.1511
Fax: 970.490.1522

Matrix: WA - Water Turnaround (Days): 28

Ship #	Ticket Number	Date / Time Sampled	Site	Location	Container	# Cont.	Preservation	Matrix	Comp.	Grab	Filtered	QC	Analysis
1	NFC433	3/11/08 1410	MOA01	0401	HDPE 125 mL	1	HNO3	WA				☐	U,Mn
1			MOA01	0401	HDPE 125 mL	1	4 C, H2SO4	WA				☐	NH3-N
1			MOA01	0401	HDPE 125 mL	1	4 C	WA				☐	Cl,Br,SO4
1			MOA01	0401	HDPE 125 mL	1	4 C	WA				☐	TDS
1	NFC439	3/13/08 0920	MOA01	0471	HDPE 125 mL	1	HNO3	WA				☐	U,Mn
1			MOA01	0471	HDPE 125 mL	1	4 C, H2SO4	WA				☐	NH3-N
1			MOA01	0471	HDPE 125 mL	1	4 C	WA				☐	Cl,Br,SO4
1			MOA01	0471	HDPE 125 mL	1	4 C	WA				☐	TDS
1	NFC440	3/13/08 0930	MOA01	0473	HDPE 125 mL	1	HNO3	WA				☐	U,Mn
1			MOA01	0473	HDPE 125 mL	1	4 C, H2SO4	WA				☐	NH3-N
1			MOA01	0473	HDPE 125 mL	1	4 C	WA				☐	Cl,Br,SO4
1			MOA01	0473	HDPE 125 mL	1	4 C	WA				☐	TDS
1	NFC441	3/13/08 0940	MOA01	0477	HDPE 125 mL	1	HNO3	WA				☐	U,Mn
1			MOA01	0477	HDPE 125 mL	1	4 C, H2SO4	WA				☐	NH3-N
1			MOA01	0477	HDPE 125 mL	1	4 C	WA				☐	Cl,Br,SO4
1			MOA01	0477	HDPE 125 mL	1	4 C	WA				☐	TDS

Reliquished by (signature)	Date	Time	Reliquished by (signature)	Date	Time	Reliquished by (signature)	Date	Time
[signature]	3/13/08	1300						
Received by (signature)	**Date**	**Time**	**Received by (signature)**	**Date**	**Time**	**Received by (signature)**	**Date**	**Time**

Figure A-2. Example of Chain of Custody/Sample Submittal Form

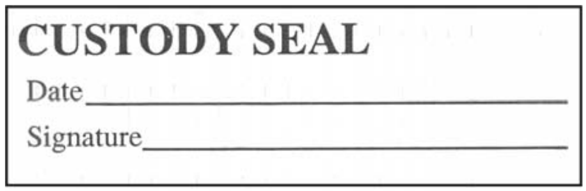
Chain of Custody Procedure

The sampler shall complete the chain of custody record during or after sample collection.

1. Use reproducible ink to complete the form.
2. The initiator of the form is responsible for legibility of all entries other than signatures.
3. When the samples are physically transferred from one person to another, the relinquisher and receiver shall sign the appropriate block, with the date and time of sample transfer. The relinquishers, by signing, verify that the samples have been within their custody.
4. It is each signatory's responsibility to write the signature legibly.
5. The relinquisher retains a copy of the form.
6. Noncontractor employees are not required to sign the form (e.g., employees of 0 shipping companies).
7. The following is the minimum information required on the form to ensure sample identification.
   - Date Chain of Custody Form was prepared
   - Site name
   - Sampler's printed name
   - Sample location and virtual ticket number, if used
   - Date and time of sample collection
   - Number and types of sample bottles

8. Complete all information blocks or label the blocks "NA" for not applicable.
9. In addition to the chain of custody, the analytical laboratory may require a radiological scan of the cooler and the samples jars. If so, the documentation needs to be included with the chain of custody.

10. When samples will be transported by a non-contractor shipper, use custody seals or tags to seal the individual sample containers or the inner or outer shipping carton.
11. When seals are applied to the sample container, they must not obscure the information on the sample label (Figure A-3).
12. Securely wrap or fasten shipping containers before application of the custody seals. The seals are inherently fragile and will not withstand pressure from an inadequately packaged container. Seal all possible access flaps or lids of the shipping container.
13. Enter the date the samples are sealed and sign the custody seals or tags as shown below. Clear plastic tape may be applied over the seals for protection.


CUSTODY SEAL

Date____________________

Signature____________________

Figure A-3. Example of Custody Seal

14. The original chain of custody record and the radiological scan (if necessary) shall accompany the samples until they are received by the laboratory.
15. Unless otherwise specified by the project, the chain of custody record shall be maintained as part of the project records.

Physical Security of Samples

The sampler must maintain physical security of the samples, sampling process, and equipment by physical possession or visual contact.

Use security seals where appropriate. Although security seals do not provide physical security, the seals are evidence that the samples were not tampered with while unattended.

Use best professional judgment when providing physical security of the samples or sampling process. The sampler should be knowledgeable of the programmatic requirements for the samples and provide the appropriate degree of physical security.

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Procedure 4
Standard Practice for Sample Submittal to Contract Analytical Laboratories

Scope

This standard practice describes the process for submitting samples to contracted analytical laboratories. This practice applies to the submittal of samples to laboratories that provide services procured under the Integrated Contractor Purchasing Team (ICPT) BOA.

This practice applies to the submittal of all sample types, including samples of ground water, surface water, soil, vegetation, biota, wastes, and other types of samples collected for analysis within the scope of the BOA.

Terminology

Basic Ordering Agreement (BOA) – The ICPT BOA provides a standardized system for procuring analytical services from commercial laboratories, including a statement of work (SOW) for analytical services and provisions for laboratory audits.

Environmental samples – Air, soil, water, or other media samples that are collected from surface waters, wells, soils, or other locations and are not expected to exhibit properties classified by the U.S. Department of Transportation (DOT) as hazardous.

DOT-regulated samples – Samples of on-site air particulates, soil, or water and materials collected at waste sites that are known or thought to meet the definition of a hazardous material as defined in 49 CFR 171.8. In this procedure "hazardous" does not refer to Resource Conservation Recovery Act hazardous wastes unless so stated.

Integrated Contractor Purchasing Team (ICPT) – The ICPT was established by DOE to provide a vehicle for communication of procurement-related issues of the prime contractor community. The ICPT provides BOAs negotiated by or in support of ICPT for use by DOE and its eligible subcontractors.

Line item code – A cost code used to specify analytes or analyte groups. Line item codes are defined in the BOA based on sample matrix, analytes(s), analytical methods, and required detection limits.

Radioactive material – Any material having an activity greater than 2,000 picocuries per gram and the radionuclide is evenly distributed.

Report identification number (RIN) – A unique seven-digit number that identifies a group of samples that are submitted, analyzed, and reported together.

Significance and Use

This practice provides an organized, documented sample submittal process when requesting analytical services and will be used for all sample submittals to commercial laboratories contracted under the BOA.

This practice complements procedures for the collection, preservation, and shipment of samples as documented elsewhere.

Procedure

Samples are classified by type: environmental or DOT-regulated. In general, samples collected are expected to have a low concentration of potential contaminants, although higher concentrations will be present in some cases. These low-concentration samples are classified as environmental samples because they do not meet the DOT hazard class definitions and are not subject to DOT regulations. Historical data, knowledge of process, and field screening results will assist in classification of samples as environmental or as a DOT-regulated material.

The classification of sample types to be collected must be made as part of the planning process to comply with DOT shipping requirements (see Procedure 6).

Laboratory Coordinator Notification

The laboratory coordinator is responsible for scheduling chemical analyses with contracted analytical laboratories. The laboratory coordinator must be notified of upcoming sampling events in advance (usually 5 days or more) to arrange sample analyses. More lead time may be needed when a large number of samples are planned or if unusual analyses are requested.

The following information is needed:

- Number and types of samples
- Analytes requested
- Special requirements, regulatory methods, and detection limits
- Turnaround time requirements
- Reporting requirements

The laboratory coordinator assigns a unique RIN to the sample event and selects the line item codes to specify the analyses to be performed. RINs are generated through a sequence of seven numbers: the first two numbers are the last two digits of the year of the sampling event, the second two numbers correspond to the month of the sampling event, and the last three numbers are sequential. The Sample Management System Database is used to produce sample labels and a Chain of Custody Form.

Sample Collection and Documentation

Samples are collected, preserved, and packaged in accordance with the appropriate procedures; refer to Procedure 6.

Field activities and all comments or deviations from procedures are documented on the water sampling field data form or trip report in accordance with Standard Practice for Field Documentation Processes (see Procedure 1).

Samples are sealed and labeled for shipment; refer to Standard Practice for Sample Labeling (see Procedure 2).

Sample integrity must be maintained (samples must be under constant supervision and protected from tampering) and documented on a chain of custody form. Refer to Procedure 3 for guidance on protecting sample chain of custody. See Figure A-4 for an example of a Chain of Custody Sample Submittal Form.

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Chain of Custody / Sample Submittal Form

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RIN: 0908035 COC: 0908035.1.1

PO #: 24314 Shipping Cost #: ______ Sampler(s): ______

Project: Moab: Interim Action

Laboratory: Paragon Analytics, Inc.
Address: 225 Commerce Dr.
Ft. Collins, CO 80524
Phone: 970.490.1511
Fax: 970.490.1522

Matrix: WA - Water Turnaround (Days): 28

Ship #	Ticket Number	Date / Time Sampled	Site	Location	Container	# Cont.	Preservation	Matrix	Comp.	Grab	Filtered	QC	Analysis
1			MOA01	0216	HDPE 125 mL	1	HNO3	WA			Y		Mn,U
1			MOA01	0216	HDPE 125 mL	1	4 C, H2SO4	WA			Y		NH3-N
1			MOA01	0216	HDPE 125 mL	1	4 C	WA			Y		TDS
1			MOA01	0236	HDPE 125 mL	1	HNO3	WA			Y		Mn,U
1			MOA01	0236	HDPE 125 mL	1	4 C, H2SO4	WA			Y		NH3-N
1			MOA01	0236	HDPE 125 mL	1	4 C	WA			Y		TDS
1			MOA01	0239	HDPE 125 mL	1	HNO3	WA			Y		Mn,U
1			MOA01	0239	HDPE 125 mL	1	4 C, H2SO4	WA			Y		NH3-N
1			MOA01	0239	HDPE 125 mL	1	4 C	WA			Y		TDS
1			MOA01	0240	HDPE 125 mL	1	HNO3	WA			Y		Mn,U
1			MOA01	0240	HDPE 125 mL	1	4 C, H2SO4	WA			Y		NH3-N
1			MOA01	0240	HDPE 125 mL	1	4 C	WA			Y		TDS
1			MOA01	0241	HDPE 125 mL	1	HNO3	WA			Y		Mn,U
1			MOA01	0241	HDPE 125 mL	1	4 C, H2SO4	WA			Y		NH3-N
1			MOA01	0241	HDPE 125 mL	1	4 C	WA			Y		TDS
1			MOA01	0242	HDPE 125 mL	1	HNO3	WA			Y		Mn,U

Reliquished by (signature) *Date* *Time* *Reliquished by (signature)* *Date* *Time* *Reliquished by (signature)* *Date* *Time*

Received by (signature) *Date* *Time* *Received by (signature)* *Date* *Time* *Received by (signature)* *Date* *Time*

Figure A-4. Chain of Custody/Sample Submittal Form

Sample Shipment

The samples are shipped in compliance with DOT regulations. Samples are shipped in coolers with ice, if necessary. The shipment must include copies of sample tickets (if used), a signed chain of custody form, and a radiological release of the sample jars and the cooler (per laboratory requirements). These documents must be scanned and emailed to the laboratory before shipment.

Sample Receipt

On sample receipt, the contracted analytical laboratory is required to:

- Sign, date, and note the time on the chain of custody form, indicating sample receipt.
- Assign unique laboratory identification numbers to the samples.
- Record the pH and/or temperature on the chain of custody form or sample receiving report.
- Contact the laboratory coordinator to resolve any discrepancies in documentation or samples received.
- Return a copy of the chain of custody form, if applicable, to the laboratory coordinator
- The laboratory shall notify the laboratory coordinator within 24 hours of discovery of lost, damaged, or destroyed samples.
- The laboratory shall provide a sample condition on receipt report to the laboratory coordinator within 24 hours of receipt.

It is the responsibility of the laboratory coordinator to ensure the laboratory complies with these requirements.

Analytical Reports

The laboratory sends an analytical report to the laboratory coordinator at the completion of sample analysis. Other deliverables are provided as specified in the Moab Project SOW for Analytical Laboratory Services. The laboratory coordinator then initiates data review and validation.

Records

Records generated during the sample submittal process are identifiable by a site code. Records are managed as defined in site-specific indices.

All records will be managed in accordance with the *Records Management Manual* and the *Records Management Program Plan*.

Procedure 5
Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites

Summary of ASTM International (ASTM) Standard D 5088-90
The purpose of this practice is to provide guidance for the decontamination of field equipment used in the sampling of soils, soil gas, sludges, surface water, and ground water at nonradioactive waste sites.

Additions Applicable to the Operating Contractor and its Subcontractors
This standard guide shall be referenced when preparing sampling and analysis plans for site investigation activities. The guidance provided may be superseded by other project documents, such as project safety plans or project QA plans.

The following sections shall be interpreted in conjunction with the current published version of the ASTM guide. The sections shall be interpreted in numerical order, using the published version as the base document for reference.

Summary of Practice
Equipment that does not contact the samples may not require decontamination due to limited use and/or site conditions that do not pose a risk.

The information included in an equipment decontamination protocol, as well as how the information is presented in site plans should be determined on a site specific basis.

Procedure for Sample Contacting Equipment
When samples undergo inorganic analyses, the use of an inorganic desorbing agent may not be required if the QA/QC program documents that the decontamination protocol is sufficient for the sampling methods being used.

QA/QC
The frequency for the minimum number of samples to demonstrate completeness of decontamination for QA/QC purposes may be either increased or decreased on a site-specific basis based on an evaluation of QA/QC samples and project-specific objectives.

Report
The activities associated with reporting equipment decontamination should be determined on a site-specific basis based on the specific objectives of each project.

Hazard Analysis
Exposure to hazardous substances and chemicals is possible during performance of this task. The applicable site HASP or project safety plan shall be used for all decontamination work.

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Procedure 6
General Considerations for the Sampling of Liquids

Introduction

The importance of proper sampling techniques for liquids cannot be overemphasized. Many factors shall be considered to obtain a sample that is: (1) representative of the population being sampled; (2) collected in a manner that does not compromise the sample; (3) preserved properly until it can be analyzed in the laboratory; and (4) documented so that it can be properly traced. Accurate sampling shall be responsive to all of these considerations and to other items discussed in this procedure.

Scope

Because the objective of most liquid sampling is to obtain a sample that is representative of the population being sampled and retains the physical and chemical properties of the population, the sampler shall make decisions concerning sample types, equipment to be used, QC, and decontamination that will greatly affect the results obtained from the sampling event. The information provided in this procedure will guide the sampler and provide the necessary background for the proper collection of liquid samples.

Significance and Use

The two general sample types are grab samples and composite samples. Grab samples are the most widely used type. They provide a sample that represents the characteristics of the liquid being sampled at a particular point in space and time. Grab samples are used where:

- The flow of liquid is not continuous (e.g., batch discharges or intermittent flows)
- The characteristics of the liquid are known to be fairly constant
- The samples are to be used for parameters with characteristics that are likely to change significantly with time (e.g., dissolved gases, bacterial decay, hydrolysis reactions, oxidation/reduction reactions)
- The compositing process would significantly affect the concentration of an analyte.

Composite samples are composed of small aliquots of constant volume collected at constant time intervals or flow increments. Composite samples are used to generate data that describe average characteristics. Composite samples are collected in several ways depending on the particular variability being studied. The five types of composite samples are:

1. Simple composite samples which consist of small aliquots of constant volume collected at constant time intervals.
2. Flow-proportional composite samples that are collected by varying the time intervals with flow or by proportionally varying the volume collected with flow.
3. Flow-proportional sampling that is used where the liquid flow is highly variable.
4. Sequential composite samples that require a series of individual samples collected per container with each container representing a specific time period. This sampling technique is used where the liquid being sampled varies significantly over short periods.
5. Continuous composite samples that are collected by extracting a small continuously flowing stream from the bulk source and directing it into the sample container.
6. Areal composite samples that are a composite of individual grab samples collected on an areal or cross-sectional basis. Areal composite samples are generally used to collect a sample from a lake or stream.

Interpretation of results depends on knowledge of ground water flow direction and formation transmissivity, lithology sampled, and a properly collected, preserved, and uncontaminated sample.

See Tables A-1 through A-6 for advantages and disadvantages of different sampling devices. A description of the depth of monitoring wells and a depth to the sample interval is necessary before proper sampling strategies can be chosen.

Material Considerations
The quality of the analytical data can be greatly affected by interactions between the sample and the sampling device. These interactions include chemical attack, microbial colonization, sorption, and leaching effects. To ensure the integrity of the sample and maximize the analytical quality, the sampling device shall be constructed of a nonreactive material.

The materials listed below are generally used in construction of sampling devices and sampling containers.

Rigid materials:
- Teflon
- Stainless steel
- Polyvinyl chloride (PVC)
- Low-carbon steel
- Galvanized steel
- Carbon steel

Flexible materials:
- Teflon
- Polypropylene
- Linear polyethylene
- Flexible PVC
- Viton
- Conventional polyethylene
- Tygon
- Silicone/neoprene

The choice of materials used shall be considered with respect to the parameter being sampled. The factors to be considered are:
- Negative Contamination – The potential for the measured analyte concentration to be artificially low because of losses that are due to precipitation, volatilization, or absorption.
- Positive Contamination – The potential for the measured analyte to be artificially high because of leaching or introduction of foreign matter into the sample by particle fallout or gaseous air contaminants.
- Cross-contamination – A type of contamination caused by the introduction of part of one sample into a second sample.

Equipment Selection Considerations

Because each sampling situation is unique, the sampler may have to modify equipment and applications to ensure a representative sample is collected and to maintain the sample's physical and chemical integrity. No one particular device will fit every situation. The sampler shall understand the various sampling devices and their advantages and disadvantages to effectively use them to collect samples. The following items shall be considered when selecting a sampling device.

- Potential impact of the device on sample integrity
- Method of sample delivery
- Flow controllability
- Depth of sampling interval
- Ease of operation, cleaning, and maintenance
- Reliability and durability
- Portability of the device
- Initial cost and operational cost

There are basically four types of sampling devices.

1. Grab mechanisms
2. Suction-lift mechanisms
3. Positive-displacement mechanisms
4. Submersible pumps

Discussion of the uses, advantages, and disadvantages of these devices follow.

Grab Mechanisms

Grab mechanisms consist of bailers and dip-type samplers. These devices are the oldest and simplest for collection of liquid samples. They can be made of virtually any material and can be used to collect liquid samples from almost any source. Table A-1 presents the advantages and disadvantages of a grab-type mechanism.

Table A-1. Grab Mechanism

Advantage	Disadvantage
Virtually any material can be used for construction. Device is inexpensive. No external power source is required. Mechanism can be constructed in any size and shape. Device is easy to use and easily cleaned; requires little training for operation and little maintenance.	Sampling is labor intensive and time consuming. Aeration, degasing, and turbulence occur during sampling. Sampler is susceptible to exposure to any contaminants in the sample. Device does not provide a continuous supply of sample.

Suction-Lift Mechanisms

Suction-lift mechanisms consist of peristaltic-type pumps and centrifugal pumps that apply a vacuum, which causes the liquid to be drawn upward through a suction line. Their use is generally limited to purging wells of stagnant water and sampling for inorganic analytes. Table A-2 presents the advantages and disadvantages of a suction-lift mechanism, and Table A-3 presents the advantages and disadvantages of an inertia pump mechanism.

Table A-2. Suction-Lift Mechanism

Advantage	Disadvantage
Flow rates are easily adjustable. Device has no contact with the sample. Device can be used in wells of any diameter. High flow rates are obtainable for well purging. Only the tubing requires cleaning (peristaltic pumps only).	Use is limited to situation where the liquid level is less than 25 ft below the surface. Drop in pressure of suction-lift mechanism causes degasing of the sample and loss of volatiles. Choice of construction material is limited. Centrifugal pumps need to be primed, resulting in possible sample contamination. Aeration and turbulence occur with centrifugal pump.

Table A-3. Inertia Pump

Advantage	Disadvantage
Easy to decontaminate. Inexpensive. Portable.	Labor intensive. Difficult to sample from a set depth. Creates turbidity.

Positive-Displacement Mechanisms

Positive-displacement mechanisms consist of gas-driven devices and gas-operated bladder pumps. These devices are generally used to sample ground water when the liquid must be pumped to the surface. Positive-displacement devices can be constructed of a variety of materials to fit most sampling situations. Tables A-4 and A-5 present the advantages and disadvantages of positive-displacement mechanisms.

Table A-4. Gas-Driven Device

Advantage	Disadvantage
Device can be used in wells of 1.5-inch inside diameter. Device is inexpensive and highly portable for most sampling applications. Permanent installation is possible in boreholes without casing. Inert materials can be used for construction of device. Sample delivery rate can be controlled. Burst strength of the materials used to make device and tubing is only limiting factor in determining sampling depth.	Oxidation and gas-stripping of volatiles may occur if air or oxygen is used as the driving gas. Requires air compressor or large compressed-air tanks. Application of excessive air pressure can rupture the gas entry or discharge tubing. Difficult to retrieve for repair, cleaning, and maintenance when installed permanently in boreholes without casing.

Table A-5. Gas-Operated Bladder Pumps

Advantage	Disadvantage
Pump is constructed of inert materials; most pumps are designed specifically to sample for low levels of contaminants. Driving gas does not contact the sample, thus minimizing sample aeration and gas stripping. Pump is portable, though accessory equipment may be cumbersome. Relatively high pumping rate allows well evacuation and collection of large sample volumes. Sample delivery rate can be controlled on some models. Most models are capable of pumping lifts in excess of 200 ft. Pump diameters are variable, depending on the application. Pump is easily disassembled for cleaning.	Deep sampling requires large volumes of gas and longer cycles, thus increasing operating time and expense and reducing portability. Check valves in some models are subject to failure in water and high solids content. Most available models are expensive. Minimum rate of sample discharge of some models may be higher than ideal for sampling of volatile compounds.

Submersible Pumps

Submersible pumps are generally not used for sample collection. They are useful in purging large-volume wells of stagnant water; however, severe aeration and turbulence of the sample occur because of their method of sample delivery. Table A-6 lists the advantages and disadvantages of using a submersible pump.

Table A-6. Submersible Pump

Advantage	Disadvantage
High pumping rates are possible for well purging. Pump can be used at depths of more than 200 ft.	Sampler has little control of flow rates; not possible to adjust from a high rate for purging to a low rate for sampling. Severe aeration and degassing of sample occurs, thus volatilizing organics and other sensitive compounds. Pump has limited portability and requires a power source for operation. Pump is not easily disassembled for cleaning.

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Procedure 7
Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells

Introduction

Water level measurements shall be taken before any sampling or well purging. These measurements are needed to determine the casing volume of water in the well; the data are used to interpret the monitoring results. High water levels could indicate recent recharge to the system, which would dilute the sample. Low water levels could reflect the influence of nearby production wells. Documentation of nonpumping water levels also provides historical information on the hydraulic conditions at the site.

Scope

Water levels shall be measured from the top of the well casing and, for consistency, shall always be made from the same spot on the well casing. If the planning documents do not specify a reference point and other reference points do not exist, the measurement shall be made on the north side of the well casing.

Terminology

Conductivity cell – A simple electrical circuit that, when completed, causes electrical current to flow.

Dedicated water-level probe – A stainless steel probe permanently attached with polyethylene tubing to the cap of a well and used to obtain water-level information.

Electric water-level sounder – An electronic probe that uses a conductivity cell to activate an alarm when it contacts a conductive liquid.

Electronic/pneumatic water-level meter – A device that uses an internal compressed air source (pneumatic) to force air down the dedicated water-level probe. The meter senses the amount of pressure needed to push the water out of the dedicated water-level probe using a pressure transducer and associated circuitry and software (electronic). The meter converts this pressure to the depth of submersion of the probe.

Monitoring well – A well installed for the purposes of obtaining water quality data, hydrogeologic information, and/or water-level data.

Significance and Use

Accurate measurements of water depth are necessary in the calculation of well bore volumes; measurements to the nearest $^{1}/_{100}$ of a foot are routine.

Water-Level Measurements Using an Electric Sounder

Apparatus include:

- Electric sounder (there are many adequate electric sounders available; this procedure covers most models).
- Kimwipes or equivalent lint-free tissue.
- Distilled or deionized water in a squeeze wash bottle.
- Measuring tape with an engineering scale.

Procedure

The following procedure is supplemental to the instruction found in the instrument-specific operating manual.

1. Check the sounder to ensure the batteries are charged.
2. Slowly lower the probe into the well until the indicator sounds.
3. Raise the probe slightly until the indicator stops sounding.
4. Carefully lower the probe until the indicator sounds again and read the depth to water to the nearest $^{1}/_{100}$ of a foot, using a measuring tape with an engineering scale if necessary.
5. Repeat Steps 3 and 4 until a repeatable measurement is achieved.
6. Record the depth to water to the nearest $^{1}/_{100}$ of a foot.
7. Slowly withdraw the probe from the well while wiping the cable with a lint-free tissue moistened with distilled or deionized water.
8. Clean the probe with distilled or deionized water and wipe dry with a lint-free tissue.

Procedure Bias

With this method, water-level measurements must be repeatable to approximately $^{1}/_{100}$ of a foot.

Method B – Water-Level Measurements Using an Interface Probe

Method B apparatus include:

- Solinst Model 122 Interface Probe or equivalent
- Kimwipes or equivalent lint-free tissue
- Distilled or deionized water in a squeeze wash bottle

QA

The following information shall be logged when taking water-level measurements.

- Date and time of measurements
- Well identification and site
- Name of person performing the measurement
- Reference point if not top of casing
- Remarks if necessary (e.g., wells pumping nearby, recent heavy rains, ice in well)
- Depth to water

Procedure 8
Standard Practice for Purging of Monitoring Wells

Introduction

To obtain a representative ground water sample, the stagnant water in the well casing shall be removed. The recommended amount of purging depends on many factors such as the hydrogeological nature of the aquifer, the characteristics of the well, the type of sampling equipment to be used, and the parameters to be sampled. There is no one standard that will fit all situations. The general rule of thumb is to monitor the purge water using an in-line flow cell for pH, conductivity, and temperature. When these parameters stabilize to ±10 percent for two successive well volumes, the sampler can be reasonably assured that the stagnant water has been removed from the well casing.

Scope

The five methods provided here are representative of those generally used to purge monitoring wells. Each method has advantages and disadvantages that must be considered. A review of Procedure 6 provides guidance for selecting the proper method.

Significance and Use

Water may become stagnant in a well and will not reflect the local resident water's chemical and physical properties. The purging of a well can reduce this bias. Care shall be taken to allow screened intervals to come to equilibrium before sampling is performed.

Calculation of Volume of Standing Water in a Well

Calculations are performed for the amount of water in the well with the following formula:

$$r^2 \times \pi \times (h1 - h2) \times 7.48 = \text{gallons per casing volume}$$

Where:

r = radius of well casing (ft) (the radius of the well is obtained from the well completion logs or can be measured with a tape measure)

h1 = depth of well (ft) from the top of the well casing (the depth of the well is obtained from the well completion logs)

h2 = depth to water (ft) measured from the top of the well casing (the depth of water is measured using Procedure 7)

Method A – Well Purging Using a Peristaltic-Type Pump

Method A apparatus include:

- Peristaltic-type pump.
- Silicone, C-FLEX, or neoprene tubing for the pump head.
- Silicone, Teflon, polyethylene, or vinyl tubing for placing in the well.
- Generator or other source of electricity (if needed).
- Gasoline for generator, if needed (gasoline is a DOT-regulated material; its hazard class is Flammable Liquid).

Procedure

The following procedure is supplemental to the instruction in the instrument-specific operating manual.

1. Place the suction line in the well so it is just below the liquid surface.
2. Connect the suction line to the pump.
3. Connect the pump outlet to the in-line flow cell or place the pump outlet hose into an open container to be used to make the field measurements.
4. Place calibrated pH, conductivity, and temperature electrodes into the in-line flow cell or the open container.
5. Initiate pumping and monitor the water level to insure that drawdown is not occurring.
6. Routinely monitor and record the volumes purged and the readings for the pH, conductivity, and temperature.
7. When these readings have stabilized to ±10 percent for two successive well volumes, sampling can begin. Typically, 2.5 to 3 liters (L) of water are purged and readings are collected at ½-L increments.
8. Remove the suction line from the well, and clean and decontaminate the suction line and pump tubing, as required.

Method B – Well Purging Using a Bladder-Type Pump

Method B apparatus include:

- Bladder-type pump.
- Air compressor.
- Teflon, polyethylene, or vinyl tubing for the air and sample lines.
- Gasoline for the air compressor (gasoline is a DOT-regulated material; its hazard class is Flammable Liquid).

Procedure

The following procedure is supplemental to the instruction found in the instrument-specific operating manual.

1. Lower the pump gently to a position just above the screened interval.
2. Connect the air line to the pump controller.
3. Connect the pump outlet to an in-line flow cell; see Procedure 18.
4. Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.
5. Initiate pumping and routinely monitor and record the volume purged and the pH, conductivity, and temperature measurements.

NOTE: Purge water may have to be contained and properly disposed of. Consult the site-specific planning documents for requirements.

7. When these readings have stabilized to ±10 percent for two successive well volumes, sampling can begin.
8. Remove the pump from the well; clean, and decontaminate as required.

Method C – Well Purging Using a Bailer
Method C apparatus include:

- Teflon or stainless steel bailer.
- Teflon or stainless steel cable or line.
- Bailer reel.

Procedure

1. Attach the bailer to the cable or line.
2. Lower the bailer slowly until it contacts the liquid.
3. Allow the bailer to sink until it is totally submerged.
4. Slowly raise the bailer to the surface.
5. Tip the bailer or use a bottom-emptying device and fill a container in which calibrated pH, conductivity, and temperature probes have been placed.

NOTE: Purge water may have to be contained and properly disposed of. Consult the site-specific planning documents for requirements.

6. Routinely monitor and record the pH, conductivity, temperature, and volume purged.
7. When the readings have stabilized to ±10 percent for two successive well volumes, sampling can begin.
8. Clean and decontaminate the bailer, as required.

Method D – Well Purging Using a Submersible Pump
Method D apparatus include:

- Submersible-type pump.
- Discharge tubing of vinyl, polyethylene, polyvinyl chloride, or Teflon.
- Power source of generator or batteries.
- Gasoline for generator, if needed (gasoline is a DOT-regulated material; its hazard class is Flammable Liquid).

Procedure
The following procedure is supplemental to the instructions provided in the instrument-specific operating manual.

1. Set up the pump according to the operating manual.
2. Gently lower the pump down the well so that the pump head is submerged sufficiently and will not run dry.

CAUTION: Submersible pumps cannot be allowed to run dry.

3. Connect the pump outlet to an in-line flow cell; see Procedure 15, "Standard Test Method for Field Measurements of pH."
4. Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.
5. Initiate pumping and monitor and record the volumes purged and the pH, conductivity, and temperature measurements.

NOTE: Purge water may have to be contained and properly disposed of. Consult the site-specific planning documents for requirements.

6. When pH, conductivity, and temperature have stabilized for two successive well volumes, sampling can begin.
7. Remove the pump from the well, clean, and decontaminate.

Method E – Well Purging Using an Inertia Pump

Method E apparatus include:

- Foot valve.
- Tubing.
- Tubing cutters.

Procedure

1. Attach the foot valve to the end of the tubing.
2. Lower the tubing to the desired sample depth and mark where the tubing hits the top of the casing with a marker to keep track of the location.
3. Raise and lower the tubing slowly approximately 1 to 2 ft, allowing the water to ascend toward the top of the tubing.
4. Allow the water to purge out into the YSI flow cell until the parameters stabilize.
5. Place a filter on the end of the tubing and sample the location.
6. Decontaminate the tubing and the foot valve.

QA

All of the methods listed above require the following information to be logged for QA documentation.

- Depth to water
- Depth of well
- Well diameter or radius
- Depth of water
- Type of mechanism used to evacuate the well
- Date
- Well identification
- Name of person performing the purging
- Volume purged
- Conductivity, pH, and temperature measurements

Procedure 9
Standard Practice for Purging Extraction/Remediation Wells

Scope
This procedure addresses the collection of ground water samples from extraction/remediation well locations.

Significance
Analysis of the extraction/remediation well ground water is used to calculate the contaminant mass removal. Proper sampling procedures are necessary to obtain accurate analytical results.

Apparatus
- Sample labels
- YSI
- Sample jars
- Filters
- Turbidimeter
- Field data sheets
- Water level indicator

General Sample Collection Procedures
1. Obtain a water level on the extraction/remediation well to be sampled.
2. The CF1 water level ports are located in cement vaults. Use the 6-ft PVC pipe to lower the water-level indicator into the port and subtract 6 ft from the obtained water level.
3. Record total 1, total 2, and the gallons per minute from the flowmeter and record the readings on the field data sheet. Do not clear the readings.
4. Connect the flow cell to the dedicated sample-port tubing and slowly turn on the sample port nozzle until water is flowing through the tubing.
5. Record the temperature, pH, temperature, conductivity, ORP, and DO onto the field data sheet after the parameters stabilize.
6. Sample the location as described in Procedure 6.

QA
The following information about extraction/remediation well sampling shall be logged for QA documentation.
- Field data sheets
- Chain of custody
- Photographs

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Procedure 10
Standard Practice for Sampling Surface Water

Scope
This procedure addresses the collection of water samples from surface water locations.

Significance
Surface water quality is crucial to the Moab UMTRA Project. Proper sampling procedures are necessary to obtain accurate analytical results.

Apparatus
- Dedicated sample tubing
- Stainless steel weight for the end of the sample tubing
- Sample labels
- Peristaltic pump
- YSI
- Sample jars
- Filters
- Turbidimeter
- Camera
- Field data sheets

General Sample Collection Procedures
It is important to sample a surface water location before sampling any adjacent well points to avoid any cross contamination.

1. Take a photograph of the surface water sample location.
2. Place the weighted end of the sample tubing in the channel.
3. For surface water features less than 6 ft wide, the sample should be collected from approximately the middle.
4. For surface water features greater than 6 ft, collect the sample 1 to 3 ft from the shore.
5. If possible, sample the surface water location in flowing water and not a stagnant pocket or eddy.
6. Record observations on the surface water characteristics (e.g., backwater channel versus main river channel, flow velocity, whether fish are observed, if the channel is connected to the river upstream and downstream) on the field data sheet.
7. Attach the pump-head tubing to the surface water tubing and the YSI flow cell and place the pump-head tubing through the peristaltic pump.
8. Record start time on field data sheet and begin pumping.
9. Record parameters on the field data sheet after the parameters have stabilized.
10. Once step 9 is complete, it is time to sample the surface water location.
11. Label and preserve the samples according to Procedures 2, "Standard Practice for Sample Labeling," and 6, "General Considerations for the Sampling of Liquids."
12. Remove the sample tubing and place it in the appropriate location. Decontaminate the tubing if it is not dedicated to the particular sample location (see Procedure 5).

QA

The following information about surface water sampling shall be logged for QA documentation.

- Field data sheets
- Chain of custody
- Photographs

Procedure 11
Standard Practice for Sampling Well Points

Scope
This procedure addresses the collection of ground water samples from well points. The well points are located along the river bank adjacent to the IA well field.

Significance
The Moab UMTRA Project well points are Type II wells and require a specific sampling procedure.

Apparatus
- Dedicated sample tubing
- Sample labels
- Peristaltic pump
- Water-level indicator
- YSI
- Sample jars
- Filter
- Turbidimeter
- Camera
- Field data sheets
- Sharpie marker

General Sample Collection Procedures
1. The first step is to purge all of the well points before the sampling event. This will allow the removal of any stagnant water in the well points.
2. The greatest volume of water in a well point is approximately ¼-L, so if a well point purges more than this volume, it is recharging. It is helpful to keep track of which well points produce and which do not for reference while sampling. Appendix C contains a Well Point Purging Record worksheet that may be helpful in tracking well point productivity.
3. Take a photograph of the well point cluster that is scheduled to be sampled.
4. Unscrew the protective cap on the well point.
5. Using the water-level indicator, measure the total depth of the well point, the water level, and the stick up height. Record this data in the appropriate location of the Field Data Sheet.
6. Insert the dedicated sample tubing into the well point until it is in the screened portion. This may require some twisting and turning of the tubing as it is lowered.
7. Attach the pump-head tubing to the well point tubing and the YSI flow cell and place the pump-head tubing through the peristaltic pump.
8. Record the start time on the field data sheet and begin pumping.
9. The well points are Category II wells since the water level during pumping is not obtainable (due to the ¾-inch casing) and because many of the well points dewater during the purge.
10. Record parameters and turbidity on the field data sheet at every ½-L until the well point dewaters or the parameters stabilize.
11. If the well point dewaters before purging ½-L, pour the purge water into a smaller cup to obtain readings (e.g., sample jar). Make sure that the conductivity window is fully saturated.
12. Once step 10 is complete, it is time to sample the well point.

13. If the well point recharged, you may place the filter directly on the pump-head tubing and sample through the filter.
14. If the well point dewatered, it is easiest to pump the sample, unfiltered, into clean sample jars and then filter the water out of the jars into new sample jars. Label the outside of the jar with the sample location to keep track of the sample location. Be sure to use dedicated tubing when transferring the fluids.
15. It may be possible to sample a dewatering well point directly through a filter, but the filter will likely air-lock.
16. If the entire sample volume is not obtainable, it is possible to collect a limited volume to send to the laboratory. If it is not possible to collect a sample for each analyte, the priority is: (1) ammonia; (2) total dissolved solids; (3) metals.
17. Label and preserve the samples according to Procedures 3 and 16, "Standard Test Method for the Field Measurement of Temperature."
18. Remove the well tubing from the well point and place it back in the appropriate location.
19. Replace the cap on the well point.

QA

The following information about the well point sampling shall be logged for QA documentation:

- Field data sheets
- Photographs of sample locations
- Chain of custody

Procedure 12
Standard Test Method for the Field Measurement of Specific Conductance

Introduction

Specific conductance is a widely used indicator of water quality. It measures the ability of water to carry an electrical current under specific conditions. This ability depends on the presence of ions and their total concentration, mobility, and temperature. Specific conductance is a simple indicator of change within a system and is used as an aid in evaluating whether a sample is representative of the water in the system.

Scope

This procedure describes the field measurement of the specific conductance of an aqueous sample. The specific conductance is measured using a conductance meter and a platinum or stainless steel electrode.

Significance and Use

The specific conductance or conductivity of a sample is defined as the conductance of the sample between opposite sides of a cube, 1 centimeter (cm) in each direction. Because it is impractical to build electrodes with these characteristics, electrodes are manufactured in various forms. A cell constant is determined by measuring a solution of known conductivity. Solutions of known conductivity are purchased or can be made from reagent-grade potassium chloride. Samplers shall consult operating instructions for the specific instrument used for the determination of the cell constant. This conductivity is expressed in micromhos per centimeter (µmhos/cm).

Interferences

Temperature, ionic strength, and the determination of the cell constant are features that affect the measurement of conductivity.

The conductivity of a solution increases with temperature at approximately 2 percent per degree centigrade (ºC). Significant errors can result from inaccurate temperature measurements. If the conductivity meter does not have automatic temperature correction, the sampler can use the following formula to correct the conductivity reading for temperature:

$$K = \frac{Em}{1 + 0.0191(t - 25)}$$

Where:

K	=	corrected conductivity in µmhos/cm
Em	=	measured conductivity in µmhos/cm
t	=	temperature in ºC

The conductivity of a solution is a function of the concentration and charge of the ions in solution and of the rate at which the ions move under the influence of an electrical potential. As the ionic strength increases, the rate at which the individual ions move decreases. Conductivity varies linearly with ionic strength for values below 1,000 µmhos/cm. As conductivity increases above 5,000 µmhos/cm, the line curves significantly; beyond 50,000 µmhos/cm, the conductivity is an unsatisfactory index of ionic concentration.

Apparatus

- Specific conductance meter
- Conductivity check solutions (Normally, a 10,000 microsiemens per centimeter [µS/cm] solution will cover the range of expected sample conductivity
- Distilled or deionized water in a squeeze bottle
- Kimwipes or equivalent lint-free tissue

Calibration

1. Calibrate the conductivity probe according to manufacturer's specifications.
2. Rinse the temperature probe and conductivity cell with distilled water and blot dry with a lint-free tissue.
3. Place the temperature probe and conductivity cell in the 10,000 µS/cm standard and allow the readings to stabilize. Record the temperature and conductivity reading in the field data sheet book.
4. If the reading is within ±10 percent of the accepted value, the cell/instrument calibration check is acceptable.
5. If the cell/instrument calibration check is unacceptable, consult the instrument operation manual for cell cleaning and instrument trouble-shooting procedures.

Procedure

These calibration procedures are as listed in the YSI instrument handbook. If the YSI is not being used to record conductivity, please follow the manufacturer's calibration instructions.

1. When filling the calibration vessel before performing the calibration procedure, make certain that the level of the calibration standard is high enough in the calibration cup to cover the entire conductivity window.
2. After placing the sonde in the calibration solution, agitate the sonde to remove any air bubbles.
3. Allow the temperature sensor to stabilize.
4. Calibrate the sonde to 10,000 µS/cm.

QA

The following information about the field measurement of specific conductance shall be logged for QA documentation:

- Source and expiration date of standards
- Instrument manufacturer and model number
- Date and time of calibration check
- Temperature and conductivity of standards used to check calibration
- Sample temperature and conductivity reading
- Name of person performing the measurement

Procedure 13
Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential for Calculation of Eh

Introduction

Knowledge of the Eh of a system is useful for predicting the migration or attenuation of contaminants in ground water or surface water. However, the ORP measurement should be used with caution. Only under certain conditions are ORP measurements, from which the Eh is calculated, reliable. Therefore, the resulting Eh value is primarily used as a descriptive tool.

Scope

This method describes the procedure for the measurement of ORP in aqueous samples and calculation of Eh. It does not address the theoretical interpretation of ORP. This procedure has been designed for routine field measurements.

Significance and Use

ORP is defined as the electromotive force developed when a noble metal electrode and a reference electrode are placed in an aqueous sample. This potential, sometimes referred to as the redox potential, is related to the standard potential by the Nernst equation:

$$Eh = E^{\circ} + \frac{RT}{nF} \ln \frac{\text{oxidized state}}{\text{reduced state}}$$

Where:

E^{o}	=	standard potential of the reaction
R	=	gas constant
T	=	absolute temperature
n	=	number of electrons involved in the half-cell reaction
F	=	Faraday constant

The potential is reported as volts or millivolts (mV) relative to the standard hydrogen electrode taken as zero.

Interferences

ORP measurements are sensitive to temperature change of the solution. Because the reference-electrode potential and the liquid-junction potential also vary with temperature, instrumental compensation is not possible. Reference solutions used to check the accuracy of the electrode system should be within ±10 °C of the sample temperature for the readings to be valid.

Reproducible ORP measurements cannot be obtained for chemical systems that are not reversible. Samples containing dissolved oxygen above $^{1}/_{100}$ parts per million (ppm) are essentially irreversible, and ORP measurements of these samples are not recommended. Because exposure to the atmosphere can cause rapid changes in DO, all sample measurements shall be taken in a closed, flow-through container or in situ.

Samples containing hydrogen sulfide will poison the electrode as will other ions that are stronger reducing agents than platinum.

ORP measurements are relatively free from interferences from color, turbidity, colloidal matter, and suspended matter.

Apparatus

- Field pH meter capable of measuring ORP to ±1 mV (Most field pH meters have the capability of measuring ORP by substitution of an appropriate set of electrodes.)
- Combination ORP (Eh) electrode
- ZoBell reference solution

Caution: This solution is poisonous and must be handled with care.

- Temperature-measuring device capable of reading temperatures to ±0.1 °C
- Distilled or deionized water in a squeeze wash bottle
- Kimwipes or equivalent lint-free tissue

Calibration

The ORP probe should be calibrated according to the manufacturer's procedure. The following calibration procedure is an excerpt from the YSI Environmental Monitoring Systems Manual.

1. To determine whether the ORP sensor is properly functioning, place the probe in Zobell solution. If the probe is working correctly, the readings should be in the range of 221 to 241 mV. If it is reading outside of the range, the probe should be recalibrated according to the temperature chart shown in Table A-7, and a new Zobell Solution standard should be prepared.
2. After the probe is checked and recalibrated as necessary, rinse the probe with deionized water and blot dry with a lint-free tissue.

Table A-7. ORP Values with Corresponding Zobell Solution Temperature

Temperature (Celsius)	Zobell Solution Value (mV)
-5	270.0
0	263.5
5	257.0
10	250.5
15	244.0
20	237.5
25	231.0
30	218.0
35	218.0
40	211.5
45	205.0
50	198.5

QA
The following information about the ORP measurement shall be logged for QA documentation.

- Temperature of sample
- Temperature of ZoBell solution
- ORP of ZoBell solution
- Name of person performing the measurement

Calculation
The Eh of the sample is calculated relative to the standard hydrogen electrode as follows:

$$D = A - B + C$$

Where:

D	=	Eh of sample relative to the standard hydrogen electrode (report to nearest ±10 mV)
A	=	Observed ORP of sample
B	=	Observed ORP of ZoBell solution
C	=	Theoretical Eh of ZoBell solution relative to the standard hydrogen electrode (Figure A-4)

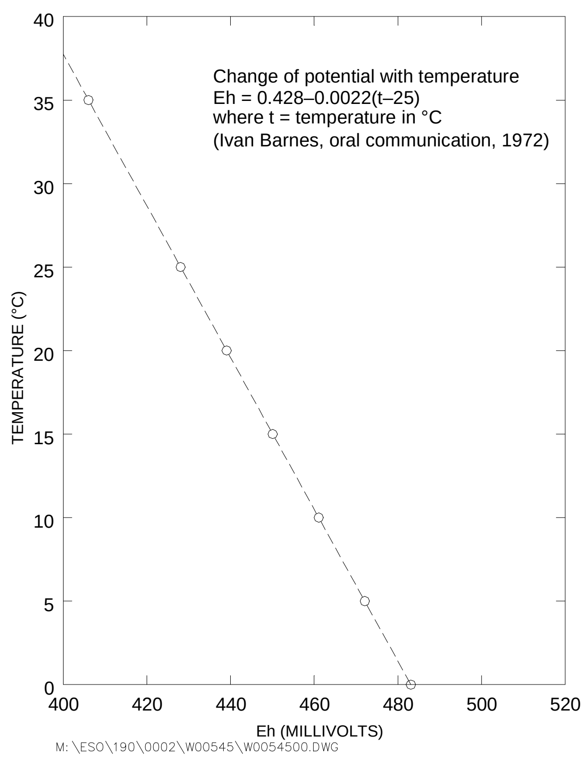

Figure A-4. The Eh of ZoBell Solution, Relative to the Standard Hydrogen Electrode at Various Temperatures

Precision and Bias
Precision and accuracy of the measurement depend largely on the condition of the electrode system and the degree to which the sample fits the interference problems previously mentioned in the section on calibration. In the absence of substances that coat or poison the electrode, the precision is ±10 mV.

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Procedure 14
Standard Test Method for the Field Measurement of Dissolved Oxygen

Introduction
DO is required for the survival and growth of many aquatic organisms, and the absence of DO may permit anaerobic decay of organic matter and the production of toxic and esthetically undesirable materials in the water. The measurement of DO is needed to accurately characterize the ORP of a hydrologic system and can be an indicator of atmospheric contact of water.

Scope
This method contains the field procedures used to determine DO in aqueous samples using a polarographic technique with a membrane-covered electrode. The probe method is much more rapid and efficient than other methods, has fewer interferences, and can be used for continuous monitoring.

Significance and Use
Oxygen-sensitive membrane electrodes are composed of two solid metal electrodes separated from the sample by an oxygen-permeable membrane. The membrane serves as a diffusion barrier against impurities. The rate of oxygen diffusion across the membrane creates a current that is directly proportional to the amount of DO in the sample. This current is converted to concentration units during the calibration.

Interferences
Membrane electrodes are sensitive to temperature variations. Most DO meters have automatic temperature compensators that correct for these variations.

Oxygen-permeable membranes are also permeable to other gases that can affect the measurement. Chlorine and hydrogen sulfide will eventually desensitize the probe during long-term exposures. These gases are not normally found in ground water samples or their concentrations are too small to cause significant problems.

Because atmospheric oxygen is rapidly absorbed by water samples, use of an air-exclusion chamber is required if in situ measurements cannot be made.

Apparatus
- YSI DO probe
- Bottle of electrolyte and extra membranes for probe
- Distilled or deionized water in a squeeze wash bottle
- Kimwipes or equivalent lint-free tissue

Calibration
The following steps describe the calibration of the YSI Model 600XLM.
1. Place approximately 3 mm of water in the bottom of the calibration cup
2. Place the probe end in the calibration cup, making sure that the DO probe is not immersed in the water
3. Screw the calibration cup onto the sonde only part way

4. From the calibrate menu, select DO, then milligrams per liter (mg/L), then press enter. The Moab UMTRA Project YSI Instruments (600XLM) have a barometric pressure gauge, so it does not have to be entered. Tables A-8 and A-9 indicate how temperature, pressure, and altitude affect DO concentrations.

Table A-8. DO Saturation Values at Various Temperatures

Temp. (°C)	Sat. Value (ppm)	Temp. (°C)	Sat. Value (ppm)	Temp. (°C)	Sat. Value (ppm)	Temp. (°C)	Sat. Value (ppm)
0	14.6	12	10.8	24	8.5	36	7.0
1	14.2	13	10.6	25	8.6	37	6.8
2	13.9	14	10.4	26	8.2	38	6.7
3	13.5	15	10.2	27	8.1	39	6.6
4	13.2	16	9.9	28	7.9	40	6.5
5	12.8	17	9.7	29	7.8	41	6.4
6	12.5	18	9.5	30	7.7	42	6.3
7	12.2	19	9.3	31	7.5	43	6.2
8	11.9	20	9.2	32	7.4	44	6.1
9	11.6	21	9.0	33	7.3	45	6.0
10	11.3	22	8.8	34	7.2		
11	11.1	23	8.7	35	7.1		

Sat. = saturation; Temp. = temperature

Table A-9. Correction Factors for DO Saturation Values as Determined by Pressure or Altitude

Pressure (mm)	Altitude (ft above msl)	Correction Factor
684	2,864	0.90
669	3,466	0.88
654	4,082	0.86
638	4,756	0.84
623	5,403	0.82
608	6,065	0.80
593	6,744	0.78
578	7,440	0.76
562	8,204	0.74
547	8,939	0.72
532	9,694	0.70
517	10,472	0.68
502	11,272	0.66

msl = mean sea level

Precision and Bias

Under normal conditions, precision and accuracy of ±½ mg/L can be expected from this procedure.

Procedure 15
Standard Test Method for the Field Measurement of pH

Introduction

Perhaps no water quality parameter is measured as frequently as pH. The pH measurement is so easily made that the attention given to it is often inadequate. An accurate pH is critical for the prediction and interpretation of the reactions and migration of dissolved species. This procedure provides a useful pH measurement under most field situations.

Scope

This is the procedure for the measurement of pH in an aqueous solution. The pH is determined using a glass hydrogen-ion electrode compared to a reference electrode of known potential by means of a pH meter.

Significance and Use

The pH of a solution is defined as the negative logarithm to the base 10 of the hydrogen-ion activity in moles per liter: $pH = -\log [H^+]$. Because pH is exponentially related to concentration, great care shall be taken in making the measurement.

Natural waters usually have pH values in the range of 4 to 9. The primary control over pH in natural waters is the carbonate system, including gaseous and dissolved carbon dioxide, bicarbonate, and carbonate ions.

Interferences

Temperature, atmospheric contamination, and ionic strength are factors that affect pH measurements. The pH measurement is relatively free from interference from color, turbidity, colloidal matter, oxidants, or reductants.

The temperature compensation on a pH meter only permits adjustment of the electrode slope. It does not compensate for changes in the potential of the reference electrode, the asymmetry potential of the glass electrode, or the liquid-junction potential. Nor does it compensate for changes in pH due to temperature. Thus, the temperature of the buffer and the unknown shall be recorded at the time of measurement. Ideally, their temperatures shall be within ±10°C.

Atmospheric contamination can be a significant problem for ground water samples. DO and carbon dioxide can be evolved or dissolved when the sample is exposed to air, and a considerable change in pH may result. In situ measurements should be taken where possible, but for ground water that must be pumped, the use of a flow cell gives the best results (see Procedure 18).

Because of errors due to ionic strength (which are not worth correcting in the field), pH measurements shall be accompanied by a measurement of the specific conductance. The pH is a measurement of the hydrogen-ion activity. An ideal solution is assumed in which other ions do not affect the hydrogen activity. This assumption deteriorates if the ionic strength is too high. Similarly, samples with low ionic strength will cause difficulties because the resistance of the sample approaches that of the glass electrode. For best results, samples with very low ionic strength should be stirred for a few seconds before the reading. Even then, it may require several minutes for the reading to stabilize.

High sodium and alkalinity may also produce errors in the pH measurement. For pH 9 and a sodium concentration of 10 moles per L, a special electrode is needed. Similarly, any pH value that is less than 1 or greater than 9 will have a greater uncertainty associated with it because the electrode response is non-Nernstian in these regions.

Apparatus

- pH meter with a temperature-compensating device, slope adjustment, and capable of reading pH to $\pm^{1}/_{100}$ units
- A flow cell for continuous-flow measurements
- Standard pH-buffer solutions of 4, 7, or 10
- Combination pH electrode
- Temperature-measuring device capable of reading temperatures to $\pm^{1}/_{10}$ °C
- Distilled or deionized water in a squeeze wash bottle
- Kimwipes or equivalent lint-free tissue

Procedure

These calibration procedures are as listed in the YSI instrument handbook. If the YSI is not being used to record conductivity, please follow the manufacturer's calibration instructions.

1. Fill the calibration cup with the pH calibration solution so that the pH probe is covered. Use the following procedures for pH 4, 7, and 10 when calibrating. Start with pH 7.
2. Rinse the sensors with deinoized water and blot dry between changes of calibration buffer solutions.
3. During pH calibration, allow the sensors time to stabilize with regard to temperature before proceeding with the calibration protocol.
4. Recalibrate the pH values if necessary. Use the temperature/pH plot for the appropriate calibration values.

QA

The following information about the field measurement of pH shall be logged for QA documentation.

- Time of the last two-buffer calibration
- The two-buffer calibration shall be performed a minimum of once each hour
- Buffer temperature at time of calibration
- Sample temperature at time of measurement
- Measurement conditions (i.e., in situ, open container, or air-exclusion container)
- Source and expiration date of buffers used
- Instrument manufacturer and model number
- Name of person performing the measurement

Procedure 16
Standard Test Method for the Field Measurement of Temperature

Introduction
Temperature readings are important for numerous applications. They are used in the measurement of Eh, pH, conductivity, and DO and in saturation and stability studies. It is important to know the temperature of surface waters and ground waters for the accurate geochemical evaluation of equilibrium thermodynamics. Temperature readings of ±1°C are necessary for the above applications.

Scope
This procedure gives general guidance and recommendations that shall be considered when taking a temperature measurement. There are numerous instruments on the market that can provide adequate temperature measurements. Each instrument operating manual shall be consulted for detailed procedures.

Significance and Use
Temperature is a basic physical property that is measured by the response of matter to heat. There are many devices that, once calibrated, are acceptable for taking temperature measurements. These devices include liquid in glass (mercury in glass), thermocouples, bimetallic, and electrical-resistance thermometers. At a minimum, the device should measure temperature to $\pm^{1}/_{10}$°C readability.

Interferences
The instrument operating manual shall be consulted to identify any interferences particular to the device being used. In general, the true sample temperature is affected by the atmospheric temperature of the surroundings and the temperature of the devices used to collect the sample.

Apparatus
- Temperature-measuring device
- Distilled or deionized water in a squeeze wash bottle
- Kimwipes or equivalent lint-free tissue

Procedure
1. Rinse the thermometer with distilled or deionized water and blot dry.
2. Immerse the thermometer in the sample.
3. Allow the reading to stabilize and record the temperature.

QA
The following information about the temperature measurement shall be logged for QA documentation.
- Instrument used
- Temperature of sample
- Name of person performing the measurement

Precision and Bias
Precision is instrument dependent. Most measurement devices for field use are accurate to $\pm^{1}/_{10}$°C.

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Procedure 17
Standard Test Method for Turbidity of Water

Summary of ASTM D6698-07, Standard Test Method for On-Line Measurement of Turbidity Below 5 NTUs
This test method describes the measurement of turbidity in water and wastewater discharges.

Additions Applicable to the Operating Contractor and Its Subcontractors
This addendum addresses specific procedures, equipment, and documentation requirements when using the HACH model 2100P portable turbidimeter to measure turbidity of ground water.

The following sections shall be interpreted in conjunction with the current published version of this ASTM procedure. These sections shall be interpreted in numerical order, using the published version as the base document for reference.

Scope
Turbidities up to 1,000 NTUs can be accurately measured using the HACH model 2100P portable turbidimeter.

Turbidities greater than 1,000 NTUs may be measured using the HACH model 2100P portable turbidimeter by serial dilution to below 1,000 NTUs.

Significance and Use
Turbidity measurements are used as indicators of the effectiveness of well development activities. Turbidity measurements also are used to determine when purging of a monitoring well is complete and ground water sampling can commence.

Interferences
Periodically apply a thin layer of silicone oil to the sample cell to mask minor imperfections and scratches in the glass.

Apparatus
- Portable turbidimeter
- HACH model 2100P portable turbidimeter
- Glass sample cells
- Silicone oil
- AEPABI styrene/divynlbenzene polymer primary standard or Formazin primary calibration solution
- Gelex secondary turbidity standards
- Batteries
- Log book
- Kimwipes or equivalent lint-free tissue

Calibration Procedure
Please refer to the 2100Q User Manul in Attachment 1.

QA

Documentation for QA purposes when making turbidity measurements includes the following information.

- Date and time of the primary calibration
- Manufacturer, expiration date, and NTUs of the primary calibration standards
- Values assigned to the Gelex secondary standards after the primary calibration
- Measurements of the Gelex standards before making the turbidity measurement
- Date and time of the turbidity measurement
- Measured sample turbidity
- Instrument manufacturer, model, and serial number of the turbidimeter
- Name of person performing the measurement

Procedure 18
Standard Practice for the Use of a Flow Cell for Field Measurements

Introduction
Reliable field measurements are an essential part of a ground water sampling program. Some properties or constituents in ground water may change considerably within a few minutes of collection. These changes are caused by turbulence, heating or cooling, depressurization, and gas exchange with the atmosphere. Use of a closed flow-through cell will minimize these changes.

Scope
This procedure describes the use of a closed flow-through cell for monitoring selected chemical parameters in ground water. The cell is used when monitoring the purging of stagnant water from monitor wells before sample collection and for the measurement of pH, ORP, conductivity, temperature, and DO under conditions as close to in situ as practical.

Significance and Use
Flow cells allow the sampler to obtain test results that are more representative of conditions present in the water when it resided in the ground. That is, fewer chemical and physical changes occur if the test is made immediately through a flow cell than if the water is exposed to air and to a longer period of time before measurements are made.

Apparatus
- Flow-through cell
- Stoppers, fittings, valves, and tubing, as required
- YSI sonde

Procedure
1. Connect the pump outlet to the inlet of the flow cell.
2. Insert the calibrated electrodes into the flow cell and connect tubing to the outlet of the flow cell.
3. Recheck electrode calibration as necessary.
4. Turn off the pump and disconnect the tubing.

Procedure Bias
The flow rate through the cell shall not be more than 1 liter per minute (L/m). If flow rates exceed 1 L/m, streaming potentials could occur. Streaming potentials are caused by the static charge effect of water moving through small openings. These potentials can cause erroneous pH readings. If necessary, reduce the flow rate or stop pumping to take readings.

The cell assembly, electrodes, and hoses should be insulated or kept out of direct sunlight when possible to reduce the effect of temperature changes on the readings.

QA
The use of a closed flow-through cell should be noted on the sample documentation form or in the field log book.

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Procedure 19
Standard Test Method for the Field Measurement of Alkalinity

Scope
This method describes the procedure for the measurement of alkalinity in an aqueous solution.

Significance and Use
Alkalinity is used to measure the amount of bicarbonate and carbonate concentration and the ability to resist acidification in ground and surface water.

Apparatus
- Digital titrator
- Sulfuric acid cartridges
- Delivery tube
- Graduated cylinder
- Erlenmeyer flask
- Bromcresol green methyl red indicator powder pillows
- Filters
- Deionized water

Calibration
1. Slide the sulfuric acid cartridge into place in the digital titrator and turn it to lock into place.
2. Remove the cap on the cartridge and insert the delivery tube into the open end.
3. Turn the knob until fluid goes into the delivery tube and then zero the counter.
4. Collect 100 milliliters (mL) of filtered water in the graduated cylinder.
5. Use 50 mL of water to clean out the Erlenmeyer flask and then dump that water out into the purge cup.
6. Pour the other 50 mL of sample water into the Erlenmeyer flask.
7. Empty a packet of bromcresol green methyl red indicator into the flask; the solution will turn green.
8. Begin titrating the sulfuric acid into the Erlenmeyer flask until the solution turns light pink.
9. The number on the titrator, doubled, is the mg/L of calcium carbonate.
10. Record the concentration on the field data sheet.
11. Dump the water into the purge cup.
12. Rinse the graduated cylinder and Erlenmeyer flask with de-ionized water.

QA
The following information about the alkalinity measurement shall be logged for QA documentation.
- Time and date of analysis
- Concentration of alkalinity in ppm of calcium carbonate

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Procedure 20
Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples

Scope

This procedure addresses the collection, filtration, and preservation of liquid samples, including general collection procedures, collection of organics, sample filtration, and guidelines for sample preservation. Table A-10 summarizes the generally accepted bottle types, volume requirements, preservatives, and holding times for most analytes.

Improper filtration, preservation, or residence time before analysis may compromise sample integrity.

Many factors should be considered during the sample collection phase: bottle type, bottle size, preservation, sample filtration, holding time, and order of sample collection.

Terminology

***Meniscus* –** The curved, upper surface of a liquid in a container.

***Material Safety Data Sheet (MSDS)* –** Printed material that provides descriptions of the properties, hazards, and health and safety considerations of a chemical or material; emergency measures in case of an accident; and instructions on the safe handling of the chemical or material.

***Organic* –** A compound that contains carbon.

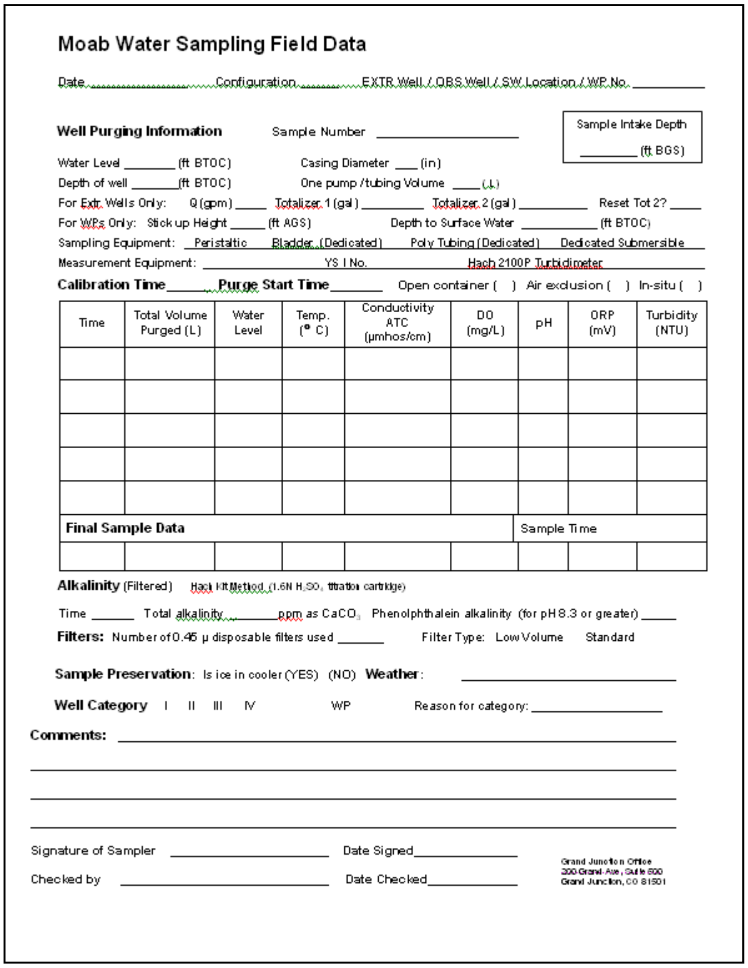
***Volatile* –** A compound that readily evaporates at normal temperatures and pressures.

Significance and Use

The procedures listed here are general guidelines. Site-specific requirements vary, and no single procedure will fit all situations. In many cases, the judgment of a well-trained, experienced team leader is required to make the necessary decisions in the field to obtain the best sample possible and meet all requirements.

Apparatus

- Sample bottles
- Sample labels
- Sampling field data sheets (Figure A-5)
- Preservative solutions as required by the planning documents
- Coolers and ice for cooling collected samples
- In-line filter holders and filter sheets of 0.45-micrometer (µm) pore size or in-line disposable 0.45-µm pore size filters
- Pump and tubing
- Distilled water and lint-free tissue



Moab Water Sampling Field Data

Date ________ Configuration ________ EXTR Well / OBS Well / SW Location / WP No. ________

Well Purging Information Sample Number ________

Sample Intake Depth ________ (ft BGS)

Water Level ________ (ft BTOC) Casing Diameter ____ (in)

Depth of well ________(ft BTOC) One pump /tubing Volume ____ (L)

For Extr. Wells Only: Q (gpm) _____ Totalizer 1 (gal) ________ Totalizer 2 (gal) ________ Reset Tot 2? _____

For WPs Only: Stick up Height _____ (ft AGS) Depth to Surface Water ________ (ft BTOC)

Sampling Equipment: Peristaltic Bladder (Dedicated) Poly Tubing (Dedicated) Dedicated Submersible

Measurement Equipment: YS I No. Hach 2100P Turbidimeter

Calibration Time______ **Purge Start Time**______ Open container ( ) Air exclusion ( ) In-situ ( )

Time	Total Volume Purged (L)	Water Level	Temp. (° C)	Conductivity ATC (μmhos/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
Final Sample Data						Sample Time		

Alkalinity (Filtered) Hach Kit Method (1.6N H_2SO_4 titration cartridge)

Time ______ Total alkalinity ______ ppm as $CaCO_3$ Phenolphthalein alkalinity (for pH 8.3 or greater) ______

Filters: Number of 0.45 μ disposable filters used ______ Filter Type: Low Volume Standard

Sample Preservation: Is ice in cooler (YES) (NO) **Weather**: ________

Well Category I II III IV WP Reason for category: ________

Comments: ________

Signature of Sampler ________ Date Signed ________

Checked by ________ Date Checked ________

Grand Junction Office
2000 Grand Ave, Suite 500
Grand Junction, CO 81501

Figure A-5. Example of a Water Sampling Field Data Sheet

General Sample Collection Procedures

1. Collect all samples as close to the source as possible.
2. Choose the appropriate bottles for the analytes needed (see Table A-10). Visually inspect the bottles for cleanliness, breaks, and missing parts before sampling. Sample bottles should be pre-cleaned to guidelines established by the EPA in reference 3.2.
3. Label the bottles as required by the planning documents or Procedure 2, "Standard Practice for Sample Labeling."
4. Preservatives may be added at this time, or they may be added after sample collection.
5. Collect the samples by allowing the liquid to flow gently down the side of the bottle with minimal turbulence. Collect unfiltered samples before filtered samples.
6. Collect unfiltered samples in the following order:
   - Volatile organics and total organic halides
   - Dissolved gases and total organic carbon
   - Large-volume samples for organic compounds
   - Sensitive inorganics, such as nitrogen dioxide, ammonium, and ferrous oxide
   - Total metals

7. Collect filtered samples in the following order:
   - Alkalines
   - Trace metals
   - Major cations/anions
   - Radionuclides
8. Add preservative as required, if not pre-preserved.
9. Cap the bottle securely.
10. Store as required. Some samples may require storing at 4°C immediately after collection. Use a cooler with ice for storing these samples.
11. Complete the water sampling field data sheet as shown.

Table A-10. Guidelines for Preservation of Samples

Analytical Parameter	Container Type/Size[a]	Preservation	Holding Time
Inorganic Anions			
Chloride (Cl), sulfate (SO_4), fluoride (F), bromide (Br), and orthophosphate	P/125 mL	Filtered 0.45 µm, cool to 4°C	Cl, SO_4, F, Br 28 days; Orthophosphate 48 hours
Nitrate (NO_3), Nitrite (NO_2)	P/125 mL	Filtered 0.45 µm, cool to 4°C	48 hours
Nitrate (NO_3 and NO_2 as N)	P/125 mL	Filtered 0.45 µm, Sulfuric acid pH <2	28 days
Ammonia, NO_3, NO_2	P/125 mL	Filtered 0.45 µm, Sulfuric acid pH <2	28 days
Ammonia	P/125 mL	Filter, cool, Sulfuric acid pH <2	28 days
Inorganic Cations			
Dissolved metals	P/125 mL	Filtered 0.45 µm, Nitric acid pH <2	6 months (except mercury is 28 days)
Total metals	P/125 mL	Nitric acid pH <2	6 months
Radioisotopes			
Uranium-234/uranium-238	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Thorium-230	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Polonium-210	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Lead-210	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Radium-226	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Radium-228	P/1 L, 3 each	Filtered 0.45 µm, Nitric acid pH <2	6 months
Gross alpha/beta	P/1 L	Filtered 0.45 µm, Nitric acid pH <2	6 months
Radon	G/40 mL with Teflon-lined septa, 3 each	Cool to 4°C	Not established; analyze ASAP

Table A-10. Guidelines for Preservation of Samples (continued)

Analytical Parameter	Container Type/Size[a]	Preservation	Holding Time
Organics			
Volatile organics	GA/40 mL with Teflon-lined septa, 3 each	Cool to 4°C, hydrochloric acid pH <2	14 days
Semivolatile organics	GA/2.5 L with Teflon-lined cap	Cool to 4°C	7 days extraction, 40 days analysis
Polychlorinated biphenyls and pesticides	GA/1 L with Teflon-lined cap	Cool to 4°C	7 days extraction, 40 days analysis
Total organic carbon	GA/125 mL	Sulfuric acid pH <2, cool to 4°C	28 days
Phenols	GA/1 L	Sulfuric acid pH <2, cool to 4°C	28 days
Oil and grease	GA/1 L	Sulfuric acid pH <2, cool to 4°C	28 days
Other			
Biochemical oxygen demand	GA/1 L	Cool to 4°C	48 hours
Chemical oxygen demand	GA/1 L	Cool to 4°C, Sulfuric acid pH <2	28 days
Total dissolved solids	P/125 mL	Cool to 4°C	7 days
Cyanide	P/1 L	Sodium hydroxide pH >12, cool to 4°C	14 days
Sulfide	P/1 L	2 mL zinc acetate, Sodium hydroxide pH >9, cool to 4°C	7 days

[a]P = polyethylene; G = glass; A = amber; L = lit

Note: Amber container is not required for metals unless photosensitive metals (e.g., silver) are being analyzed.

Nonvolatile Organics Sampling Procedure

1. Add preservatives to the bottle, if required.
2. Collect samples for nonvolatile organics by slowly filling the bottle, allowing the liquid to flow gently down the side of the bottle with minimal turbulence. Do not filter samples to be analyzed for organics.
3. Cap the bottle securely.
4. Store as required. Most organic samples require storage at 4°C.

Volatile Organics Sampling Procedure

1. Take special care when collecting a volatile organic sample to reduce the possibility of losing the volatile constituents. Volatile organics are collected in a 40-mL glass vial that has a Teflon-lined, silicone-septum cap.
2. Label the vial.
3. Add preservative (if required).
4. Slowly fill the vial to overflowing.

5. Hold the vial level or carefully set it on a level surface.
6. Place the cap with septum, Teflon-side down on the convex water meniscus and seal by screwing the cap to the bottle.
7. Check for air bubbles by inverting the vial and lightly tapping. There can be no air bubbles entrapped in the sample. If bubbles are present, uncap the vial, empty the contents, and repeat Steps 3 through 7.

Sample Filtration Procedure
1. Collect samples requiring filtration after unfiltered samples. If a pump is used, connect an in-line membrane filter directly to the pump outlet to filter the sample. If a bailer is used, connect the filter to the portable pump and pump the sample from the bailer or a clean sample bottle.
2. Start the pump and discard the first 100 mL of sample to flush the filter.
3. Place the sample bottle directly under the filter outlet and fill to the desired volume.
4. Preserve the sample (if not pre-preserved), as required.
5. Stop the pump and disconnect the filter.
6. Discard the used filter after each sample. If a filter holder is used, clean all surfaces of the filter holder with distilled water and wipe dry with a lint-free tissue.
7. If a filter holder is used, place a new filter in the holder and reassemble.

Sample Preservation Guidelines
Samples are preserved by a variety of means to stabilize specific parameters so that the samples can be shipped to a laboratory for analysis. Preservatives are intended to retard biological effects, retard hydrolysis, reduce sorption effects, and reduce volatility of constituents. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light. The following guidelines shall be considered during sample preservation:

- Preservation of samples uses a variety of strong acids and bases; care shall be taken in their storage and use.
- Preserve samples before or as soon after collection as possible.
- Take care not to cross-contaminate samples with preservatives. As of late 2009, the only regular samples that have to be preserved include ammonia and metals. The ammonia 125-mL jars require approximately 13 drops of sulfuric acid, and the metals 125-mL jars require ½-mL of nitric acid. Follow all MSDS and IWP safety precautions when using these acids.
- Place samples requiring cooling to 4°C in an ice chest with ice immediately after collection.
- Consult Table 1 or the planning documents for recommended sample preservation techniques for each parameter. Generally, the laboratory performing the analysis will determine the bottle type, volume, and preservative to be used for a particular sampling event.

QA
In the water sampling field data sheet (Figure A-5), record the following information about the sample collection, filtration, and preservation for QA documentation:
- The number and type of filter used for filtration
- The bottle size, bottle type, and number of samples collected
- The type of sample filtration, if any
- The preservative used
- The name of the person performing the sampling
- Bottles, collection, filtration, liquid samples, organics, and preservation

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Procedure 21
Standard Practice for the Inspection and Maintenance of Ground Water Monitoring Wells

Introduction

Ground water monitoring wells are commonly used for obtaining ground water samples, ground water elevation measurements, and aquifer hydraulic parameters. Because of natural processes and human activities, the condition of ground water monitoring wells may deteriorate with time. If the deterioration of a particular monitoring well is not documented and corrected, decisions based on data collected from that well may be adversely affected. This procedure provides a standard practice for maintaining a record of the condition of a well and remediating wells that have deteriorated.

Scope

This procedure describes the standard practice for conducting routine inspections of ground water monitoring wells. The procedure also provides criteria to use in determining if and when a monitoring well should receive corrective maintenance. Corrective maintenance activities are based on the results of the routine inspections. This procedure describes the standard practices for conducting well maintenance. Well maintenance includes correcting deficiencies in the surface components of the well and redeveloping the well.

This procedure shall be applied only to ground water remediation and monitoring wells. Because of the limitations associated with the redevelopment methods described in this procedure, the redevelopment section is not applicable to wells exceeding 6 inches in diameter. This procedure shall not be applied to multiport, single-string monitoring wells.

This procedure shall be executed by a designated well maintenance technician on all monitoring wells under the control of contractor personnel. At the discretion of the Ground Water Manager and appropriate regulatory agencies, inactive monitoring wells may be excluded from redevelopment activities. At the discretion of the Ground Water Manager, the procedure may be implemented in conjunction with routine ground water sampling and data collection activities. In such a case, the inspection portion of the procedure shall be conducted before ground water sampling and other data collection activities. All well maintenance activities shall be conducted after ground water sampling activities to eliminate the potential for contaminating samples or altering the chemistry of ground water samples.

Significance and Use

Application of this practice will prevent most forms of degradation in monitoring wells. Application of this procedure will prevent the undetected contamination of monitoring wells by infiltrating surface water and ensure a long service life for monitoring well installations.

This procedure shall be used to maintain an ongoing permanent record that documents the condition of ground water monitoring wells, to identify when monitoring wells require maintenance, and to specify the procedures that shall be used to conduct monitoring well maintenance.

Each time the inspection portion of the procedure is executed, the Water Levels and Well Maintenance Data Sheet (Figure A-6), or a project-specific well maintenance checklist form shall be completed and filed in the project records. The project manager shall be notified in writing of any well maintenance discrepancies. If the procedure is executed by a sampling team, the inspection portion of the procedure shall be performed before sampling a well. Any required maintenance activities shall be performed after sampling a well. This procedure shall not be applied to water-supply wells. Application of this procedure shall be limited to monitoring wells 6 inches in diameter or less.

Apparatus

- Well location map
- Water Levels and Well Maintenance Data Sheet (Figure A-6)

WATER LEVELS and WELL MAINTENANCE DATA SHEET

Site: ____________________ Date: ____________ Measuring Device: ____________________

	Subsurface Inspection			Surface Components Inspection*							
Well	Time	Depth to Water (ft.)	Total Depth (ft.)	Well Label	Guard-posts	Lock	Conc. Pad	Protective Casing	Riser Cap	Initials	Comments

*Surface Components Inspection: S - Satisfactory D - Deficient (comment to describe problem)

Figure A-6. Well Maintenance Checklist

- Electric water level sounder
- Interface probe (optional)
- Measuring tape with engineering scale (required if graduations on water-level sounder or interface probe are greater than $^1/_{100}$ of a foot)
- Distilled or deionized water in a squeeze wash bottle or pump spray canister
- Alconox or equivalent
- Kimwipe or equivalent lint-free tissue
- Compressed-nitrogen tank (required when using compressed nitrogen)
- Compressed-gas regulator (required when using compressed nitrogen)
- Nitrogen-jetting well-head apparatus (required when using compressed nitrogen)
- Flexible compressed-gas transmission hose (required when using compressed nitrogen)
- Threaded PVC pipe (required when using compressed nitrogen)
- Jetting-T (required when using compressed nitrogen)
- Submersible pump (optional)
- Suction-lift pump (optional)
- Surge block (optional)

- PVC hose (optional)
- Foot valve (optional)
- High-visibility spray paint
- Black permanent marking pen
- Black ink pen
- Personnel protective equipment/clothing (e.g., safety glasses, steel-toed safety shoes, hard hats, gloves, monitoring equipment) may be required based on site conditions and as specified in the Ground Water and Biota Sampling IWP.

Procedures

This procedure is composed of three sections: Inspection and Documentation, Maintenance Criteria and Corrective Action Protection, and Redevelopment Procedures.

Inspection and Documentation

Each item on the Water Levels and Well Maintenance Data Sheet shall be completed as the inspection is conducted. Corrective action to eliminate deficient aspects of a well installation is described in the section below titled Maintenance Criteria and Corrective Action Protection**.** For multi-completion monitoring wells (multiple well casings in a single borehole), a single Water Levels and Well Maintenance Data Sheet may be completed for a group of completions in a common borehole.

Surface Components Inspection

The first step of the inspection is to inspect the above-ground components of a monitoring-well installation. Some surface components identified in this section of the procedure are optional and will not be required at each well installation. An example is guard posts. The Project Manager and well-maintenance technician shall determine which components are required.

1. Check for presence of a lid on the steel security casing. If damaged, describe damage in the "Comments" section of the Well Maintenance Checklist.
2. Check the lock on the steel security casing for proper operation.
3. Inspect the steel security casing for damage. If a drain or vent hole is present in the security casing, check to ensure it is not plugged with debris. Clean the hole if necessary.
4. Check for presence of a casing-riser cap. If the well is a flush-mount well, note whether the casing-riser cap is a watertight cap, slip-on cap, or a threaded cap.
5. Inspect the casing riser for damage. No contamination should be able to enter the well through openings in the side of the casing riser. Note that some casing risers have a "weep" hole drilled just below the riser cap. This hole allows air pressure in the well to equilibrate with atmospheric pressure as water levels or the atmospheric pressure fluctuates. This weep hole should not be closed. If the well is a flush-mount installation and the riser has a weep hole, note this fact in the "Comments" section of the well maintenance checklist. Weep holes are generally not recommended for flush-mount wells as they permit liquids to enter the well if the flush-mount vault becomes flooded. Weep holes in the risers of flush-mount wells are permissible if the vault of the flush-mount installation has been installed to permit drainage from the vault or the vault has a watertight cover.
6. Check for the presence of guard posts. If present, note whether guard posts are adequately painted for high visibility. If guard posts are not present, note this on the well maintenance checklist.

7. Check for the presence of a concrete surface pad surrounding the security casing. If the concrete surface pad is absent or damaged, note this information on the Well Maintenance Checklist.
8. Check the well number or well identification to determine if it is clearly marked and in agreement with the well location map.

Subsurface Inspection

The second step of the inspection is to determine the subsurface condition of the well. This includes measuring the depth to water and the depth to the bottom of the well. These measurements should be recorded to the nearest $^1/_{100}$ of a foot below the top of the casing. The measured depth to the bottom of the well, when compared to the recorded well depth and screened interval depth, will indicate the amount of sediment in the well. If sediment has accumulated to a level above the bottom of the screened interval, the well should be redeveloped.

1. Clean the water-level sounder or interface probe before inserting in the well, following the procedure presented in Procedure 7, “Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells.”
2. Measure the depth to water to the nearest $^1/_{100}$ of a foot and record it on the checklist. The depth shall be measured from the top of the casing riser; see Procedure 7, “Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells.”
3. Measure the total depth of the well by gently lowering the probe to the bottom of the well. After the probe reaches the well bottom, slowly raise and lower it several times to accurately determine the depth to the top of any sediment column that may have accumulated in the well. Record the depth to the nearest $^1/_{100}$ of a foot on the well maintenance checklist.
4. Use lint-free tissue and distilled or deionized water to clean the cable as it is removed from the well. If nonaqueous phase liquids are present in a well, the cable and probe should be cleaned with Alconox (or equivalent) before cleaning with isopropanol or methanol and deionized water. During decontamination, care should be taken to prevent decontamination fluids from dripping into the well.

Maintenance Criteria and Corrective Action Protection

This section describes criteria used to evaluate the conformance or nonconformance aspects of each component of the well inspection. For each nonconformance criteria, a corrective action is described. Whenever possible, corrective action should be implemented during the same field trip during which a nonconformance aspect was identified. Any corrective action taken should be noted on the well maintenance checklist.

1. If the lid on the security casing is missing or damaged to the point of permitting access to the well, arrange a temporary cover, if possible, and make arrangements to have a new lid fixed to the security casing (commonly by welding).
2. If the lock on the steel security casing is missing, it should be replaced. If all monitoring-well locks currently in use at a site are keyed identically, a similarly keyed lock should be used to replace a missing one. However, if a lock of the same key type as other security casing locks is not immediately available; any strong lock should be installed for temporary well protection. In such a case, note the need for a new lock on the checklist. If a lock has become difficult to operate because of exposure, a lubricant should be added to the tumbler assembly.

3. Do not over lubricate, as these actions will give rise to contamination of the well or sampling equipment that will be used at the well in the future. Note all corrective action on the checklist.
4. If the entire steel security casing is missing, make arrangements to replace it. The bottom of the security casing should be set 3 ft below the ground surface in concrete. The concrete should extend to the surface and be sloped away from the well. Repairs should be made if the security casing is in place but is damaged and allows liquids to drain into the annular space around the well casing or is preventing proper access to the well. If repairs cannot be made, the need for these should be noted on the checklist.
5. If the casing-riser cap is missing, replace it. If the well is not a flush-mount well and the casing riser does not have a small hole drilled just below the cap, the riser cap should not be installed in an air-tight manner. If the well is a flush-mount well, the riser cap should be a water-tight cap. The water-tight cap should be installed securely in the well to prevent liquids that collect in the vault from entering the well casing. Flush-mount wells with vaults that permit drainage from the vault or those with water-tight vault lids do not need water-tight riser caps.
6. If the casing riser is damaged to the extent that standing liquids inside the security casing can enter the well, the damaged section should be cut off below the point of breakage and a new section of riser installed. The new riser should have a weep hole drilled in it just below the cap to allow air pressure equilibration within the well bore. Care should be taken to ensure the new casing riser is fitted with a casing-riser cap. This corrective action should be noted on the checklist and the well should be scheduled for a new elevation survey.
7. If the well is not a flush-mount installation and is in a location subject to equipment or vehicle traffic, guard posts should be present. If guard posts are not present but are needed, make arrangements for installation as soon as possible. To be effective, three guard posts should be installed in the shape of an equilateral triangle centered at the well with each post, 2 to 3 ft from the well. The guard posts should be painted with a highly visible paint, such as Day-Glo orange or safety yellow. Approval of the manager of the site should be obtained before installing and painting guard posts.
8. If the concrete surface pad is damaged or is missing, a new concrete surface pad should be installed or arrangements should be made for the installation of a concrete surface pad. The pad should extend 1 foot below the ground surface and 3 ft horizontally from the security casing. The pad should be sloped away from the well.
9. If the well is not numbered or marked with a well identification label, or if the number on the well does not match the well location map, a correct well identification number must be marked on the well. First, the correct well identification must be conclusively determined. This can be done by consulting the well location map (if it has been certified to be correct), consulting original field logs and completion records relating to the well's installation, and consulting logs from other previous field activities such as sampling, episodes, and water-level measurements. Project personnel may also be interviewed in an effort to establish well identification. Once the identity of the well has been conclusively established, the well should be labeled with this number using a permanent method. Stamping the well identifier into the steel security casing with a steel stamp is recommended. The identifier should be stamped in the lid on the security casing and on the security casing itself, just below the lock. The identifier should also be written on the bottom side of the security casing lid using a permanent ink pen. Multiple-completion wells should have the top of each riser cap marked with a letter designating the completion, such as "U" and "L" for "upper" and "lower." The casing risers in a multiple-completion well should then be marked in a similar manner. Take care to ensure the label on the casing riser is below the position occupied by the cap or the weep hole, if present.

Redevelopment Procedures
Monitoring wells shall be redeveloped if the well inspection procedure indicates that excessive sedimentation is occurring, if the capacity of the well appears to have significantly declined during the course of a sampling program, if there is evidence of screen encrustation or clogging by iron bacteria, or if the well is simply scheduled for regular redevelopment.

1. Possible redevelopment techniques include compressed-nitrogen jetting and air-lift pumping, surge blocking and pumping or bailing, suction-lift pumping, submersible pumping, and foot valve pumping.
2. Successful redevelopment requires that water be forced from the casing into the formation, and from the formation into the casing. This is best accomplished through the use of a surge block. Compressed-nitrogen jetting can also accomplish this flow reversal to some extent.
3. Before placing any redevelopment equipment in a monitoring well, the equipment shall be cleaned by washing with soapy water (Alconox or equivalent) and deionized water, and wiping dry with a lint-free tissue. After removing redevelopment equipment from a well, the equipment shall be cleaned again.

Nitrogen-Jetting Redevelopment Procedure
If this procedure is to be used at the Moab UMTRA Project site, Health and Safety must be notified, and the work steps must be added to the IWP.

1. If site conditions require that purge water from the well be contained, a discharge-control apparatus should be installed on the well riser. This apparatus typically consists of a compression-sleeve coupling with a discharge port that is connected to the well riser. A compression-type seal for the jetting pipe is rigged at the top of the discharge-control apparatus. Even if site regulations do not require discharge water to be collected and stored, a discharge-control apparatus should be used at sites that may have contaminated ground water. Use of the discharge-control apparatus will prevent the splashing of discharge water on well-maintenance technicians.
2. A jetting-T is connected to a series of PVC pipes (the jetting pipe) and lowered to the top of the screened interval. The top of the jetting pipe is then connected to a compressed nitrogen source via a flexible compressed gas transmission hose. The flexible hose is connected to a two-stage regulator on the nitrogen source. The first stage of the regulator displays the pressure in the nitrogen tank. The second stage displays the pressure at the flexible hose when the regulator is opened. To prevent injury caused by the nitrogen tank falling over, the tank must be either secured in an upright position with a chain or placed on its side and secured by wheel chocks.
3. Set the line pressure on the regulator at a maximum of 60 pounds per square inch. Jet the well screen by quickly opening the line valve, allowing the water to rise in the well, and then closing the line valve. As air (or nitrogen) escapes from the water column, the water in the well will fall back to near static levels and give rise to a flow reversal from the well into the formation. This pulsed jetting should be repeated for the entire length of screened interval by lowering the jetting pipe in small increments. The pulsed jetting will loosen sediment from the screen, the filter pack, and the well bottom.

4. As material is loosened during the pulsed jetting, the well should be air-lift pumped to remove the dislodged sediment. Air-lift pumping is accomplished by slowly but steadily opening the line valve. This action will discharge nitrogen into the water column within the well. The water will rise in the well as the nitrogen is introduced and expands. If the water level reaches the top of the well before the injected nitrogen reaches the top of the water column, "successful" air-lift pumping will occur. Air-lift pumping can continue as long as water is entering the well at a fast enough rate to maintain an aerated water column that extends to the top of the well.
5. Repeat the combination of pulsed jetting over the length of the well screen and air-lift pumping at least once. If the capacity of the well is not returned to near-original levels, or if the clarity of the well water fails to improve after the second cycle, the nitrogen-jetting redevelopment process shall be continued until the capacity of the well and the clarity of the water cease to improve.

Surge-Blocking Redevelopment Procedure

1. Lower the surge block into the well to a position below the water level in the well but above the top of the screened interval, if possible. Surging action should be initiated gently to loosen obstructing sediment. As the circulation improves during the redevelopment, more vigorous surging should be undertaken.
2. After operating the surge block in a given depth increment for several minutes, lower it to the next interval and repeat the surging action. This process should be repeated until surge blocking has been conducted in the entire screened interval.
3. After surge-blocking the entire screened interval, the surge block should be removed. Install a suction-lift pump intake and a submersible pump or a foot valve pump, and pump water from the well to remove the dislodged sediment. An effort should be made to pump accumulated sediment from the bottom of the well. Pumping should continue until the discharged water is clear and several bore volumes have been removed.
4. The process of surge blocking and then pumping should be repeated at least once. If the capacity of the well is not restored to near-original levels, or if the clarity of the well water fails to improve after only two surge-and-pump cycles, the complete process should be continued until the capacity of the well and the clarity of the water cease to improve.

Suction-Lift Pumping

Suction-lift pumping is most suitable to use in combination with either surge-blocking or nitrogen jetting. When used with either of these techniques, suction-lift pumping is an effective means of removing suspended sediment particles and accumulated sediment that have collected at the bottom of a well. When used alone, suction-lift pumping is capable of providing only limited improvement in the capacity of a well.

When using suction-lift pumping in combination with surging or jetting, the suction-lift pump should be used to remove any accumulated sediment from the bottom of the well. This should be done before surging or jetting. Subsequently, the suction-lift pump should be used after each surging or jetting cycle to remove loosened sediment particles. Suction-lift pumping is conducted by simply installing the intake line in the well, connecting it to the pump intake port, and turning on the pump. Suction-lift pumping should then continue until the discharge water is clear. Suction-lift pumping can only be used if the depth to water is less than approximately 25 to 30 ft.

When using suction-lift pumping as the sole means of development, "over-pumping" is used to remove entrapped sediment from the well screen, filter pack, and formation. For this approach, the intake line is installed at the bottom of the well, and the well is pumped at its maximum rate for extended periods (in excess of 10 minutes) and then allowed to recover. The process is repeated until maximum improvements in capacity and/or well-water clarity have been achieved.

Submersible Pumping
Submersible pumps may also be used in conjunction with surging or jetting for well development. Submersible pumps are not as effective as suction-lift pumps for pumping water with large amounts of suspended sediment (particularly sand-size sediment). In addition, submersible pumps cannot be used to pump accumulated sediment from the bottom of a well. For this reason, submersible pumping should not be used as the sole means of developing a well, as can be done when using a suction-lift pump. The sequence of surging or jetting and submersible pumping should continue until the capacity of the well and the clarity of the water cease to increase.

When using a submersible pump in conjunction with surging or jetting, the pump should be installed after completion of each surging or jetting episode. To provide for maximum removal of suspended sediment, the submersible pump should be lowered to the bottom of the well on a suspension cable. For small pumps and shallow wells, the cable can be lowered by hand. For large pumps or deep wells, the weight of the pump and the discharge hose requires that a cable reel mounted on a tripod or vehicle be used for lowering and retrieving the pump.

After the pump is lowered into position, the electrical cord should be connected to a power supply. Do not connect the electrical cord to the power supply until the pump is installed in the well. Some submersible pumps are not grounded and could electrocute an individual if the pump is touched while turned on. After turning on the pump, continue pumping until the discharge water is clear.

After the discharge water becomes clear (or ceases to improve) and the pump is disconnected from the power supply, remove the pump by lifting or cranking up the suspension cable. The pump should never be removed by lifting or pulling on the electrical cord or the discharge hose.

Foot Valve Pumping
A foot valve pump is simply a length of semirigid hose or pipe with a foot valve attached to one end. A foot valve pump uses the momentum of water contained in the "discharge line" to lift water from the well as the discharge line is rapidly moved up and down. The foot valve on the bottom opens during the downstroke, allowing water to enter the discharge line. During the upstroke, a spring in the valve, combined with the weight of the water, forces the valve closed. A foot valve pump can be used in conjunction with surging or jetting to remove entrapped sediment particles from a well. Foot valve pumping is effective for removing sand-size particles. The method is also effective in removing accumulated sediment from the bottom of a well before initiating surging or jetting activity.

When using a foot valve pump in conjunction with surging or jetting, the sediment in the bottom of the well should be removed before initiating surging or jetting activities. Install the foot valve pump so that the lower end of the unit (the valve end) is at the bottom of the well. Commence pumping by rapidly raising and lowering the discharge line.

As the line fills with water, its weight will increase. For shallow wells, this operation of the pump can be accomplished manually. For deep wells, the weight of the discharge line will require a mechanical means of raising and lowering the unit. Such mechanical devices typically consist of a specially made jack handle or a commercially made apparatus.

Once the initial pumping effort begins to produce water, pumping should continue until the discharge water is clear.

Surging or jetting should then be conducted, followed by another episode of foot valve pumping. This sequence of steps shall be repeated until the capacity of the well and the clarity of the water cease to increase.

Precision and Bias

This standard practice presents guidelines for maintaining high-quality monitoring well installations. Therefore, statements regarding precision and bias are not applicable, except in the context of such statements that might be included in Procedure 7, "Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells."

QA

To maintain QC standards, the Water Levels and Well Maintenance Data Sheet must be completed for each well that undergoes inspection and maintenance. The checklist and data sheet must be signed by the person completing the forms. Any discrepancies should be corrected by the well-maintenance technician. The checklist and data sheet should then be filed in the project records files in accordance with the *Records Management Manual* and the *Records Management Program Plan*.

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Appendix B.
Sample Location Information

Table B-1. Baseline Well Locations and Sample Depths

Well Number	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0405	I	Observation	1	18	20.3
0406	I	Observation	1	18	18.3
0488	I	Observation	6	39	40.3
SMI-PW01	I	Observation	4	40	60.2
SMI-PZ1D2	I	Observation	2	73	75.0
SMI-PZ1M	I	Observation	2	57	60.8
SMI-PZ1S	I	Observation	2	18	19.1
0494	II	Well Point	1	2.4 to 3.4	3.4
0495	II	Well Point	1	4.6 to 5.6	5.6
0496	II	Well Point	1	2.2 to 3.2	3.2
0497	II	Well Point	1	3.9 to 4.9	4.9
0597	II	Well Point	1	9.3 to 10.3	10.3
0598	II	Well Point	1	9.1 to 10.1	10.1
0599	II	Well Point	1	9.4 to 10.4	10.4
0617	II	Well Point	1	1.7 to 2.7	2.7
0618	II	Well Point	1	5.3 to 6.3	6.3

ft bgs = feet below ground surface

Table B-2. CF1 Well Locations and Sample Depths

Well Number	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0470	I/IV	Extraction	4	18	21.3
0471	I/IV	Extraction	4	18	21.3
0472	I/IV	Extraction	4	18	21.3
0473	I/IV	Extraction	4	18	21.3
0474	I/IV	Extraction	4	18	21.3
0475	I/IV	Extraction	4	18	21.3
0476	I/IV	Extraction	4	18	21.3
0477	I/IV	Extraction	4	18	21.3
0478	I/IV	Extraction	4	23	25.5
0479	I/IV	Extraction	4	23	25.2
0403	I	Observation	1	18	18.4
0407	I	Observation	1	17	18.5
0480	I	Observation	4	18	20.3
0481	I	Observation	4	28	31.3
0482	I	Observation	4	58	61.3
0483	I	Observation	4	18	20.3
0484	I	Observation	4	28	30.3
0485	I	Observation	4	58	60.4
0551	I	Observation	1	18	20.6
0552	I	Observation	1	18	20.4
0553	I	Observation	1	18	20.8
0554	I	Observation	1	18	20.6
0555	I	Observation	1	18	20.4
0556	I	Observation	1	18	20.4
0557	I	Observation	6	40	45.9
0558	I	Observation	6	36	45.1
0559	I	Observation	1	19	20.7
0560	I	Observation	6	31	40.4
0561	I	Observation	6	50	55.3
0596	I	Observation	1	24	25.5
0562	II	Well Point	1	1.3 to 2.3	2.3
0563	II	Well Point	1	4.6 to 5.6	5.6
0564	II	Well Point	1	1.2 to 2.2	2.2
0565	II	Well Point	1	4.0 to 5.0	5.0
0606	II	Well Point	1	9.3 to 10.3	10.3
0607	II	Well Point	1	9.6 to 10.6	10.6
0608	II	Well Point	1	8.9 to 9.9	9.9
0611	II	Well Point	1	2.2 to 3.2	3.2
0612	II	Well Point	1	4.3 to 5.3	5.3

ft bgs = feet below ground surface

Table B-3. CF2 Well Locations and Sample Depths

Well Number	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0570	I/IV	Observation	6	30	31.3
0571	I/IV	Observation	6	40	41.3
0572	I/IV	Observation	6	30	31.3
0573	I/IV	Observation	6	40	41.3
0574	I/IV	Observation	6	30	31.3
0575	I/IV	Observation	6	40	41.3
0576	I/IV	Observation	6	30	31.3
0577	I/IV	Observation	6	40	41.3
0578	I/IV	Observation	6	30	31.3
0579	I/IV	Observation	6	40	41.3
0401	I	Observation	1	18	18.9
0402	I	Observation	1	17	18.5
0408	I	Observation	1	26	28
0580	I	Observation	1	18	20.4
0581	I	Observation	1	18	20.5
0582	I	Observation	1	18	20
0583	I	Observation	1	18	19.1
0584	I	Observation	1	18	20.5
0585	I	Observation	1	18	20.6
0586	I	Observation	1	18	20.2
0587	I	Observation	1	18	20.2
0588	I	Observation	6	34	35
0589	I	Observation	6	52	53
0600	I	Observation	1	27	29.7
0601	I	Observation	1	27	29.7
0602	I	Observation	1	18	19.7
0590	II	Well Point	1	1.0 to 2.0	2.0
0591	II	Well Point	1	3.9 to 4.9	4.9
0603	II	Well Point	1	9.2 to 10.2	10.2
0604	II	Well Point	1	7.3 to 8.3	8.3
0605	II	Well Point	1	9.4 to 10.4	10.4
0613	II	Well Point	1	1.2 to 2.2	2.2
0614	II	Well Point	1	5.1 to 6.1	6.1
0615	II	Well Point	1	1.4 to 2.4	2.4
0616	II	Well Point	1	5.0 to 6.0	6.0

ft bgs = feet below ground surface

Table B-4. CF3 Well Locations and Sample Depths

Well Number	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0670	I/IV	Remediation	6	40	46.3
0671	I/IV	Remediation	6	40	44.8
0672	I/IV	Remediation	6	40	45.4
0673	I/IV	Remediation	6	40	46.7
0674	I/IV	Remediation	6	40	45.5
0675	I/IV	Remediation	6	40	46.4
0676	I/IV	Remediation	6	40	46.3
0677	I/IV	Remediation	6	40	45.6
0678	I/IV	Remediation	6	40	46.6
0679	I/IV	Remediation	6	40	45.4
0404	I	Observation	1	18	18.9
0680	I	Observation	1	18	20.0
0681	I	Observation	1	18	20.4
0682	I	Observation	1	28	29.7
0683	I	Observation	1	27	31.4
0684	I	Observation	1	18	21.5
0685	I	Observation	1	28	30.2
0686	I	Observation	1	18	20.2
0687	I	Observation	1	27	30.2
0688	I	Observation	6	31/ 39	41.0
0689	I	Observation	6	46/ 54	56.4
0690	II	Well Point	1	3.3 to 4.3	4.3
0691	II	Well Point	1	6.5 to 7.5	7.5
0692	II	Well Point	1	9.1 to 10.1	10.1
0693	II	Well Point	1	2.0 to 3.0	3.0
0694	II	Well Point	1	4.3 to 5.3	5.3
0695	II	Well Point	1	9.3 to 10.3	10.3
0696	II	Well Point	1	1.3 to 2.3	2.3
0697	II	Well Point	1	4.3 to 5.3	5.3
0698	II	Well Point	1	9.3 to 10.3	10.3

ft bgs = feet below ground surface

Table B-5. CF4 Well Locations and Sample Depths

Well Number	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0770	I/IV	Remediation	6	35	35.2
0771	I/IV	Remediation	6	35	35.3
0772	I/IV	Remediation	6	35	35.5
0773	I/IV	Remediation	6	35	35.5
0774	I/IV	Remediation	6	35	35.8
0775	I/IV	Remediation	6	35	35.4
0776	I/IV	Remediation	6	35	35.5
0777	I/IV	Remediation	6	35	35.6
0778	I/IV	Remediation	6	35	35.4
0779	I/IV	Remediation	6	35	36.0
0780	I	Observation	6	28	30.5
0781	I	Observation	6	46	55.0
0782	I	Observation	6	33	41.2
0783	I	Observation	2	18	19.1
0784	I	Observation	2	18	19.9
0785	I	Observation	2	18	19.9
0786	I	Observation	6	28	30.7
0787	I	Observation	6	36	45.7
0790	II	Well Point	1	2.0 to 3.0	3.0
0791	II	Well Point	1	4.3 to 5.3	5.3
0792	II	Well Point	1	9.3 to 10.3	10.3
0793	II	Well Point	1	2.0 to 3.0	3.0
0794	II	Well Point	1	4.3 to 5.3	5.3
0795	II	Well Point	1	9.3 to 10.3	10.3

ft bgs = feet below ground surface

Table B-6. CF5 Well Locations and Sample Depths

Well	Typical Category	Type of Well	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0810	I	Extraction	8	35	40.4
0810-obs	I	Observation	1.5	N/A	14.4
0811	I	Extraction	8	35	45.0
0811-obs	I	Observation	1.5	N/A	14.35
0812	I	Extraction	8	40	44.4
0812-obs	I	Observation	1.5	N/A	13.5
0813	I	Extraction	8	40	44.4
0813-obs	I	Observation	1.5	N/A	14.35
0814	I	Extraction	8	40	42.4
0814-obs	I	Observation	1.5	N/A	13.4
0815	I	Extraction	8	45	51.7
0815-obs	I	Observation	1.5	N/A	13.4
0816	I	Extraction	8	45	50.9
0816-obs	I	Observation	1.5	N/A	13.25
PW02	1	Extraction	4	55	60.3
PW02-obs	1	Observation	1.5	N/A	13.2

ft bgs = feet below ground surface; N/A = not applicable; obs = observation

Table B-7. Site-Wide Sampling Locations and Sample Depths

Location Number	**Typical Category**	**Well Diameter (inches)**	**Sample Depth (ft bgs)**	**Total Depth (ft bgs)**
0410	I/II	1	23.5	24
0411	II	1	8	8.5
0412	I	1	9.5	12
0413	I	1	10.5	13
0414	I	1	7.5	9.5
0430	I	2	101	106
0431	I	2	91	99
0432	I	2	55	60
0433	I	2	99	104
0434	I	2	35	85
0435	I	2	173	181
0436	I	2	197	205
0440	I	2	117	119
0443	I	2	73	80
0444	I	2	116	120
0455	I	1	46	48.5
0456	I	1	53	55
0457	I	1	29	31
AMM-1-53	I	4	53	57
AMM-1-19	I	4	19	57
AMM-2	I	4	48	50
AMM-3	I	4	48	50
ATP-1-S	I	2	137	155
ATP-3	I	4	51	60
SMI-MW01	I	2	16	30
SMI-PW03	I	4	60	60
SMI-PZ2D	I	2	75	79
SMI-PZ3D2	I	2	78	81
SMI-PZ2M2	I	2	56	60
SMI-PZ3M	I	2	59	60
SMI-PZ3S	I	2	25	27
TP-01	I	1	22	24
TP-07	I	1	29	30
TP-08	I	1	29	32
TP-09	I	1	26	28
TP-11	I	1	30	32
TP-20	I	1	32	36

ft bgs = feet below ground surface

Table B-8. Locations Potentially Subject to Selenium and Copper Analyses

Sample Number	Location	Additional Analysis
0401	CF2 Observation Well	Selenium
0404	CF3 Observation Well	Selenium
0405	Baseline Observation Well	Selenium
0406	Baseline Observation Well	Selenium
0412	Background Observation Well	Selenium
0413	Background Observation Well	Selenium
0414	Background Observation Well	Selenium
0437	On-Pile Observation Well	Selenium
0438	On-Pile Observation Well	Selenium
0439	On-Pile Observation Well	Selenium
0440	Background Observation Well	Selenium
0442	Background Observation Well	Selenium
0456	Off-Site Observation Well	Selenium
0495	Baseline Well Point	Selenium
0496	Baseline Well Point	Selenium
0537	Wick Pond	Selenium, Copper
0561	CF1 Observation Well	Copper
0571	CF2 Remediation Well	Copper
0572	CF2 Remediation Well	Copper
0575	CF2 Remediation Well	Copper
0576	CF2 Remediation Well	Copper
0579	CF2 Remediation Well	Copper
0597	Baseline Well Point	Selenium
0598	Baseline Well Point	Selenium
0599	Baseline Well Point	Selenium
0604	CF2 Well Point	Selenium
0605	CF2 Well Point	Selenium
0606	CF1 Well Point	Selenium
0617	Baseline Well Point	Selenium
0618	Baseline Well Point	Selenium
0676	CF3 Remediation Well	Selenium
0683	CF3 Observation Well	Selenium
0691	CF3 Well Point	Selenium
0693	CF3 Well Point	Selenium
0695	CF3 Well Point	Selenium
0696	CF3 Well Point	Selenium
0697	CF3 Well Point	Selenium
0725	Trench Well Point	Selenium
0726	Trench Well Point	Selenium
0778	CF4 Remediation Well	Copper
0785	CF4 Observation Well	Copper
0787	CF4 Observation Well	Copper
0792	CF4 Well Point	Selenium
CR3-10	Surface Water Location	Selenium
MW-1-R	Off-Site Observation Well	Selenium
PW-11	On-Pile Observation Well	Selenium, Copper
PW-4-OB-A	On-Pile Observation Well	Selenium, Copper
SMI-PZ3S	Baseline Observation Well	Selenium
TP-03	Background Observation Well	Selenium
TP-09	Off-Site Observation Well	Selenium
TP-17	Off-Site Observation Well	Selenium
TP-18	Off-Site Observation Well	Selenium
TP-19	Off-Site Observation Well	Selenium

Appendix C.
Field Data Sheets

Moab Water Sampling Field Data

Date ______________ **Configuration** _____ **EXTR Well / OBS Well / SW Location / WP No.** __________

Sample Intake Depth
____ (ft BGS)

Well Purging Information

Sample Number ________________________

Water Level ________ **(ft BTOC)** **Casing Diameter** ____ **(in)**

Depth of well _______**(ft BTOC)** **One pump / tubing Volume** _____ **(L)**

For Extr Wells Only: Q (gpm) _____ **Totalizer 1 (gal)** __________ **Totalizer 2 (gal)** ___________ **Reset Tot 2?** _____

For WPs Only: Stick up Height ______ **(ft AGS)** **Depth to Surface Water** ______ **(ft BTOC)**

Sampling Equipment: **Peristaltic Bladder (Dedicated) Poly Tubing (Dedicated) Dedicated Submersible**

Measurement Equipment: **YS I No. Hach 2100P Turbidimeter**

Calibration Time_________ **Purge Start Time**___________ **Open container ( ) Air exclusion ( )**

Time	Total Volume Purged (L)	Water Level	Temp. (° C)	Conductivity ATC (µmhos/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
Final Sample Data						*Sample Time*		

Filters: Number of 0.45 µ disposable filters used _______ Filter Type: Low Volume Standard

Sample Preservation: Is ice in cooler (YES) (NO) **Weather:** ______________________________

Well Category I II WP Reason for category: ______________________________________ ____

Comments: ____

____

____

____

Signature of Sampler ______________________ **Date Signed**______________

Checked by ____________________________ **Date Checked**__________

Grand Junction Office
200 Grand Ave, Suite 500
Grand Junction, CO 81501

Water Sampling Field Data
Quality Assurance Sample Log

Date ______________ Well / Location No.______________

Sample Number ________________________

False Identification Location ____________________________

Sample Type: Duplicate Equipment Blank Other:____

Comment: ____

____

Date ______________ Well / Location No.______________

Sample Number ________________________

False Identification Location ____________________________

Sample Type: Duplicate Equipment Blank Other:____

Comment: ____

____

Date ______________ Well / Location No.______________

Sample Number ________________________

False Identification Location ____________________________

Sample Type: Duplicate Equipment Blank Other:____

Comment: ____

____

Well Point Purging Record

Configuration 4

Well Point	Sample Depth	Production	Revisit?
0790	Shallow		
0791	Intermediate		
0792	Deep		
0793	Shallow		
0794	Intermediate		
0795	Deep		

Configuration 1

Well Point	Sample Depth	Production	Revisit?
0562	Shallow		
0563	Intermediate		
0606	Deep		
0608	Deep		
0611	Shallow		
0612	Intermediate		
0564	Shallow		
0565	Intermediate		
0607	Deep		

Configuration 2

Well Point	Sample Depth	Production	Revisit?
0590	Shallow		
0591	Intermediate		
0603	Deep		
0605	Deep		
0615	Shallow		
0616	Intermediate		

Configuration 3

Well Point	Sample Depth	Production	Revisit?
0690	Shallow		
0691	Intermediate		
0692	Deep		
0696	Shallow		
0697	Intermediate		
0698	Deep		

Baseline

Well Point	Sample Depth	Production	Revisit?
0494	Shallow		
0495	Intermediate		
0597	Deep		
0496	Shallow		
0497	Intermediate		
0598	Deep		
0617	Shallow		
0618	Intermediate		
0599	Deep		

Infiltration Trench

Well Point	Sample Depth	Production	Revisit?
0724	Shallow		
0725	Intermediate		
0726	Deep		

YSI Daily Calibrations / Checks

Date _______ Time ______ Initials __________

YSI # _______ 2100P # _________

Calibration Check

Standard	Standard Value	Measured Value	Range*	Within Range? (Y/N)	Recalibrated? (Y/N)	Comments
Temp.	NA		NA	NA	NA	
pH 4	4.00		3.80 – 4.20			
pH 7	7.02		6.82 – 7.22			
pH 10	10.06		9.86 – 10.26			
Cond.	10,000		9,000 – 11,000			
ORP	237.5		221 – 241 mV			
D. O.	NA		NA	NA		
Turb	20 NTU		18.0 – 22.0			

* Based on ambient temperature of 20˚ C. For ranges at different temperatures, see page with pH and Zobell calibration standard charts.
Note: D.O. Correction Factor for Moab = 0.86/ D.O. should be recalibrated during each calibration check

---

Date _______ Time ______ Initials __________

YSI # _______ 2100P # _________

Calibration Check

Standard	Standard Value*	Measured Value	Range*	Within Range? (Y/N)	Recalibrated? (Y/N)	Comments
Temp.	NA		NA	NA	NA	
pH 4	4.00		3.80 – 4.20			
pH 7	7.02		6.82 – 7.22			
pH 10	10.06		9.86 – 10.26			
Cond.	10,000		9,000 – 11,000			
ORP	237.5		221 – 241 mV			
D. O.	NA		NA	NA		
Turb	20 NTU		18.0 – 22.0			

* Based on ambient temperature of 20˚ C. For ranges at different temperatures, see page with pH and Zobell calibration standard charts.
Note: D.O. Correction Factor for Moab = 0.86/ D.O. should be recalibrated during each calibration check

YSI Pre-Trip Calibration

Date __________ Time __________ YSI No. ________________

pH Buffers

4 Manufacturer ____________ Lot No. _______________ Expiration Date ______________

7 Manufacturer ____________ Lot No. _______________ Expiration Date ______________

10 Manufacturer ____________ Lot No. _______________ Expiration Date ______________

Zobell Solution

Lot Number __________________ Expiration Date __________________ Date Hydrated __________

Nitric Acid

Manufacturer ____________ Lot No. ___________

Sulfuric Acid

Manufacturer __________ Lot No. ___________

Conductivity Calibration

10,000 µmhos/cm **Temp** _____ Pre Cal. Value_______ Cal. Value_______ Exp. Date _______

pH – ORP Calibration

1 Point Calibration 2 Point Calibration 3 Point Calibration (circle) (Cal 7 buffer first)

pH 4 Buffer ________ mV Range +180 ± 50 mV Pre Cal actual value________ Cal. Value _________

pH 7 Buffer ________ mV Range 0 ± 50 mV Pre Cal actual value________ Cal. Value _________

pH 10 Buffer ________ mV Range – 180 ± 50 mV Pre Cal actual value________ Cal. Value _________

ORP cal Temp _____ Pre Cal. Value_______ Cal. Value_______

HACH 2100P Turbidity Calibration

Instrument Number: _______________

Primary Calibration Standards Expiration Date: ______________

Date of Primary Calibration: ______________

Dissolved Oxygen Calibration

DO Membrane changed? Y N

DO Charge _________ Range 50 ± 25

DO Gain _________ Range 1.0 -.3 to + .4

Temperature Check

(Compare temperature of any liquid with both YSI and NIST reference thermometer.)

Nist Temp_______ YSI Temp. _______ NIST Cal Date _________ NIST Cal Due Date ________

Name ____

Appendix D.
Required Training

Moab Technical Assistance Contractor
Confined Space Entry Criteria

According to the Ground/Surface Water and Biota Sampling IWP (TAC-IWP-2008-03), the extraction/remediation well vaults are considered a confined space until they are cleared by trained personnel.

1.0 Introduction

The Moab, Utah UMTRA Project ground water remediation activities incorporate several well vaults located adjacent to the Colorado River on the southern border of the site. These vaults meet the regulatory definition of confined spaces and each is currently posted "Permit-Required Confined Space". The reason for this posting is one of the vaults monitored under a previous contract was found to be oxygen deficient on one occasion. It was reported that during this single occurrence, the oxygen deficient condition dissipated rapidly once the vault lid was opened. It has been decided to treat these vaults as "Permit Required Confined Spaces" until evaluation has proven that no hazard exists within the space to cause it to be a permit required space.

This document describes the actions taken by the Technical Assistance Contractor (TAC) to appropriately manage these spaces and the work to be performed within them. The premise of the program is to manage each of the vaults as Permit-Required Confined Spaces and downgrade them to Non Permit-Required Confined Spaces before each entry. The following describes the mechanism used to accomplish this.

2.0 Pre-entry Monitoring

Before entry of any TAC well-field confined space, atmospheric monitoring shall be performed by a qualified individual using appropriate instrumentation to ensure worker safety. This data shall be documented and utilized to justify the downgrade from Permit-Required Space to Non Permit-Required status.

3.0 Evaluation of Monitoring Data

Monitoring data shall be evaluated to ensure a hazardous atmosphere is not present. Oxygen levels shall be between 19.5 percent and 23.5 percent; lower explosive limit level shall be less than 10 percent; carbon monoxide level shall be less than 17 ppm; and no other hazards shall be present that require the space to be treated as a Permit-Required Confined Space (e.g. standing water, exposed electrical conductors, biological hazards, etc.)

If the above criteria are satisfactorily met, the space becomes a Non Permit-Required Confined Space. If any of these criteria are exceeded, the space shall not be entered. If it is determined that the space must be entered, a confined space entry permit shall be initiated as described in the Confined Space Entry Procedure and work shall be performed under those controls.

4.0 Working Within the Non Permit-Required Confined Space

While working within the Non Permit-Required Confined Space, it is recommended that continuous monitoring be performed. This is accomplished by simply placing the instrument in an appropriate location and letting it run. If at any time, the monitoring results exceed acceptable levels or an unexpected situation is encountered, the workers shall safely stop work, quickly exit the space, and contact health and safety. The cause for the unacceptable monitoring results or unexpected situation shall be determined and corrected with the assistance of Health and Safety. Once the cause of the unacceptable condition has been identified and corrected, the space may be re-entered. Additional monitoring shall be performed to ensure conditions remain satisfactory. If the cause cannot be determined and corrected, there shall be no entry into the space and management shall be consulted.

NOTE: Health and Safety must be notified of any confined space work involving the use of chemicals, paints, gases, solvents, or performamce of hot work before entry of any TAC permit- or nonpermit-required confined space.

5.0 Non Permit-Required Confined Space Emergencies

If a worker becomes incapacitated and cannot exit the space under their own power, emergency services shall be requested immediately. No personnel shall enter the space to provide assistance until it is certain that there are no hazardous conditions present. This is easily determined by checking the monitoring instrument and observing the existing conditions within the space. If the atmosphere is safe, and no other serious recognized safety or health hazards are present, entry to provide assistance is allowable. Assistance is limited to the level of training provided in basic CPR and First Aid.

NOTE: Unless warranted by life threatening situation (e.g. fire), only qualified medical personnel shall be allowed to move the individual or perform advanced medical treatment.

Once the victim is stabilized the emergency responders will manage the removal of the victim from the space.

6.0 Work Completion

When work is completed within the space, all tools and materials shall be placed in a safe condition and general housekeeping performed. Employee(s) shall safely exit the space, secure the entrance to the space, and ensure postings are present and that the space is locked and left in a safe condition.

Water Sampling Training Requirements

Employee Name:________________________________ Date_________________

Position Title:__________________________________

Required Training Courses			
	Required?	**Date Due**	**Date Completed**
40-Hour Hazwoper/8-Hour Refresher			
First Aid/CPR			
Radiological Worker II/Dress out			
Confined Space Entry			
Moab Pre-Entry Site Brief			
Multi-gas Detection Meter			
Computer-based Training			
Defensive Driver			
Counterintelligence Training			
Hazard Communication Awareness			
DOT Hazardous Material Transportation General Awareness			
Computer Security Awareness			
Security Awareness Brief			
Emergency Response and Preparedness			
Environmental Management Systems Training			
Integrated Safety Management			
Electrical Panel and Breaker Training			
Introduction to Incident or Occurrence Reporting			
Required Sampling Training			
OJT 40 hours			
Sampling Analysis Plan for the Moab UMTRA Site			
Sampling Required Reading			
Well Field Operations and Maintenance Manual			
Moab Site HASP			
Ground Water Operations IWP			
Ground Water/Surface Water Sampling, Preservation, Shipment, and Transportation TAP			
Surface Water Monitoring and Diversion TAP			