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UMTRA Project

Moab UMTRA Project
Surface Water Groundwater Sampling and Analysis Plan

Revision 6

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Review and Approval

2/24/2021

X Ken Pill

Kenneth G. Pill
TAC Groundwater Manager
Signed by: KENNETH PILL (Affiliate)

2/25/2021

X Elizabeth Moran

Elizabeth Moran
TAC Environmental Manager
Signed by: ELIZABETH MORAN (Affiliate)

2/25/2021

X Swaine Skeen

Swaine Skeen
TAC Senior Program Manager
Signed by: Swaine Skeen

Revision History

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1	July 2012	Periodic update.
2	February 2014	Periodic update includes revisions in response to ISMS findings.
3	February 2015	Revisions include modifications to text in Sections 2.0. 4.0, 8.0, 9.0, 10.0, and addition of new figure.
4	February 2016	Revision includes clarification of text throughout and new Form 1014.
5	March 2019	Periodic update.
6	March 2021	Periodic update.

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Acronyms and Abbreviations

Atlas	Atlas Minerals Corporation
ASTM	ASTM International
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	foot or feet
FWS	U.S. Fish and Wildlife Service
GPS	global positioning system
HASP	*Health and Safety Plan*
H&S	health and safety
IA	interim action
ICPT	Integrated Contractor Purchasing Team
IDIQ	indefinite delivery indefinite quantity
IWP/JSA	Integrated Work Plan/Job Safety Analysis
µm	micrometer
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
L	liter
mL	milliliters
mL/m	milliliters per minute
mm	millimeters
MSDS	Material Safety Data Sheets
mV	millivolts
NTU	nephelometric turbidity unit
ORP	oxidation reduction potential
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
QSAS	DOE Quality Systems for Analytical Services
RIN	report identification number
SDS	Safety Data Sheets
UMTRA	Uranium Mill Tailings Remedial Action
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 between 1988 and 1995. In October 2001, the title of the property and responsibility for remediation of the tailings pile and contaminated groundwater beneath the site were transferred to the U.S. Department of Energy (DOE).

Previous investigations, including the *Moab UMTRA Project Groundwater Interim Action Performance Assessment* (DOE-EM/GJTAC1841), indicate that several contaminants have migrated from the tailings pile into the groundwater. 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. Groundwater 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 in July 2005, 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) and reinitiated in July 2018, the U.S. Fish and Wildlife Service (FWS) 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 groundwater from the shallow plume to an evaporation pond on top of the tailings pile. The evaporation pond was removed in April 2016 due to remedial activities, and extracted groundwater continues to be used as dust control inside the Contamination Area. The IA also includes the application of diverted Colorado River water into shallow groundwater. The goal of this action is to reduce contaminant mass in groundwater 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.

2.0 Purpose and Scope

The purpose of this Sampling and Analysis Plan is to present all pertinent information associated with surface and groundwater sampling associated with the Moab Project site and the Crescent Junction disposal cell 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 preparation and collection of samples, Appendix B includes tables of the sample locations for each of the sampling events. Appendix C contains examples of datasheets used throughout the groundwater program, and Appendix D includes a list of required training for groundwater personnel. Attachment 1 (posted on the Project's SharePoint website) contains manufacturers' sampling equipment manuals.

Groundwater/surface water sampling safety hazards and controls can be found in the *Moab UMTRA Project Integrated Work Plan* (IWP)/*Job Safety Analysis* (JSA) *Groundwater and Surface Water Sampling, Preservation, Shipment, and Transport* (IWP/JSA-003). The *Groundwater Laboratory Chemical Hygiene Plan* (DOE-EM/GJTAC2144) includes information on the groundwater laboratory and required training. In addition, laboratory chemical Safety Data Sheets (SDS) can be found in the groundwater laboratory trailer.

Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites (40 CFR 192, Subpart A), includes the assurance of conformance concerning groundwater protection provisions and states that a monitoring program shall be present. The purpose of the sampling events listed in this document is to ensure compliance with 40 CFR 192.

3.0 Summary of Sampling Events

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

IA Well Field Performance Sampling Event
The purpose of this sampling event is to obtain data required to evaluate the performance of the groundwater extraction, fresh water injection, and/or the surface water diversion systems. Typically, groundwater extraction wells and observation wells in the vicinity of active freshwater injection wells are sampled during extraction and injection 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 frequency of this sampling event will be determined based on system operation schedules.

Site-wide Sampling Event
The site-wide sampling event is typically conducted twice a year, near the time when the Colorado River experiences peak spring runoff flows (May/June timeframe) and during base flow conditions (November/December). The main purpose of this sampling event is to monitor any changes and trends to the groundwater chemistry. In addition, the results are used to monitor plume migration and determine the overall distribution of the contaminants associated with the Moab site. Figure 2 shows the potential site-wide groundwater sampling locations. In addition to groundwater sampling, surface water samples (also shown on Figure 2) are collected to assess the surface water quality adjacent to the site compared to the upstream and downstream water quality. Table B-7 lists the monitoring well sampling locations, and Table B-8 is a list of the surface water sampling locations (Appendix B).

Habitat Sampling Event
As the river flow decreases after the annual peak runoff, backwater channels may form adjacent to the IA well field. These backwater channels may be utilized by endangered fish species, primarily the Colorado pikeminnow and also including the razorback sucker, and humpback chub. Surface water monitoring (Figure 2) takes place in conjunction with the surface water diversion from early July (or when flows decrease to less than 7,000 cubic feet per second [cfs])

to late September, when a suitable habitat may develop in these channels. Surface water monitoring includes collecting real-time ammonia samples from habitat areas, and surface water samples are also collected for laboratory analysis. Refer to Section 10.0 for more information on surface water monitoring.

Crescent Junction Monitoring Well Sampling Event
When water is present in any of the monitoring wells or the standpipe associated with the Crescent Junction Disposal Cell (locations shown in Figure 3), a sample may be collected for laboratory analysis. Typically these locations are dry; however, water has been present in well 0205 consistently since June 2015. These samples may be analyzed for additional analytes, including inorganics, metals, and isotopic uranium.

Matheson Wetlands Sampling
Wells within the Matheson Wetlands Preserve are sampled every 3 to 5 years to obtain background chemical data. Figure 4 shows a map of the observation wells and Table B-9 (Appendix B) lists the sampling locations.

4.0 Sampling Protocol

4.1 Groundwater

Groundwater samples are typically collected from a series of extraction wells, observation wells in the vicinity of injection wells, observation wells, and less frequently, from well points.

4.1.1 Well Classification
Groundwater 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 1.

Table 1. 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

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 horizontally 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 UMTRA Groundwater 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 Groundwater 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.

Figure 1. IA Well Field

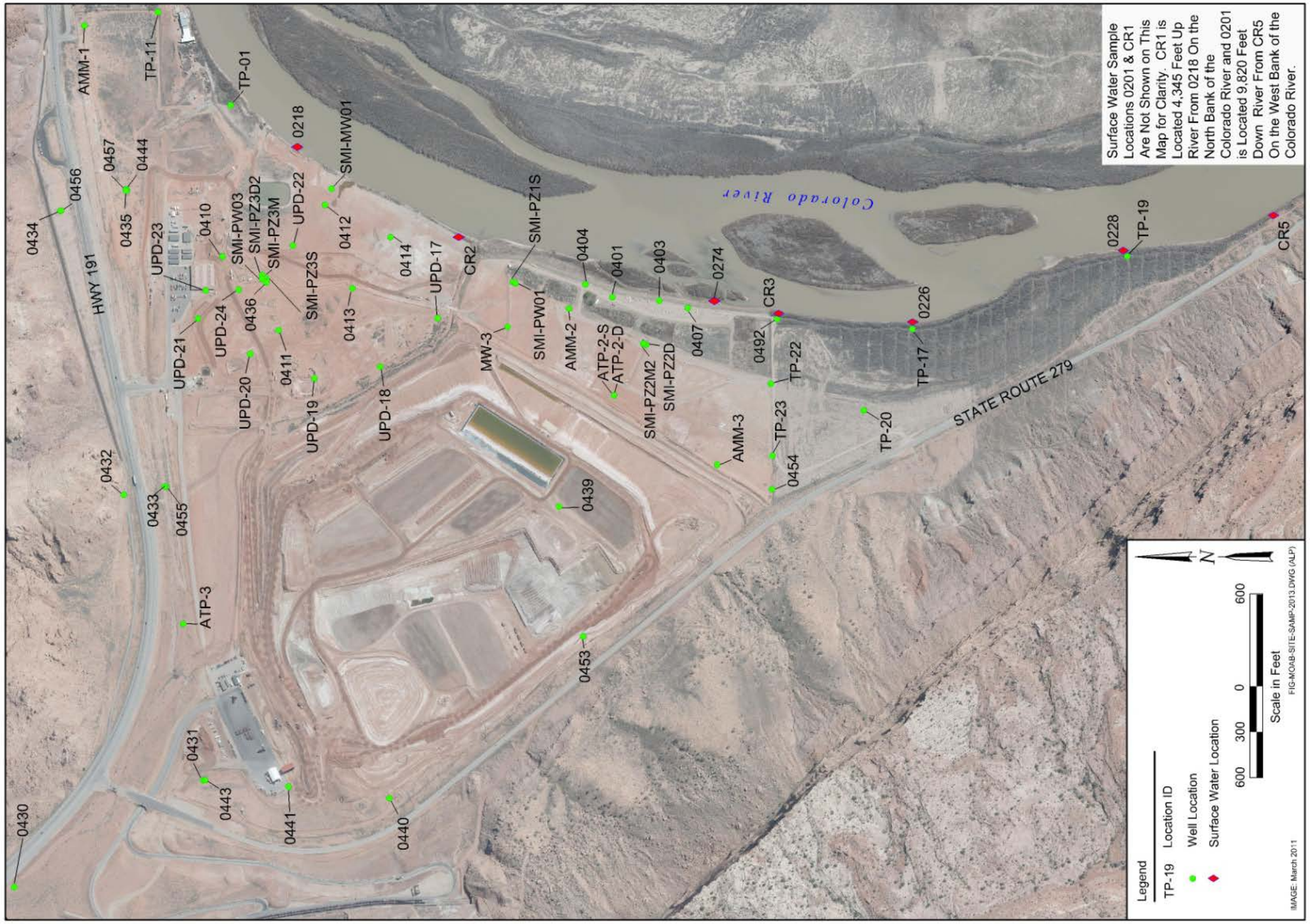


Figure 2. Site-wide Groundwater and Surface Water Sampling Locations

Figure 3. Crescent Junction Sampling Locations

Figure 4. Matheson Wetlands Sampling Locations

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 including temperature, pH, specific conductance, 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 2.

Table 2. Summary of Groundwater Sampling Protocol

Well Classification	Parameter	Purge Criteria
Category I	Purge volume	1 pump or 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 or 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, such as the *Technical Approach for the Management of UMTRA Groundwater 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 or 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-diameter casing, and the water level cannot be monitored during the purge due to space limitations. 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, the well cannot be sampled. If there is a sufficient column of water in the well to utilize a dedicated pump or dedicated tubing, the entire water column available can be sampled. Recording 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.

Table 3. Current Sample Analytes and Container and Preservation Requirements

Analytical Parameter	Container Type/Size	Preservation	Holding Time
Alkalinity (bicarbonate, carbonate, total)	125 mL HDPE	Filtered (0.45µm)	28 days
Ammonia as N	125 mL HDPE	Filtered (0.45µm), cool 0ºC to 4ºC, sulfuric acid pH<2	28 days
Anions (bromine, chloride, fluoride, sulfate)	125 mL HDPE	Filtered (0.45µm)	28 days
Metals (arsenic, barium, calcium, cadmium, chromium, copper, iron, magnesium, manganese, molybdenum, sodium, lead, selenium, uranium)	500 mL HDPE	Filtered (0.45µm), nitric acid pH<2	6 months
Nitrate/Nitrite as N	125 mL HDPE	Filtered (0.45µm), cool 0ºC to 4ºC, sulfuric acid pH<2	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
Uranium (isotopic)	125 mL HDPE	Filtered (0.45µm), nitric acid pH<2	6 months

HDPE = high density polyethylene; µm = micrometers; mL = milliliters

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 the 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 (Appendix A).

4.3 Sample Collection

Groundwater samples can be collected with a peristaltic pump, bladder pump, submersible pump, inertia pump, or a bailer (refer to Procedures 6 and 8 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 19, "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 3 shows current sample analytes and container and preservation requirements. Calibration of field instrumentation will be conducted in the groundwater laboratory as specified in Table 4. Calibration checks will be conducted the morning of each day samples are being collected. If calibration acceptance criteria are not met during the operational check, a primary calibration of the affected probe(s) and instrument(s) must be conducted.

Probe replacement or cleaning may also be required if the operational acceptance criteria are not met. If a calibration check is off on one of the probes, the data that was collected in that time frame may be qualified during the data validation process.

Table 4. YSI Monitoring Meter Calibration Requirements

Parameter	Requirement	Frequency	Operational Check Criteria
pH	Three-point calibration	Before start of sampling event	NA
	One-point check	Once a day	±0.2 pH unit
Specific Conductance	One-point calibration	Before start of sampling event	NA
	One-point operational check	Once a day	±10% of standard
ORP	One-point calibration	Before start of sampling event	NA
	One-point operational check	Once a day	±10% of standard
Turbidity	Four-point calibration	Every 6 months	NA
	One-point calibration	Once a day	±10% of standard
Temperature*	NA	NA	NA

Note: * = The temperature probe is calibrated by the manufacturer.

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 submitted to the laboratory. Procedure 3, "Standard Practice for Chain-of-custody Control and Physical Security of Samples," in Appendix A will be implemented to provide security and document sample custody.

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

Packages, receipts, and any other shipping-related documents sent by a commercial carrier are retained as part of the chain-of-custody documentation. The sampling lead will record package tracking information and place shipping receipts in the appropriate folder.

Chain-of-custody records document all transfers of sample possession and show the samples were in constant custody between collection and analysis. A Chain-of-custody form (see Figure A-2 in Appendix A) will accompany samples sent or transported to an analytical laboratory by individuals other than a member of the field sampling team; a copy is retained by the originator and is eventually transferred to Records Management.

6.0 Decontamination of Sampling Equipment

Decontamination of non-dedicated 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 Non-radioactive Waste Sites" (Appendix A). Decontamination of non-dedicated sampling equipment will be conducted immediately after use at a sampling location. Between sampling or until further use, decontaminated equipment will be stored in protective containers or plastic bags (see Section 8.1.2, "Equipment Blanks").

7.0 Analytical Program

A comprehensive list of analytes, along with the required analytical methods and required detection limits, are listed in the indefinite deliver indefinite quantity (IDIQ) subcontract. The analytical methods used for surface water and groundwater 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 5.

Commercial laboratories provide these analytical services in accordance with "DOE Quality Systems for Analytical Services" (QSAS) to ensure data is 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 requirements in the *Moab UMTRA Project Standard Practice for Validation of Laboratory Data* (DOE-EM/GJTAC1855).

Table 5. 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 410.4
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	EPA 335.4
Fluorine	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 7470A
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
Nitrate-Nitrate Nitrogen	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
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	Titrimetric	EPA 376.1
Total Organic Carbon	0.3	IR	EPA 415.1
Technetium-99	1.0	PC	NA

Table 5. Analytes and Laboratory Techniques (continued)

Analyte	Required Detection Limit (mg/L)	Analytical Technique	EPA Analytical Method
Thallium	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; 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; PC = proportional counting; RE = radon emanation

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. Samples will be stored in the refrigerator in the groundwater laboratory trailer, and the temperature will be recorded on sampling event work days to ensure the temperature is at or below 4°C.

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. A Chain-of-custody form will show 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 codified at Title 49 Code of Federal Regulations Chapters 171-179 [49 CFR 171-179], "Pipeline and Hazardous Materials Safety Administration, Department Of Transportation" 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 Quality Assurance

Field QA procedures include following the standard operating procedures 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.

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 samples are collected as part of a site investigation and are validated at Level 1 or 2, then duplicates are not required (as per the *Standard Practice for Validation of Laboratory Data*). 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." If only one sample is collected, a duplicate is not necessary.

8.1.2 Equipment Blanks

Equipment blanks provide a check for cross-contamination of samples from improper equipment decontamination. One equipment blank sample will be prepared in the field for every 20 water samples that are collected with non-dedicated equipment. If fewer than 20 (and at least five) samples are collected with non-dedicated equipment, one equipment blank will be required. Equipment blanks will be prepared by collecting a sample of the final deionized (rinsate) water used to decontaminate non-dedicated 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. Refer to the *Groundwater Laboratory Chemical Hygiene Plan* for the training requirements for the laboratory.

8.3 Documentation

The Moab Water Sampling Field Data sheet (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 sheet 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 (if applicable).
- Field variances.
- Analytical report identification number(s).
- Equipment problems.
- Required action items.
- Photographs of sample locations as needed (well points and surface water locations).

8.4 Sampling Records

Records associated with or generated through groundwater and surface water sampling activities include, but are not limited to:

- Analytical Data.
    - Monitoring Reports
    - Water Sampling Field Data Forms
    - Chain-of-custody Sample Forms
    - Sampling Trip Reports

After each sampling event, the completed field data forms should be scanned into the designated folder and added to the Moab Environmental Sampling (MESa) software database. Once completed, the sampling trip report should be placed in the designated folder so that it is accessible for data validation. The documentation should also be submitted to Project Records.

9.0 Health and Safety

Information on health and safety (H&S) 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/Incident 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 H&S requirements described in the HASP.

Water sampling activities will be conducted according to the H&S requirements specified in the *Moab UMTRA Project Groundwater and Surface Water Sampling, Preservation, Shipment, and Transport* (IWP-JSA-003) and the HASP. Task-specific H&S requirements may also be addressed in H&S 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 an IWP/JSA, it will be necessary to contact H&S. Groundwater laboratory use will be conducted according to the *Groundwater Laboratory Chemical Hygiene Plan* (DOE-EM/GJTAC2144).

10.0 Surface Water Monitoring

The FWS Biological Opinion (which is presented in the Final EIS) includes five Reasonable and Prudent Measures that were developed to minimize the impacts of incidental take of endangered Colorado River fishes. The first measure states the DOE will implement monitoring backwater habitats near the Moab site for any indication of fish being affected by surface water contamination.

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 an on-site ammonia probe with the backwater channel observations and introducing fresh water into the backwater channels (using the freshwater diversion system) for ammonia dilution, if necessary. The ammonia probe manual is included in Attachment 1, posted on the Project's SharePoint website with the Plan.

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 Colorado River hydrograph has peaked and is on the descending limb (as measured at the U.S. Geological Survey Cisco gaging station number 09180500).Visual inspections of the habitat area during the descending limb will allow staff to notice if or when a suitable habitat has formed. 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 no longer utilize these types of habitat areas.

There may be years when a suitable habitat does not exist adjacent to the site (if the channel is dry, for example). When this occurs, the conditions should be documented and photographed. The channel should continue to be visually monitored during fluctuating river flow in case a suitable habitat develops.

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 FWS 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. 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.

Historical sampling events indicate the areal extent of potentially suitable fish habitat at the site 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 four foot deep knotless seine dipnet (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 10.6. 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 (or equivalent) monitoring meter, and the area will be photographed and documented. In addition, ammonia samples may be collected and analyzed with a Hach Sension (or equivalent) Ammonia Gas Sensing Combination Electrode (see Attachment 1). If the unionized ammonia concentration exceeds background in a habitat area, fresh water will be diverted into the backwater channel to dilute the contaminants as discussed in Section 2.3, “Surface Water Diversion,” in the September 2020 update of *Moab UMTRA Project Operations and Maintenance Manual* (DOE-EM/GJTAC1973). 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 contaminant plumes discharge to the Colorado 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 riverbed 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 riverbank, 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 2019 Groundwater Program Report* (DOE-EM/GJTAC3037) indicate the potential habitat area has migrated south and east, toward Configuration (CF) 4, since the IA commenced in 2005.

10.4 Personnel

The surface water 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 any stressed fish should also be documented.

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). If dead or nearly dead fish cannot be readily identified then should be placed in a plastic zippered bag and covered with a 50:50 solution of isopropyl alcohol. 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

The FWS Ecological Services office should be notified at (801) 975-3330 as soon as possible after collection of fish samples to make arrangements for fish identification. Additionally the Moab office of the Utah Division of Wildlife Resources can be contacted with fish sampling and identification questions.

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 clarification regarding protocols, collection techniques, or other habitat monitoring requirements is needed at any time during the monitoring period, the FWS or UDWR 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 Records

All documentation created as a result of compliance with this Plan is considered a Project record and will be managed in accordance with the *Moab UMTRA Project Records Management Manual* (DOE-EM/GJ1545). Moab UMTRA Project Records are retained and maintained in accordance with federal orders, policies, and regulations.

12.0 References

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

49 CFR 171-179 (Code of Federal Regulations), "Pipeline and Hazardous Materials Safety Administration, Department Of Transportation."

40 CFR 192 (Code of Federal Regulations), "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings."

42 USC 6901 (United States Code) Resource Conservation and Recovery Act.

ASTM (ASTM International) Standard D5088-02(2008), "Standard Practice for Decontamination of Field Equipment Used at Waste Sites."

ASTM (ASTM International) Standard D6698-07, "Standard Test Method for On-Line Measurement of Turbidity Below 5 NTUs."

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

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

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

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

DOE (U.S. Department of Energy), *Moab UMTRA Project Groundwater Laboratory Chemical Hygiene Plan* (DOE-EM/GJTAC2144).

DOE (U.S. Department of Energy), *Moab UMTRA Project 2019 Groundwater Program Report* (DOE-EM/GJTAC3037).

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

DOE (U.S. Department of Energy), *Moab UMTRA Project Integrated Work Plan/Job Safety Analysis Groundwater and Surface Water Sampling, Preservation, Shipment, and Transport*. (IWP/JSA-003).

DOE (U.S. Department of Energy), *Moab UMTRA Project Operations and Maintenance Manual* (DOE-EM/GJTAC1973).

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

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

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

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

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

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).

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

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

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

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

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

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

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

Appendix A.
Sampling Procedures

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 (see Plan Section 11.0).

Field Data Collections – For purposes of this practice, technical record collections will refer to log books and field data sheets.

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 (see Plan Section 11.0).

- 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.
- 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 Collections
Field Data sheets will be collected and maintained by sampling personnel until uploaded to drives and/or Moab Environmental Sampling (MESa) software database and submitted to records.

Issue and Control of Field Data Collection

A Field Data Collection will be designated for an activity or a person for use on a project. Upon completion of the collection, the document(s) is transported to Records Management by the Groundwater Manager or designee. If a Field Data Collection contains information on more than one activity or project, the collection will clearly identify the portion associated with each activity or project, and reproducible copies of the applicable sections are submitted to Records Management (see Plan Section 11.0).

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

1. Keep the collection in his or her possession during the sampling event.
2. Ensure all appropriate information is entered into the Moab Environmental Sampling (MESa) software database.
3. Ensure the QC/calibration/and data sheets are legible, correct, and complete before turning the sheets into Records Management.

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 Collection 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; non-conformances 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 a deviation from “shall,” “must,” or “will” statements in 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 Collections

A reviewer will review Field Data Collections 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 or she must sign and date the bottom of each Field Data Sheet.

Appendix A. Sampling Procedures (*continued*)

Procedure 2
Standard Practice for Sample Labeling

Scope

This procedure addresses labeling requirements and recommended practices for labeling samples 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.

Samples collected for in-house ammonia probe analysis may be labeled directly on the sample container.

Terminology

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

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

***Duplicate sample*s** – 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.

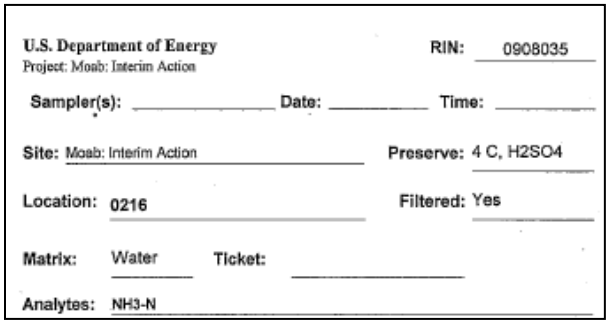

U.S. Department of Energy
Project: Moab: Interim Action
RIN: 0908035
Sampler(s): _____ Date: _____ Time: _____
Site: Moab: Interim Action
Preserve: 4 C, H2SO4
Location: 0216
Filtered: Yes
Matrix: Water
Ticket: _____
Analytes: NH3-N

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 Forms

Procedure for Obtaining Sample Numbers

Sample numbers are created for each sample location Every sample 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 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).
    - Location sample collected; examples include well numbers, grid locations, or surveyed coordinates.
    - Time 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.

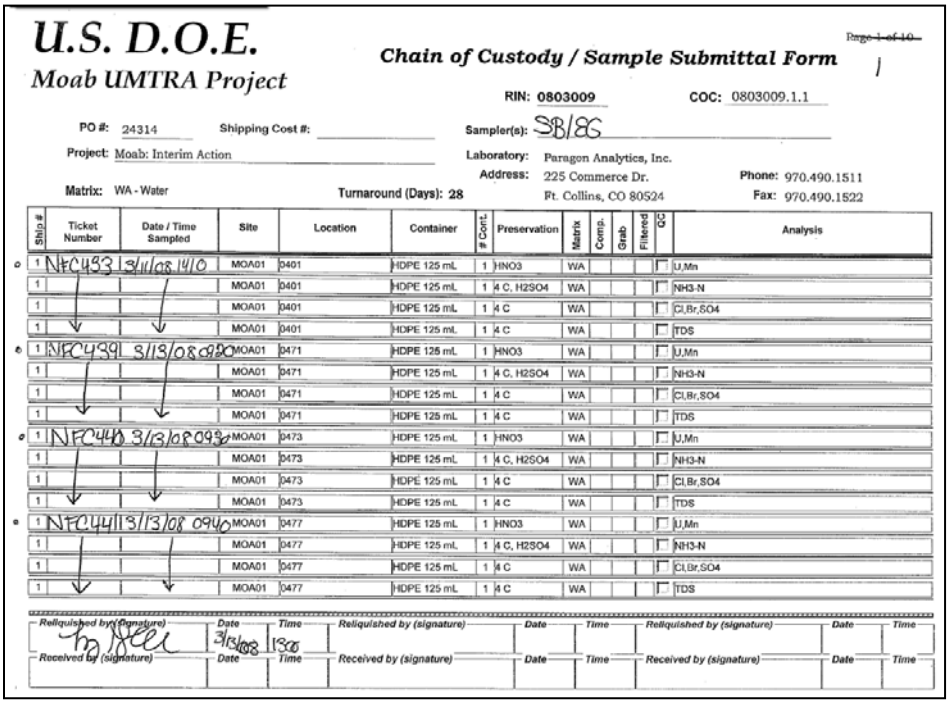
Duplicate samples – More than one sample collected from the same source location, but placed in separate containers.

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
- Containers and/or enclosures as appropriate to provide physical security of the samples



U.S. D.O.E.
Moab UMTRA Project

Chain of Custody / Sample Submittal Form

Page 1 of 10

RIN: 0803009 COC: 0803009.1.1

PO #: 24314 Shipping Cost #:

Sampler(s): SB/BG

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	GC	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 0820	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

Relinquished by (signature)	Date	Time	Relinquished by (signature)	Date	Time	Relinquished by (signature)	Date	Time
[illegible]	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 or fill out the form on a computer and print it.
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 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. Non-contractor employees are not required to sign the form (e.g., employees of 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 and initials
   - Sample location and virtual ticket number, if used
   - Date and time of sample collection
   - Number and types of sample bottles
8. 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 must be included with the chain-of-custody.

9. 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.
10. When seals are applied to the sample container, they must not obscure the information on the sample label (Figure A-3).
11. 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.
12. 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.

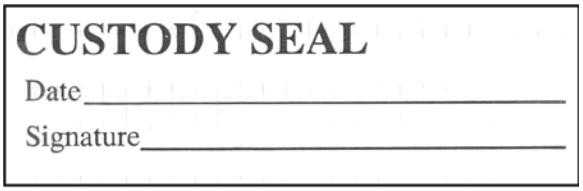


Figure A-3. Example of Custody Seal

13. The original chain-of-custody record and the radiological scan (if necessary) shall accompany the samples until they are received by the laboratory.
14. 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. Samples will be stored in the refrigerator in the groundwater laboratory trailer. During sampling event work days, the temperature of the refrigerator will be recorded on a log on the refrigerator door.

Use security seals where appropriate. Although security seals do not provide physical security, the seals are evidence 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.

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) IDIQ.

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

Terminology

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 (Title 42 United States Code Section 6901) 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 IDIQs 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 IDIQ 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 an evenly distributed radionuclide.

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 IDIQ.

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 with 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.

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 sampling 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 Moab Environmental Sampling (MESa) 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 (see 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-2 for an example of a 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 a signed Chain-of-custody Form. 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, if applicable.
- 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 statement of work 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 (see Plan Section 11.0).

Procedure 5
Standard Practice for Decontamination of Field Equipment Used at Non-radioactive Waste Sites

Summary of ASTM International (ASTM) Standard D5088-02(2008)

ASTM Standard D5088-02(2008), "Standard Practice for Decontamination of Field Equipment Used at Waste Sites," which provides guidance for the decontamination of field equipment used in the sampling of soils, soil gas, sludges, surface water, and groundwater at non-radioactive 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.

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.

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 when:

- 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 as 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 that 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 groundwater 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-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 non-reactive 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 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, degassing, 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 situations when the liquid level is less than 25 ft below the surface. • Drop in pressure of suction lift mechanism causes degassing of the sample and loss of volatiles. • Choice of construction material is limited. • Centrifugal pumps must 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 groundwater 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 volatile compounds. • Must wait more than 24 hours after installation to collect sample.

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.

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

Introduction
Water level measurements shall be taken before any sampling or well purging. 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 non-pumping 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 northern 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.

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 $^{1}/_{100}$ ft 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.

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 $^{1}/_{100}$ ft, 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 $^{1}/_{100}$ ft.
7. If dirt is visible on the indicator, 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 $^{1}/_{100}$ ft.

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 groundwater 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 at the appropriate sample depth.
2. Connect the suction line to the pump.
3. Connect the pump outlet to the in-line flow cell (bottom connection of 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. Routinely monitor and record the volumes purged and the readings for the pH, conductivity, and temperature.
6. When pH and specific conductance have stabilized to ±10 percent for two successive readings, sampling can begin. Typically, 2.5 to 3 liters (L) of water are purged, and readings are collected at 1L increments.
7. 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 (bottom connection of flow cell).
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 pH and specific conductance have stabilized to ±10 percent for two successive readings, 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, PVC, 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 and specific conductance have stabilized for two successive readings, 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:

- YSI monitoring meter.
- 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 monitoring meter 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, as required.

QA

All of the methods listed above require the following information to be logged for 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 Wells

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

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

Apparatus
- Sample labels
- Field water parameter monitoring meter(s)
- 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 by lowering the water level indicator directly into the well.
2. 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.
3. Record the temperature, pH, temperature, conductivity, and ORP onto the Field Data Sheet after the parameters stabilize.
4. 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

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
- Field water parameter monitoring meter(s)
- 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 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 field parameter monitoring meter 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. On occasion, a grab sample may be collected. These samples are collected by dipping a jar directly into the body of water. This may be done when collecting ammonia probe samples from the backwater channel.

12. Label and preserve the samples according to Procedures 2 and 6.
13. 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 groundwater samples from well points. The well points are located along the riverbank 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
- Field water parameter monitoring meter(s)
- 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 with 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 field parameter monitoring meter 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 with 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 to determine 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 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 monitoring meter instrument handbook. If the YSI monitoring meter 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, which contains all the probes, 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 groundwater 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:

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

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 Zobell reference 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 monitoring meter 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 under normal ambient temperatures. If it reads 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 (ºC)	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)

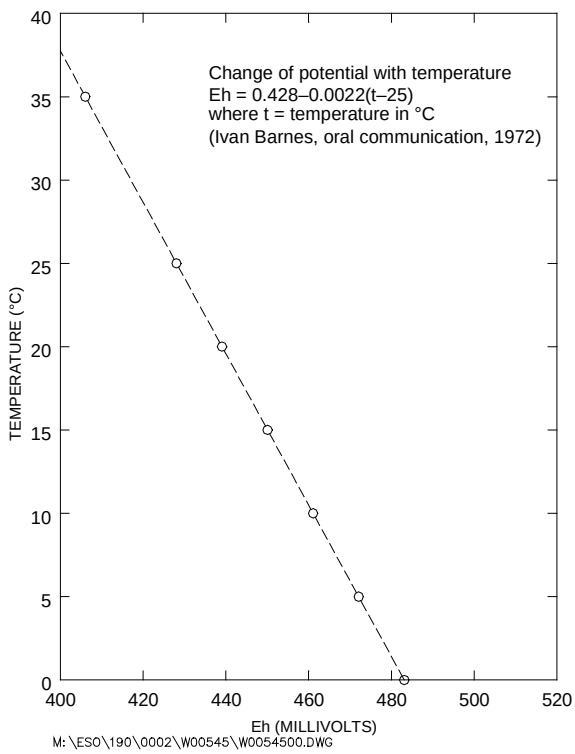


Figure A-4. The Eh of Zobell Solution, Relative to the Standard Hydrogen Electrode at Various Temperatures

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.

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 groundwater 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 monitoring meter 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 monitoring meter.
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 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 monitoring meter 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

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 groundwater 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 groundwater 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 liter, 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 monitoring meter instrument handbook. If the YSI meter 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 deionized 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 calibration of the pH probe shall be logged for QA documentation.

- Buffer temperature at time of calibration
- Expiration date of buffers used
- 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, DO, and in saturation and stability studies. It is important to know the temperature of surface waters and groundwaters for the accurate geochemical evaluation of equilibrium thermodynamics.

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.

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.

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 appendix addresses specific procedures, equipment, and documentation requirements when using the HACH model 2100Q portable turbidimeter to measure turbidity of groundwater.

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 2100Q portable turbidimeter.

Turbidities greater than 1,000 NTUs may be measured using the HACH model 2100Q 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 groundwater 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
- Field data sheets
- Kimwipes or equivalent lint-free tissue

Calibration Procedure
Please refer to the 2100Q User Manual 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 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 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 deionized 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
- Sampler’s name

Procedure 19
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.

Organic – A compound that contains carbon.

Safety Data Sheet – Printed material that provides descriptions of the properties, hazards, and H&S considerations of a chemical or material, emergency measures in case of an accident, and instructions on the safe handling of the chemical or material.

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

UMTRA Project

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

Sampling Equipment:

☐ Peristaltic ☐ Bladder (Dedicated) ☐ Poly Tubing (Dedicated) ☐ Dedicated Submersible

YSI 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**		

SAMPLE

Filters: Number of 0.45 µ disposable filters used _____ **Weather:** _____

Sample Preservation: Is ice in cooler ☐ YES ☐ No

Well Category: I II III IV WP

Comments: _____

Signature of Sampler _____ **Date Signed** _____

Checked By _____ **Date Checked** _____

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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 "Specification and Guidance for Contaminant-Free Sample Containers."
3. Label the bottles as required by the planning documents or Procedure 2.
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 using fume hood and proper personal protective equipment ().
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.

Table A-10. Guidelines for Preservation of Samples

Analytical Parameter	Container Type/Size	Preservation	Holding Time
Inorganic Anions			
Cl, SO_4, F, 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 48 hrs

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

Analytical Parameter	Container Type/Size	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 = amber; G = glass; hrs = hours; P = polyethylene

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 vial.
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.
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.

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. The fume hood will be used to preserve all samples.
- Preserve samples as soon after collection as possible.
- Take care not to cross-contaminate samples with preservatives. The ammonia 125-mL bottles require approximately 13 drops of sulfuric acid, and the metals 125-mL jars require ½-mL of nitric acid. Follow all SDS 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 3 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

On the water sampling Field Data Sheet (Figure A-5), record the following information about the sample collection, filtration, and preservation for QA documentation.

- Time and date of purge
- The number and type of filter used for filtration
- The name of the person performing the sampling

Procedure 20
Standard Practice for the Inspection and Maintenance of Groundwater Monitoring Wells

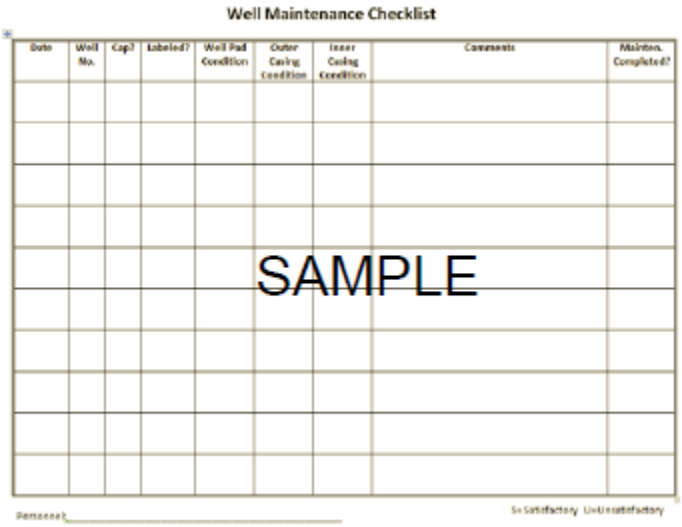
Introduction
Groundwater monitoring wells are commonly used for obtaining groundwater samples, groundwater elevation measurements, and measuring aquifer hydraulic parameters. Because of natural processes and human activities, the condition of groundwater monitoring wells may deteriorate with time. If 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 required well maintenance.

Scope
This procedure describes the standard practice for conducting routine inspections of groundwater 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 may include correcting deficiencies in the surface components of the well and redeveloping the well.

Significance and Use
Application of this practice will prevent most forms of degradation in monitoring wells, 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 groundwater 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 Well Maintenance Checklist (Figure A-6) shall be completed and filed in Project records.

Apparatus
- Well location map
- Well Maintenance Checklist (Figure A-6)
- Black ink pen
- PPE/clothing (e.g., safety glasses, steel-toed safety shoes, hard hats, gloves, monitoring equipment).



Well Maintenance Checklist

Date	Well No.	Cap?	Labeled?	Well Pad Condition	Outer Casing Condition	Inner Casing Condition	Comments	Mainten. Completed?

SAMPLE

Personnel: _____ S=Satisfactory U=Unsatisfactory

Figure A-6. Well Maintenance Checklist

Procedures

Inspection and Documentation

Each item on the Well Maintenance Checklist shall be completed as the inspection is conducted. This completed form shall be given to Records.

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.

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.
6. 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.
7. Check the well number or well identification to determine if it is clearly marked and in agreement with the well location map.
8. All deficiencies should be noted and corrective actions should be completed and noted on the Well Maintenance Checklist.

QA

The checklist must be signed by the person completing the forms. Any discrepancies should be corrected by the well maintenance technician. The checklist should then be filed in the Project records files in accordance with the *Records Management Manual* (see Plan Section 11.0).

Appendix B.
Sample Location Information

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

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
0564	II	Well Point	1	1.2 to 2.2	2.2
0565	II	Well Point	1	4.0 to 5.0	5.0
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

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

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

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 Pump 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; obs = observation

Table B-7. Site-wide Observation Well Sampling Locations and Sample Depths

Location Number	Typical Category	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
0401	I	1	18	18.1
0403	I	1	18	20
0404	I	1	18	20
0407	I	1	17	18.5
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
0439	I	2	118	120
0440	I	2	117	119
0441	I	2	53	54.2
0443	I	2	73	80
0444	I	2	116	120
0453	I/II	2	80	80.5
0454	I	2	13	21.4
0455	I	1	46	48.5
0456	I	1	53	55
0457	I	1	29	31
0492	I	1	18	20
AMM-1-19	I	4	19	57
AMM-2	I	4	48	50
AMM-3	I	4	48	50
ATP-1-S	I	2	143	145
ATP-1-IS	I	2	213	215
ATP-1-D	I	2	395	402
ATP-1-ID	I	2	293	400
ATP-2-S	I/II	2	25	38
ATP-2-D	I/II	2	88	90
ATP-3	I	4	51	60
MW-3	I	2	44	62
SMI-MW01	I	2	16	30
SMI-PW01	I	4	40	63
SMI-PW03	I	4	60	60
SMI-PZ1S	I	2	18	20
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

Table B-7. Site-wide Observation Well Sampling Locations and Sample Depths (continued)

Location Number	Typical Category	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
TP-09	I	1	26	28
TP-11	I	1	30	32
TP-17	I	1	28	32
TP-19	I	1	29	32
TP-20	I	1	32	36
TP-22	I	2	17	18
TP-23	I	2	25	26
UPD-17	I	1.5	14.5	15.3
UPD-18	I	1.5	13	14.7
UPD-19	I	1.5	14	15.25
UPD-20	II	1.5	17	29.4
UPD-21	I	1.5	25	27
UPD-22	I	1.5	9	16.6
UPD-23	II	1.5	26	29
UPD-24	I	1.5	27	29.8

ft bgs = feet below ground surface

Table B-8. Site-wide Surface Water Sample Locations

Sample Number	Location
CR1	Upriver
0201	On site
0218	On site
CR2	On site
CR3	On site
0226	Downriver
0228	Downriver
CR5	Downriver

Table B-9. Matheson Wetlands Sample Locations

Location Number	Typical Category	Well Diameter (inches)	Sample Depth (ft bgs)	Total Depth (ft bgs)
BL1-S	I	2	55	57
BL1-M	I	2	99	101.1
BL1-D	I	2	140	142
BL2-S	I	2	57	56
BL2-M	I	2	100	102
BL2-D	I	2	142	142
BL3-M	I	2	47	48
BL3-D	I	2	100	101
N6-6.4	I	2	11	12
N3 8.3	I	0.75	24	27

Table B-10. Locations Potentially Subject to Arsenic, 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
0411	Observation well	Selenium
0412	Background Observation Well	Arsenic, Selenium
0413	Background Observation Well	Selenium
0414	Background Observation Well	Arsenic, Selenium
0437	On- pile Observation Well	Selenium
0439	On-pile Observation Well	Arsenic, Selenium
0440	Background Observation Well	Selenium
0442	Background Observation Well	Selenium
0453	Observation well	Selenium
0456	Off-site Observation Well	Selenium
0778	CF4 Remediation Well	Copper
0785	CF4 Observation Well	Copper
0787	CF4 Observation Well	Copper
0792	CF4 Well Point	Selenium
SMI-MW01	Observation Well	Arsenic
MW-1-R	Off-site Observation Well	Selenium
MW-3	Observation well	Selenium
SMI-PZ3S	Baseline Observation Well	Arsenic, Selenium
TP-01	Observation Well	Arsenic
TP-17	Off-site Observation Well	Selenium
UPD-17	U-Plume Observation Well	Arsenic, Selenium
UPD-18	U-Plume Observation Well	Arsenic, Selenium
UPD-20	U-Plume Observation Well	Arsenic, Selenium
UPD-21	U-Plume Observation Well	Arsenic, Selenium
UPD-22	U-Plume Observation Well	Arsenic, Selenium
UPD-23	U-Plume Observation Well	Arsenic, Selenium
UPD-24	U-Plume Observation Well	Arsenic, Selenium
AMM-1	Observation Well	Arsenic, Selenium
AMM-2	Observation Well	Arsenic, Selenium
AMM-3	Observation Well	Arsenic, Selenium
ATP-2-D	Observation Well	Arsenic, Selenium
ATP-2-S	Observation Well	Arsenic, Selenium
ATP-3	Observation Well	Arsenic

Appendix C.
Example Field Datasheet

Appendix C. Example Field Datasheets

UMTRA Project

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

Sampling Equipment:

☐ Peristaltic ☐ Bladder (Dedicated) ☐ Poly Tubing (Dedicated) ☐ Dedicated Submersible

YSI No.: _____ Hach 2100P Turbidimeter _____

Calibration Time _____ **Purge Start Time** _____ **Open Container** ☐ **Air exclusion** ☐

Time	Total Volume Purged (L)	Water Level	Temp (^{0}C)	Conductivity ATC (µmhos/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)
Final Sample Data						**Sample Time**		

SAMPLE

Filters: Number of 0.45 µ disposable filters used _____ **Weather:** _____

Sample Preservation: Is ice in cooler ☐ YES ☐ No

Well Category: I II III IV WP

Comments: _____

_____

_____

_____

Signature of Sampler _____ **Date Signed** _____

Checked By _____ **Date Checked** _____

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UMTRA Project

Moab Water Sampling Field Data
Quality Assurance Sample Log

Date: _____ Well / Location No.: _____

Sample Number: _____ False Identification Location: _____

Sample Type: ☐ Duplicate ☐ Equipment Blank ☐ Other: _____

Comments: _____

_____

Date: _____ Well / Location No.: _____

Sample Number: _____ False Identification Location: _____

Sample Type: ☐ Duplicate ☐ Equipment Blank ☐ Other: _____

Comments: _____

_____

SAMPLE

Date: _____ Well / Location No.: _____

Sample Number: _____ False Identification Location: _____

Sample Type: ☐ Duplicate ☐ Equipment Blank ☐ Other: _____

Comments: _____

_____

Date: _____ Well / Location No.: _____

Sample Number: _____ False Identification Location: _____

Sample Type: ☐ Duplicate ☐ Equipment Blank ☐ Other: _____

Comments: _____

_____

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UMTRA Project

YSI Pre-Trip Calibration

Name _____ **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

SAMPLE

☐ 1 Point Calibration ☐ 2 Point Calibration ☐ 3 Point Calibration (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: _____

Hach 10 or 20 NTU Gelex Standard Reading: _____

Primary Calibration Standards Expiration Date: _____

Date of Primary Calibration: _____

Dissolved Oxygen Calibration (Optional)

DO Membrane changed? ☐ Y ☐ N

DO Charge: _____Range: 50± 25 DO Gain: _____Range: 0.7 – 1.4

** For acceptable calibration standard ranges refer to calibration standard information sheet.*

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UMTRA Project

YSI Daily Calibrations / Checks

Date: _____ Time: _____ Initials: _____

YSI No.: _____ 2100P No.:_____

Calibration Check

STANDARD	STANDARD VALUE	MEASURED VALUE	WITHIN RANGE? Y / N	RECALIB-RATED? Y / N	COMMENTS
Temp.	n/a		n/a	n/a	
pH 4	4.00				
pH 7	7.02				
pH 10	10.06				
Cond.	10,000				
ORP	237.5				
D.O.[2]	n/a		n/a		
Turb	20 NTU				

SAMPLE

Date: _____ Time: _____ Initials: _____

YSI No.: _____ 2100P No.:_____

Calibration Check

STANDARD	STANDARD VALUE	MEASURED VALUE	WITHIN RANGE? Y / N	RECALIB-RATED? Y / N	COMMENTS
Temp.	n/a		n/a	n/a	
pH 4	4.00				
pH 7	7.02				
pH 10	10.06				
Cond.	10,000				
ORP	237.5				
D.O.[2]	n/a		n/a		
Turb	20 NTU				

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Appendix D.
Required Training

Appendix D. Required Training

Water Sampling Training Requirements

Employee Name:_____ Date:_____

Position Title:_____

Required Training Courses			
	Required?	**Date Due**	**Date Completed**
24-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			
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			
Introduction to Incident or Occurrence Reporting			
Required Sampling Training			
OJT 40 hours			
Moab UMTRA Project Surface/Water Groundwater Sampling and Analysis Plan			
Sampling Required Reading			
Well Field Operations and Maintenance Manual			
Moab Site HASP			
IWP-JSA-003 Groundwater and Surface Water Sampling, Preservation, Shipment, and Transport			
Groundwater Laboratory Chemical Hygiene Plan (there are additional requirements for use of the GW laboratory that are listed in this plan).			