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Mike Layton
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Fuel Cycle Licensing Branch
Mail Stop T7C6
Washington, D.C. 20555-0001

Subject: *Sampling and Analysis Plan for the UMTRA Ground Water Project*

Dear Mr. Layton:

Enclosed for your information is a copy of the above-referenced document.

Periodically, the Department of Energy-Grand Junction Office UMTRA Ground Water Project updates its Sampling and Analysis Plan (SAP). The SAP discusses sampling protocol, quality assurance, the analytical program, identification and handling procedures, and data validation. Moab ground water, as well as Long-Term Surveillance & Maintenance Program and the UMTRA Ground Water project will follow sampling and analysis procedures and protocols outlined in this SAP.

If you have any questions concerning this most recent update, please call me at 970/248-7612.

Sincerely,

A handwritten signature in black ink, appearing to read "D. Metzler", is positioned below the word "Sincerely,".

Donald R. Metzler
Projects Implementation Leader

Enclosure

cc w/o enclosure:
Project File GWADM 19.1 (P. Taylor)

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Sampling and Analysis Plan for the UMTRA Ground Water Project

October 2001

Prepared by the
U.S. Department of Energy
Grand Junction Office



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Rev. 5

UMTRA Ground Water Project

**Sampling and Analysis Plan
for the
UMTRA Ground Water Project**

October 2001

Prepared by
U.S. Department of Energy
Grand Junction Office
Grand Junction, Colorado

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Sampling and Analysis Plan for the UMTRA Ground Water Project

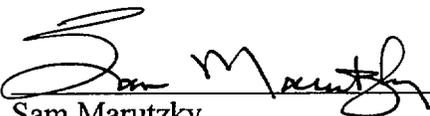
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31 Oct. 2001
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Appendix B	UMTRA Ground Water Project DOE-GJO Equivalent Water Sampling Procedures
Appendix C	UGW Data Validation Guidance

Acronyms and Abbreviations

AS	Alpha Spectrometry
ASTM	American Society for Testing and Materials
BGC	Beta/Gamma Coincidence
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FAA	Flame Atomic Absorption Spectroscopy
FY	fiscal year
GC-MS	Gas Chromatograph - Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption Spectroscopy
GJO	Grand Junction Office
Hydride AA	Sodium Borohydride Reduction Atomic Absorption Spectrometry
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
IR	Infrared
LSc	Liquid Scintillation
mL	milliliter
mL/min	milliliter per minute
NTU	nephelometric turbidity units
ORP	oxidation-reduction potential
PC	Proportional Counting
PCB	polychlorinated biphenyls
semiVOC	semivolatile organic compounds
SOP	standard operating procedures
TAC	Technical Assistance Contractor
TDS	total dissolved solids
TPH	total petroleum hydrocarbon
UMTRA	Uranium Mill Tailings Remedial Action (Project)
VOC	volatile organic compound

1.0 Introduction

This plan incorporates U.S. Department of Energy (DOE) Grand Junction Office (GJO) standard operating procedures (SOPs) into ground water and surface-water sampling activities conducted for the Uranium Mill Tailings Remedial Action (UMTRA) Ground Water Project. This document provides detailed procedures to the field sampling teams so that samples are collected in a consistent and technically sound manner. In addition, this document incorporates certain aspects of Jacobs Engineering SOPs in order to maintain consistency and continuity in sample collection activities. The *FY 2002 Sampling Frequencies and Analyses* (DOE 2001c) (and subsequent revisions) will be the document that specifies monitor well locations, sampling frequency, and analytes for each site. A flowchart detailing project tasks required to accomplish routine UMTRA water sampling is displayed in Figure 1-1.

DOE-GJO SOPs are contained in the *Environmental Procedures Catalog*, Manual 6 (DOE continually updated) which incorporates DOE and U.S. Environmental Protection Agency (EPA) guidance; specific procedures used for this project are listed in Table 1-1 and can be found in Appendix A. (Some procedures have been modified to reflect current research on sampling.)

Table 1-1. DOE-GJO Procedures Used for the UMTRA Ground Water Project

Standard Practice for Preparing or Revising Procedures for the GJO *Environmental Procedures Catalog* [GA-1(P)]
Standard Practice for Field Documentation Processes [GT-1(P)]
Standard Practice for Sample Labeling [GT-2(P)]
Standard Practice for Chain-of-Sample-Custody Control and Physical Security of Samples [GT-3(P)]
Standard Test Method for the Measurement of Water Levels in Ground Water Monitoring Wells [LQ-2(T)]
Standard Practice for Purging of Monitoring Wells [LQ-3(P)]
Standard Test Method for the Field Measurement of pH [LQ-4(T)]
Standard Test Method for the Field Measurement of Specific Conductance [LQ-5(T)]
Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential (Eh) [LQ-6(T)]
Standard Test Method for the Field Measurement of Alkalinity [LQ-7(T)]
Standard Test Method for the Measurement of Temperature [LQ-8(T)]
Standard Test Method for the Measurement of Dissolved Oxygen [LQ-9(T)]
Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)]
Standard Practice for the Sampling of Liquids [LQ-11(P)]
Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples [LQ-12(P)]
Standard Practice for the Inspection and Maintenance of Groundwater Monitoring Wells [LQ-18(P)]
Standard Test Method for Turbidity in Water [LQ-24(T)]

These procedures require additional detail from project planning documents in order to be complete; the following sections fulfill that function and specify additional procedural requirements. Appendix B summarizes a comparison of water sampling procedures contained in the Jacobs Engineering Group's *TAC Hydrological Standard Operating Procedure*, Section 16 (JEG 1992), the DOE-GJO *Environmental Procedures Catalog* (DOE continually updated), and American Society for Testing and Materials (ASTM) procedures.

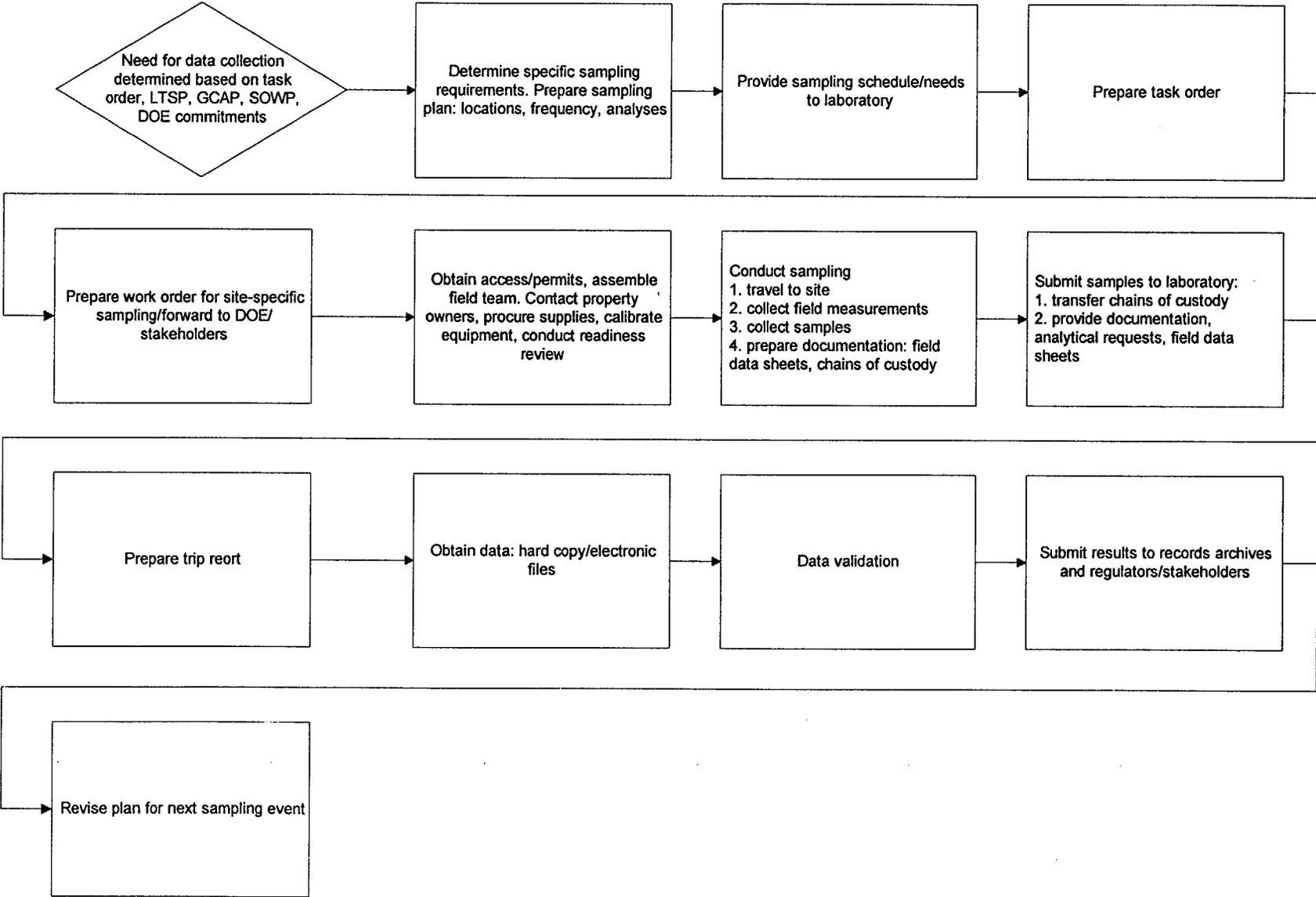


Figure 1-1. UMTRA Ground Water Project Sampling Flowchart

2.0 Sampling Protocol

2.1 Well Classification

Ground water sampling protocol will vary based on the classification of the well. Wells will be classified according to their hydraulic properties as follows:

Category I – Wells that produce a minimum of 100 milliliters per minute (mL/min).

Category II – Wells that produce less than 100 mL/min and the initial water level is above the top of the screened interval.

Category III – Wells that produce less than 100 mL/min and the initial water level is within the screened interval.

Category IV - Domestic and flowing wells.

2.2 Category I Protocol

Purging and sampling of Category I wells will be accomplished using a low-flow method that involves pumping at a low flow rate with a dedicated pump or tubing. In theory, the slow pumping rate will allow water to flow directly from the formation to the pump intake. The slow pumping rate will result in minimal mixing with the stagnant water column above the pump intake, minimal pumping-induced turbidity, and minimal disturbance of sediment collected in the end cap of the well. Using the Category I sampling protocol will provide the highest quality sample.

Category I wells will be purged using project-specific requirements. The intake of the portable pump, dedicated pump, or dedicated tubing should be placed in the approximate middle of 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 DOE-GJO procedure LQ-2 (T), *Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells*, depth to water will be measured with an electric sounder immediately prior to purging. The initial pumping rate should not exceed 500 mL/min. At the start of pumping, the water level should be monitored continuously to determine if drawdown is occurring. If drawdown is occurring at the initial pumping rate, the pump rate should be lowered until the drawdown stops or the 100 mL/min pump rate is obtained. If the water level stabilizes (no further drawdown), then the well may be purged and sampled at that flow rate. Water levels in the well will be measured and recorded every 3 to 5 minutes on the Field Data Sheet during the purging process to document that drawdown was not occurring during the purge. If the water level has not stabilized and the minimum flow rate of 100 mL/min has been obtained, then the well must be purged until the water level stabilizes or until the top of the screened interval is reached. If the top of the screen is encountered at the minimum flow rate, then the well becomes a Category II well.

After the start of the low-flow purging process, turbidity will be measured at regular intervals three to five minutes apart. Sample collection will begin as soon as turbidity stabilizes and two

pump/tubing volumes have been removed; turbidity is considered stabilized when a reading of less than 10 nephelometric turbidity units (NTUs) is measured.

Purge water will be disposed of according to the *Technical Approach for the Management of UMTRA Ground Water Investigation-Derived Wastes* (DOE 1994) and the *Management Plan for Field-Generated Investigation Derived Waste* (DOE 1997).

2.3 Category II Protocol

The following protocol will apply to wells that are classified as Category II. A maximum flow rate of 100 mL/min will be used to purge and sample wells in this category. Sampling can occur as soon as two pump/tubing volumes are removed. Although there is no turbidity or drawdown criteria, water levels will be monitored during the purge and documented every three to five minutes. Recording of water levels will document that the well is a Category II well and will document the water level at the time of sampling. If purging of two pump/tubing volumes results in a water level below the top of the screened interval, then the well becomes a Category III well.

2.4 Category III Protocol

Category III wells will be sampled with a bailer. There are no stabilization or drawdown criteria for Category III wells. 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. The bailer can either remain in the water column between sampling events, or be lowered very slowly into the water column. Because the volume of water is limited, prioritization of analytes will be required. This will require an estimation of sample volume prior to the sampling event. The volume estimate will be discussed with the Site Lead and the analytical laboratory to determine which constituents will be analyzed. If a sufficient volume of water cannot be obtained from the first bailer, then the well cannot be sampled. Note: if depth to water is within the potential for suction lift, then a peristaltic pump also can be used for category III wells and the entire casing volume can be collected.

2.5 Category IV Protocol

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

2.6 Field Measurements and Calibration

Field measurements, which include alkalinity, dissolved oxygen, electrical conductivity, pH, oxidation-reduction potential (ORP), and temperature, may be required on a site-specific basis. Turbidity is the only field measurement that is considered a stabilization parameter and will be a required measurement at all sites. Calibration and/or operational checks of instrumentation used to make field measurements will be conducted according to the following criteria.

The temperature probe will be operationally checked at the start of each sampling trip by measuring the temperature of an ice-water bath; an acceptance criterion of $0^{\circ} \pm 0.3^{\circ} \text{C}$ will be applied to the measured temperature. At the beginning of the sampling trip, the

conductivity, dissolved oxygen, ORP, pH, and turbidity instruments will be calibrated/checked according to procedures listed in Appendix A. A primary calibration of the turbidity meter will be conducted on a 6-month frequency. During the sampling trip, an operational check will be conducted and documented twice daily. Acceptance criteria is as follows: conductivity ± 10 percent, dissolved oxygen ± 0.2 mg/L, ORP ± 10 mV, pH ± 0.1 pH units, and turbidity ± 10 percent. If the acceptance criteria are not met during the operational check, then a primary calibration of the affected probe(s)/instrument(s) must be conducted. Probe replacement or cleaning also may be required if the operational acceptance criteria are not met.

Total alkalinity also will be measured in the field using a HACH digital titrator. Procedures for conducting total alkalinity measurements are in Appendix A.

2.7 Sample Collection

Ground water samples can be collected with a peristaltic pump, bladder pump, submersible pump, or a bailer. The specific method used for withdrawing water from the well will be determined in the field on the basis of site-specific conditions and the category of the well. Sample collection will be conducted using the same flow-rate used during the purging of the well. Generally, sampling will be conducted proceeding from the least to most contaminated areas of the site, as access allows, unless dedicated equipment is used.

Surface water samples will be collected using a stainless steel weight attached to the intake tubing of the peristaltic pump. The stainless steel weight has an intake port approximately 2 inches above the base of the weight, which will allow the sample to be collected near the bottom of the surface water feature. The location of a surface water grab sample will be determined using the following protocol.

For surface water features that are less than 6 feet wide, the sample will be collected from approximately the middle. For surface water features that are greater than 6 feet wide, the sample will be collected 1 to 3 feet from the shore. Samples collected in flowing surface water features greater than 6 feet wide (e.g. rivers, streams, ditches) will be collected within the main current and not in stagnant or back eddy areas. If stagnant or back eddy areas extend greater than 3 feet from the shore, then the sample will be collected at the nearest downstream location where the main current is within 3 feet of the shore. All surface locations will be designated by a wooden lathe or metal post inscribed with the location identification so that samples from subsequent rounds may be collected from approximately the same location. Sample collection location data will be collected using global positioning equipment.

Samples requiring filtration will use a 0.45-micron filter, and samples requiring refrigeration in the field will be stored with wet ice. For samples preserved with acid, the pH will be checked periodically (with pH paper) to ensure the proper pH level is maintained. Only commercially supplied, certified, solutions will be used for sample preservation. Sample container and preservation requirements are shown in Table 2-1.

Table 2-1. UMTRA Ground Water Sample Collection Requirements^a

Analytical Parameter	Container Type/Size	Preservation	Holding Time
Metals and Cations (Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Sr, Tl, Sn, U, V, Zn). Also Th-230, U-234, U-238	Amber HDPE/500 mL	Filtered (0.45 µm), HNO ₃ pH<2	6 months
Ra-226, Ra-228	HDPE/2 @ 1L ^b	Filtered (0.45 µm), HNO ₃ pH<2	6 months
Pb-210, Po-210	HDPE/1L ^b	Filtered (0.45 µm), HNO ₃ pH<2	6 months
Gross α, Gross β	HDPE/1L ^b	Filtered (0.45 µm), HNO ₃ pH<2	6 months
Gamma Spectrometry	HDPE/1L ^b	Filtered (0.45 µm), HNO ₃ pH<2	
Nickel-63	HDPE/1L ^b	Filtered (0.45 µm), HNO ₃ pH<2	
Tritium	HDPE/1L ^b	No preservative	
Anions (Br, Cl, F, SO ₄ , SiO ₂)	HDPE/125 mL	Filtered (0.45 µm), Cool 0-4 °C	28 days
Nitrate, Ammonium, Phosphate	HDPE/125 mL	Filtered (0.45 µm), H ₂ SO ₄ pH<2, Cool 0-4 °C	28 days
TDS	HDPE/125 mL	Filtered (0.45 µm), Cool 0-4 °C	7 days
TOC	HDPE/125 mL	H ₂ SO ₄ pH<2,	28 days
Sulfide	HDPE/1L ^b	Filtered (0.45 µm), NaOH pH >9, zinc acetate, Cool 0-4 °C	7 days
Cyanide	HDPE/1L	Filtered (0.45 µm), NaOH pH > 12, 0.6 g ascorbic acid if Cl ₂ present, Cool 0-4 °C	14 days
PCBs	Amber glass/1L ^c	Cool 0-4 °C	7 days
TPH	Amber glass/1L ^c	Cool 0-4 °C	14 days
VOCs	Amber glass/3 @ 40 mL	Cool 0-4 °C, HCl pH<2	14 days
SemiVOCs	Amber glass/1L ^c	Cool 0-4 °C	7 days
Radon-222	Amber glass/3 @ 40 mL	Cool 0-4 °C	Not Established

^aThis table represents all analyses conducted for the UMTRA Ground Water Project; consult the *FY 2002 Sampling Frequencies and Analyses* for the analyses required at a particular site.

^bCollection of sample volume in duplicate for every 20 samples collected is required for laboratory quality control.

^cCollection of sample volume in triplicate for every 20 samples collected is required for laboratory quality control.

3.0 Quality Assurance

3.1 Field Quality Assurance

Field quality assurance procedures include following the standard operating procedures discussed in this document and collecting quality control samples. The types of quality control samples collected include field duplicates, equipment blanks, and trip blanks.

3.1.1 Field Duplicates

Duplicate ground water and surface-water samples will be collected in the field on a frequency of one duplicate sample per 20 water samples or one per sampling event, whichever is less, for each medium and analytical parameter. Ground water and surface water are considered separate media in the context of field duplicates. Duplicate water samples will be collected by alternately filling the original and duplicate sample container per analytical parameter. Duplicate samples will be submitted blind to the laboratory under a fictitious identity that is similar to the actual sample.

3.1.2 Equipment Blanks

Equipment blanks provide a check for cross-contamination of samples from ineffective equipment decontamination. One equipment blank sample will be prepared in the field for every 20 water samples or one per sampling event, whichever is less, that is collected with non-dedicated equipment. Equipment blanks will be prepared by collecting a sample of the final deionized rinse water (rinsate) used to decontaminate non-dedicated sampling equipment. Equipment blank samples will be submitted blind to the laboratory under a fictitious identity that is similar to the actual sample.

3.1.3 Trip Blanks

Trip blanks will be prepared using organic-free water obtained from the GJO Analytical Laboratory and taken to the field by the sampling team. Trip blanks will be prepared in the field at the start of each day involving collection of ground water samples for volatile organic compound (VOC) analysis. Trip blanks subsequently will be handled as all other ground 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.

3.2 Data Qualification

Data obtained from samples collected in Category II and III wells will be qualified with a "Q" flag indicating the data is qualitative due to sampling technique. This qualification will occur during the data validation process. A section in the data validation report will specify the "Q" flagged data, and the "Q" flags will be included in the database. Database reports will have "Q" flags displayed to alert the data user. Data obtained from samples collected from Category I and Category IV wells will be the highest quality, and qualification is not required.

End of current text

4.0 Analytical Program

The constituents analyzed at each UMTRA site are specified in the *FY 2002 Sampling Frequencies and Analyses* (DOE 2001). A comprehensive list of analytes along with the required analytical methods and contract required detection limits is shown in Table 4-1. Validation of analytical data will be accomplished according to the procedure in Appendix C.

All water samples collected for the UMTRA Ground Water Project will be analyzed by the GJO Analytical Chemistry Laboratory. Laboratory quality control will be performed in accordance with the *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures* (DOE 2001a). This manual defines the non-technical policies and procedures necessary to ensure the laboratory will provide high quality analytical data and maintain customer confidentiality. It provides a framework for performing, controlling, documenting, and reporting analyses and related laboratory activities. Analytical methods used for the UMTRA Ground Water Project are detailed in *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures* (DOE 2001b). This manual contains detailed procedures used for each analytical method and includes specific requirements for reagents and standards, detection limits, quality control, calculations, and data reporting. In addition, interferences associated with each analytical method are listed in each section.

Table 4-1. UMTRA Ground Water Project Comprehensive Analyte List, Analytical Methods, and Contract Required Detection Limits

Analyte	Contract Required Detection Limit mg/L ^a	GJO Analytical Procedure ^b	EPA Analytical Method
Al	0.05	ICP-AES	SW-846 6010B
NH ₄	0.10	Colorimetric	
Sb	0.003	ICP-MS, ICP-AES	SW-846 6020, SW-846 6010B
As	0.005	Hydride AA, GFAA, ICP-AES, ICP-MS	SW-846 7062, SW-846 6010B
Ba	0.10	ICP-AES	SW-846 6010B
Br	0.10	IC	SW-846 7199
Cd	0.001	ICP-MS, ICP-AES	SW-846 6020, SW-846 6010B
Ca	0.50	ICP-AES	SW-846 6010B
Cl	0.50	IC	SW-846 7199
Cr	0.01	ICP-AES, ICP-MS	SW-846 6020, SW-846 6010B
Co	0.05	ICP-AES, ICP-MS	SW-846 6020, SW-846 6010B
Cu	0.02	ICP-AES, ICP-MS	SW-846 6020, SW-846 6010B
Cyanide	0.010	Colorimetric	
F	0.10	IC	SW-846 7199
Gross Alpha	1.0	PC	SW-846 9310
Gross Beta	2.0	PC	SW-846 9310
Fe	0.03	ICP-AES	SW-846 6010B
Pb	0.003	ICP-MS, ICP-AES, GFAA	SW-846 6020, SW-846 6010B
Pb-210	1.5	LSc	
Mg	0.10	ICP-AES	SW-846 6010B
Mn	0.01	ICP-AES	SW-846 6010B
Mo	0.01	ICP-MS, ICP-AES	SW-846 6020, SW-846 6010B

Table 4-1 (continued). UMTRA Ground Water Project Comprehensive Analyte List, Analytical Methods, and Contract Required Detection Limits

Analyte	Contract Required Detection Limit mg/L ^a	GJO Analytical Procedure ^b	EPA Analytical Method
Ni	0.04	ICP-AES, ICP-MS	SW-846 6020, SW-846 6010B
NO ₃	1.0	IC	SW-846 7199
PO ₄	1.0 (0.10)	Colorimetric, IC	SW-846 7199
Po-210	1.0	AS	
K	0.10	ICP-AES, FAA	SW-846 6010B, SW-846 7770
Ra-226	1.0	AS, LSc	SW-846 9315, 9320, modified
Ra-228	1.0	BGC, LSc	SW-846 9315, 9320, modified
Se	0.005	Hydride AA, GFAA, ICP-AES, ICP-MS	SW-846 6010B, SW-846 6020
Semi volatiles	--	GC-MS	SW-846 8270C
SiO ₂	0.10	ICP-AES	SW-846 6010B
Ag	0.01	ICP-AES, ICP-MS	SW-846 6020, SW-846 6010B
Na	1.0	ICP-AES	SW-846 6010B
Sr	0.01	ICP-AES	SW-846 6010B
SO ₄	1.0	IC	SW-846 7199
Sulfide	1.0	Titrimetric	
Tl	0.005	ICP-MS, GFAA, ICP-AES	SW-846 6010B, SW-846 6020
Th-230	1.0	ICP-MS, AS	SW-846 6020
Sn	0.05	ICP-MS, ICP-AES, GFAA	SW-846 6010B
TDS	10	Gravimetric	
TPH	1.0	IR, Spectrophotometric	SW-846 6020
U	0.001	ICP-MS	SW-846 6020
U-234, U-235, U 238	1.0	AS, ICP-MS	SW-846 6020
V	0.01	ICP-AES	SW-846 6010B
VOCs		GC-MS	SW-846 8260B
Zn	0.01 (0.05)	ICP-AES, ICP-MS	SW-846 6010B, SW-846 6020

^aRadiological detection limits are in units of pCi/L. The CRDL is typically set an order of magnitude less than the standards (see Appendix C for detailed explanation).

^bThe primary technique is listed first. Laboratory technique acronyms and abbreviations are defined below.

AS	Alpha Spectrometry
BGC	Beta/Gamma Coincidence
FAA	Flame Atomic Absorption Spectroscopy
GFAA	Graphite Furnace Atomic Absorption Spectroscopy
GC-MS	Gas Chromatograph - Mass Spectrometry
Hydride AA	Sodium Borohydride Reduction Atomic Absorption Spectrometry
IC	Ion Chromatography
ICP-AES	Inductively Coupled Plasma - Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma - Mass Spectrometry
IR	Infrared
LSc	Liquid Scintillation
PC	Proportional Counting

5.0 Sample Identification and Handling Procedures

Each sample will be assigned a unique alpha-numeric sample number and a site identification number corresponding to each well or surface sampling location. Quality control samples will be assigned a fictitious site identification number and submitted blind to the laboratory. The true site identification number and the type of quality control sample will be documented on the Quality Control Sample Cross-Reference Log.

Samples that require refrigeration will be placed in ice chests containing an ice and water bath immediately upon collection. An ice and water bath will be maintained within the ice chests at all times and will be checked and documented on the Water Sampling Field Data form after each location is sampled.

Sample bottles used for water sampling will be precleaned to guidelines established by the EPA in *Specification and Guidance for Contaminant-Free Sample Containers* (EPA 1992).

To ensure the integrity of the sample, the Site Sampling Leads, or their designee, are responsible for the care, packaging, and custody of the samples until they are dispatched to the laboratory. The procedures described in GT-3(P), "Standard Practice for Chain-of-Sample-Custody Control and Physical Security of Samples," will be implemented to provide security and document sample custody.

Custody seals and/or evidence tape will be placed on each ice chest or storage/shipping container that is not in direct control of a sampling team member to maintain physical security of the samples from time of collection to analysis. Samples not in direct control of a sampling team member will be stored in a secured (locked) location. Ice chests, cartons, and trays used for temporary sample storage that are not custody sealed must be in direct control of a field team member.

If samples are transported by subcontract employees or commercial carrier, the shipping container will have custody seals and/or evidence tape placed over the container opening before shipment to ensure that the integrity of the samples is not compromised during transportation. Custody seals are not required for containers or samples that are transported by MACTEC-ERS personnel directly to the GJO Analytical Laboratory for analysis or interim storage. The Site Sampling Lead will be responsible for ensuring that the samples are transferred to the laboratory in sufficient time for the laboratory to complete extraction/analysis prior to the expiration of sample holding times.

Mailed sample packages should be registered with return receipt requested. If packages are sent by common carrier, receipts are retained as part of the chain-of-custody documentation. Other commercial carrier documents will be maintained with the chain-of-custody records.

Chain-of-custody records will be used to list all transfers of sample possession and to show that the samples were in constant custody between collection and analysis. Samples that are sent or transported to an analytical laboratory by individuals other than a member of the field sampling team will be accompanied by a Chain of Sample Custody form (GJO 2008), with a copy retained by the originator. When samples are transported to the GJO Analytical Laboratory by a member of the field sampling team, the Chain of Sample Custody form may be completed at the sample receiving facility when the transfer is made.

End of current text

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. If non-dedicated sampling equipment is used to collect samples for organic analyses, then an additional rinse with laboratory-grade methanol will be used followed by a final deionized-water rinse. Between samplings or until further use, decontaminated equipment will be stored in protective containers or plastic bags.

End of current text

7.0 References

Jacobs Engineering Group, 1992. *TAC Hydrological Standard Operating Procedure*, Section 16, Albuquerque, New Mexico.

U.S. Department of Energy, (continually updated). *Environmental Procedures Catalog* (Manual 6), U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

———, 1994. *Technical Approach for the Management of UMTRA Ground Water Investigation-Derived Wastes*, DOE/AL/62350-109, U.S. Department of Energy UMTRA Project Office, Albuquerque, New Mexico.

———, 1997. *Management Plan for Field Generated Investigation Derived Waste*, MAC-GWADM 11.8, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

———, 2001a. *Analytical Chemistry Laboratory Administrative Plan and Quality Control Procedures*, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

———, 2001b. *Analytical Chemistry Laboratory Handbook of Analytical and Sample-Preparation Procedures*, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

———, 2001c. *FY 2002 Sampling Frequencies and Analyses*, GJO-2001-267 TAR, MAC-GWADM 19.1-2 Rev. 7. U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado.

U.S. Environmental Protection Agency, 1992. *Specification and Guidance for Contaminant-Free Sample Containers*, Directive 9240.0-05A, Office of Solid Waste and Emergency Response, Washington D.C.

End of current text

Appendix A

**DOE-GJO Procedures Used for the
UMTRA Ground Water Project**

Standard Practice for Preparing or Revising Procedures for the *GJO Environmental Procedures Catalog*

1. Scope

1.1 This practice describes the preparation, review, approval, and distribution of procedures in the *GJO Environmental Procedures Catalog* (GJO 6).

1.2 The procedures in this catalog are not intended to address all of the details and variations that might apply to an individual project. Therefore, a site-specific plan or other project-specific document will describe in detail the work that will be performed and will identify procedures from the *GJO Environmental Procedures Catalog* (GJO6) that will be used.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the Health and Safety Plan for a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials (ASTM), *Form and Style for ASTM Standards*, 10th Edition, Philadelphia, PA, August 1997

3.2 *GJO Environmental Procedures Catalog* (GJO 6): Procedure GA-3(P), "Standard Practice for Quality Assurance"

3.3 *GJO Training Manual* (GJO 4): Section 8.0, "Environmental Qualification Procedure"

4. Responsibilities

4.1 Technical Manager, MACTEC-ERS Geosciences has overall responsibility for the *GJO Environmental Procedures Catalog* (GJO 6) as defined by Task Order which includes management of the catalog and implementation of the qualification system as defined in Section 8.0 of GJO 4.

4.2 Environmental Procedures Advisory Committee (EPAC)—A combined FOS/TAR contractor group of professionals with expertise

in particular areas who serve as advisors to address questions and problems relevant to the *GJO Environmental Procedures Catalog* (GJO 6) and the associated training.

4.3 EPAC Catalog/Training Coordinator is the point contact for procedure revisions and distribution. The current electronic and paper versions of each procedure are maintained by the catalog coordinator. The coordinator also maintains the training qualifications and provides input to the Training Information System.

4.4 EPAC Technical Leads manage a section of the catalog. Their duties include assigning a key proficient person to each of the procedures, oversight for revisions to and reviews of procedures, and approval of project-specific changes to procedures.

5. Terminology

5.1 *Acceptance criteria*—Specified limits, requirements, or tolerances placed on the variation permitted in the characteristics of an item, process, report, data, or service as defined in codes, standards, drawings, specifications, procurement documents, or other requirements documents. The criteria must be definitive for decision-making purposes but might not be related to instruments or measurements.

5.2 *Environmental Procedures Advisory Committee* (EPAC)—See paragraph 4.2.

5.3 *Guide*—A procedure that outlines a suggested approach through a series of options or instructions but does not recommend a specific course of action.

5.4 *May*—In procedures, a suggestion only.

5.5 *Must*—In procedures, a required action. Synonymous with "shall" and "will".

5.6 *Planning document*—A document prepared to guide a project or task. These documents may be called Work Plans, Sample and Analysis Plans,

project plans, or task plans, depending on sponsor requirements.

5.7 *Practice*—A definitive procedure for performing one or more specific operations or functions that does not produce a test result.

5.8 *Procedure*—Steps to perform, explain, or accomplish a task. As used in this catalog, a procedure may be a practice, guide, or test method.

5.9 *Qualified*—An employee who has met the requirements for a specific position or task.

5.10 *Shall*—In procedures, a required action. Synonymous with "must" and "will".

5.11 *Should*—In procedures, a recommendation.

5.12 *Test method*—A definitive procedure for the identification, measurement, and evaluation of one or more characteristics of a material, product, system, or service that produces a test result.

5.13 *Training Information System*—A central database providing an electronic record of personnel training.

5.14 *Will*—In procedures, a required action. Synonymous with "must" and "shall".

6. Significance and Use

6.1 The catalog is intended to be a source of information that may be used with the minimum administrative burden that is consistent with control of activities. The procedures may be used as written or they may be modified by the method discussed in Section 8 "Changes to Procedures."

6.2 This practice is for use by any personnel preparing procedures for the *GJO Environmental Procedures Catalog (GJO 6)*. From the standpoint of technical accuracy, this practice will ensure that procedures are complete and scientifically sound. From the standpoint of usability, the practice will ensure that procedures are uniform and will help the user find information easily and understand it quickly.

6.3 All new, revised, or adopted procedures in this catalog will adhere to this practice.

7. New Procedures

7.1 New procedures may be needed to support new work, changes in work scope, new technology or instruments, or improved methods. When the need for a procedure to be added to the catalog is known, the EPAC will review the suggested procedure to determine if it is appropriate for inclusion.

7.2 *Types of Procedures*—Three categories of procedures are defined for this catalog on the basis of ASTM guidelines. These categories are practices, guides, and test methods. Development of the text will be based on the determination of which of these three categories best describes the procedure being prepared. Other types of procedures defined in ASTM may be used, if more appropriate. See reference 3.1, for more information.

7.2.1 Examples of practices include selection, preparation, application, inspection, necessary precautions for use or disposal, installation, maintenance, and operation of testing apparatus. Examples of guides include reference lists, general considerations, and glossaries. The following list describes headings to be included in a practice or guide. See reference 3.1, for more detailed information on practices and guides.

- Title (mandatory)
- Scope (mandatory)
- Hazard Analysis (mandatory)
- Referenced Documents
- Terminology
- Summary of Practice (or Guide)
- Significance and Use (mandatory)
- Reagents (including materials or equipment)
- Procedure
- Report
- Precision and Bias (for included tests and analyses)
- Keywords (mandatory)
- Annexes and Appendices

7.2.2 Examples of test methods include determination of fundamental properties of materials and a variety of field and laboratory analytical or measurement procedures. The following list describes headings to be included in a test method. See reference 3.1, for more detailed information on test methods.

Title (mandatory)
 Introduction
 Scope (mandatory)
 Hazard Analysis (mandatory)
 Referenced Documents
 Terminology
 Summary of Test Method
 Significance and Use (mandatory)
 Interferences
 Apparatus (includes equipment)
 Reagents and Materials
 Sampling, Test Specimens, and Test Units
 Preparation of Apparatus
 Calibration and Standardization
 Conditioning
 Procedure (mandatory)
 Calculation or Interpretation of Results
 Report
 Precision and Bias (mandatory)
 Keywords (mandatory)
 Annexes and Appendices

7.3 Procedures will adequately describe the work so that a qualified person could use the procedure to perform work. The procedure will describe responsibilities and interfaces, delineate the method and sequence, and provide a means of recording data when appropriate. Acceptance criteria will be identified when applicable.

7.3.1 Additional quality assurance concerns for procedures are available in Procedure GA-3(P), "Standard Practice for Quality Assurance".

7.4 Each procedure shall contain a section titled "Hazard Analysis," that identifies each potential hazard inherent to performance of the procedure.

7.4.1 Each procedure shall identify the potential hazards on a Hazards Identification Chart (Figure 1) by marking those hazards with a "Y" in the "Y/N" column. Hazard evaluation should not include site-specific hazards such as heat stress or contamination; these hazards are addressed in site-specific Health and Safety Plans.

7.4.1.1 For each hazard, the need for controls and the level of risk involved in performing the procedure shall be evaluated. Each hazard and any action necessary to implement a control shall be specified as a separate paragraph in this section.

7.4.2 The completed Hazards Identification Chart will be included in the procedure review package. The chart should not be included as part of the procedure. The chart is intended to assist reviewers in independently evaluating the procedure.

7.4.3 If no hazards requiring controls are identified, the Hazard Analysis section should contain the following text: "No hazards requiring controls have been identified. Site-specific controls are available in the Health and Safety Plan for a particular project."

7.5 *Procedure Format*—The format of procedures will follow the *Form and Style for American Society for Testing and Materials (ASTM) Standards*, reference 3.1, as amended by this procedure. When preparing procedures, the modified decimal numbering system (see reference 3.1) will be used to number divisions in the text. The divisions are numbered to show subordination of items within a section (e.g., 1., 1.1, 1.1.1, and 1.1.1.1 show the order of subordination).

7.6 *Miscellaneous Points of Style*

7.6.1 *Units of Measure*—Consistent units of measure will be used throughout the procedure. Units of measure are always spelled out the first time they appear in the text and any time they are not preceded by a value.

7.6.2 *Uppercase Letters*—**Do not** use uppercase letters when writing text or: numbered text headings (e.g., "5.5.9 *Uppercase Letters*," not "5.5.9 UPPERCASE LETTERS"). Use of all uppercase letters is acceptable in trade names, equations, variables, etc.

7.7 Text should be provided to the coordinator of the catalog on disk or by e-mail. The disk should be accompanied by a printed copy of the text and all figures or forms to be included in the procedure. The coordinator will ensure that the procedure is in the proper format, assign the procedure number, coordinate reviews, and assist in comment resolution.

HAZARDS IDENTIFICATION CHART

Procedure No. _____ Date _____ Performed By _____

The following hazards shall be considered. The list may not be complete. Add any other identified hazard to the list. On an attached page describe each identified hazard along with controls needed.

Potential Hazard	Y/N	Potential Hazard	Y/N
Electrical Sources		Heat Sources	
Capacitors	_____	Electrical	_____
Transformers	_____	Steam	_____
Batteries	_____	Flames	_____
Exposed Conductors	_____	Solar	_____
Static Electricity	_____	Friction	_____
Underground Utilities	_____	Spontaneous Combustion	_____
Other High Voltage	_____	Cold Sources	
Motion Sources		Cryogenic Materials	_____
Pulley Belt	_____	Ice, Snow, Wind, Rain	_____
Gear	_____	Radiant Sources	
Shears	_____	Intense Light	_____
Sharp Edges	_____	Lasers	_____
Pinch Points	_____	Ultraviolet (UV)	_____
Vehicles	_____	X-rays, Ionizing Radiation	_____
Mass in Motion	_____	Infrared Sources	_____
Rotating Equipment	_____	Electron Beams	_____
Gravity-Mass Sources		Magnetic Fields	_____
Personnel Falling	_____	RF Fields, Microwave, Radar	_____
Falling Object	_____	Other Hazards	
Lifting	_____	_____	_____
Tripping, Slipping	_____	_____	_____
Earthquake	_____	_____	_____
Pressure Sources		_____	_____
Confined Gases	_____	_____	_____
Explosives	_____	_____	_____
Noise	_____	_____	_____
Chemical Reactions	_____	_____	_____
Stressed Mechanical System	_____	_____	_____
Chemical Sources		_____	_____
Corrosive Materials	_____	_____	_____
Flammable Materials	_____	_____	_____
Toxic Materials	_____	_____	_____
Radioactive Materials	_____	_____	_____
Pathogenic Materials	_____	_____	_____
Oxygen Deficiency	_____	_____	_____
Carcinogenic Materials	_____	_____	_____

Figure 1. Example of Hazards Identification Chart

7.8 Procedure Numbering—Procedures in this catalog will be assigned a number in the following format: XX-N(A)

where:

- XX = GA (General Administrative chapter)
 GT (General Technical chapter)
 SL (Solids chapter)
 LQ (Liquids chapter)
 GS (Gases chapter)
 GP (Geophysical Measurements chapter)
 RD (Radiological Measurements chapter)
- N = The sequential number of the procedure within the chapter
- (A) = Type of procedure: Practice (P), Guide (G), or Test Method (T).

7.8.1 For example, General Considerations for the Sampling of Liquids is the first procedure in the Liquids chapter and is numbered LQ-1(G).

7.8.2 The procedure number is indicated on the upper right-hand corner of each odd-numbered page. (This position is reversed on even-numbered pages.)

7.9 Procedure Date and Revision—The date and revision number of the procedure are indicated immediately below the procedure number. The date will appear in month and year format with the revision number directly following. For example, 1/91 Rev. 0 was issued in January 1991 and is the initial version.

7.10 "GJO" will appear on the upper left-hand corner of each odd-numbered page. (This position is reversed on even-numbered pages.)

7.11 The catalog coordinator should be contacted for questions regarding new procedures.

8. Changes to Procedures

8.1 Changes to Existing Catalog Procedures—When changes to a procedure are required, the originator shall submit a hard copy and/or electronic copy of the proposed revision to the catalog coordinator. For questions, contact the catalog coordinator.

8.1.1 If only editorial changes are needed, and the changes do not affect the safety or the quality of work performed or data generated, the changes may be made without going through the formal reviews that are required for technical changes; however, the changes must be approved by the EPAC Chair. A procedure for which only editorial changes are implemented will be given a new revision number and a new date. When such a procedure is distributed, it should be accompanied by a statement that the changes are editorial only.

8.2 Project-Specific Changes to Procedures—Changes to a procedure might become necessary during project planning or during field operations. Records of review and approval for these changes will be included in the project records. These changes should be considered for incorporation in the *GJO Environmental Procedures Catalog (GJO 6)* if the same changes are made repeatedly.

8.2.1 Procedures from this catalog that will be used on a specific project in planning documents should be identified in those documents. Modification of a catalog procedure made during planning for the project will be through an addendum that is documented on the Document Addition/Revision form (Figure 2) and approved by the Project Manager.

8.2.2 Changes that are needed during field operations will be documented in the field log and on the Document Addition/Revision form. The documented changes and a copy of the procedure will be given to the Project Manager or designee for review and approval. The review must include a technical review by the original author or reviewers who have comparable technical knowledge. The approval will be documented on the Document Addition/Revision form and appended to the procedures that are used in the field.

8.2.3 The Project Manager is responsible for evaluating each revision of a catalog procedure included as part of the project documents to determine if the revised procedure should replace the version that is currently in use for that project.

Environmental Procedures Catalog Document Addition/Revision

Procedure Title GA-1(P), Standard Practice for Preparing or Revising
Procedures for the GSO Environmental Procedures Catalog

Requester Earlie Pearl

Justification

To update the Document Addition/Revision for referenced in the text &
shown in Figure 2. The editorial changes made in this form to the headings in
Sections 2.3 provide clearer information on the intended use of the areas &
required signatures.

Proposed Changes (list here or attach copies)

Amend current form.

Authorization for Changes to Catalog Procedures

New Document Change to Existing Procedure Adopt Procedure

Procedure Number Assigned GA-1(P)

Procedure Title Standard Practice for Preparing or Revising Procedures for the
GSO Environmental Procedures Catalog

Approval for Inclusion in Environmental Procedures Catalog

Will Lee
Environmental Procedures Advisory Committee Chair

7/1/99
Date

Authorization for Project-Specific Modification to Existing Catalog Procedures

Project-Specific Change for _____

Effective Date _____

Reviewed by _____ Date _____ Approved by _____ Date _____
Technical Author or Proficient Designee Manager or Designee

Figure 2. Example of a Document Addition/Revision Form

8.3 Adopting Industry-Recognized Procedures—When possible, programs should use existing industry-recognized procedures with an addendum rather than write new procedures for the catalog. The addendum will be titled "Technical Comments on (industry procedure number and title)" and shall include references to the numbered sections in the existing procedure that are being modified. A separate Hazard Analysis section and, as appropriate, specific sources of required equipment or supplies and quality assurance requirements should be added to the addendum. Any added sections will be numbered sequentially starting with the number following the last section of the industry procedure.

8.3.1 Industry-recognized procedures from source documents published by the U.S. Environmental Protection Agency, ASTM, U.S. Department of the Interior, National Water Well Association, American Petroleum Institute, or other recognized organizations should be used, if possible. Permission from the sponsoring agency, such as ASTM may be required to produce and distribute the procedure.

9. Procedure Review, Publication, Approval, and Distribution

9.1 Procedure Review—Each new, revised, or adopted procedure in this catalog will be sent to qualified technical individuals and personnel from environmental, safety, and quality groups for review. Editorial changes, as described in Section 8.1.1 require review only by the EPAC Chair.

9.1.1 The catalog coordinator sends a copy of the procedure along with a Record of Review form (see Figure 3 for front page) and Hazards Identification Chart (for new procedures) to each reviewer. Comments must be resolved by the author and/or coordinator before submitting the procedure for publication.

9.2 Publication of Procedures—The catalog coordinator arranges for production of additions or changes to the catalog.

9.2.1 Release of each revision to the catalog will require issuing a new table of contents. The table of contents lists each procedure within a chapter and the current date and revision number.

9.2.2 ~~Highly technical~~ indicates revised material in the procedures and table of contents.

9.3 Procedure Approval—A copy of the final procedure along with a completed Document Addition/Revision form is submitted to the EPAC Chair for approval before the procedure is released and distributed. A record of the approval will be maintained by the catalog coordinator.

9.4 Distribution of Procedures—The catalog coordinator, in cooperation with the Contractor Document Control Specialist, will distribute copies of the catalog to library locations on the distribution list.

10. Procedure Access

10.1 Procedures may be copied directly from the catalog, marked as "Uncontrolled Copy", and inserted into other documents, such as Sampling and Analysis Plans. Catalog procedures may be identified in the documents by reference only; however, it is recommended that they be physically attached to the documents.

11. Records

11.1 A historical hard copy of each version (revision) of each procedure will be maintained by the EPAC Catalog/Training Coordinator. Records of review and comment resolution will be maintained for the current version of each procedure; such records of previous versions may be destroyed.

12. Keywords

12.1 ASTM, guide, hazard analysis, practice, procedure, review, and test method.

Record of Review

GA-1(P)
7/99 Rev. 1

Due Date 7/11/1999	Review No. 01	Project EPC	Type of Review Comprehensive		Page 1 of 1
Document Title and/or Number and Revision GA-1(P), Standard Practice for Preparing or Revising Procedures for the GJO Environmental Procedures Catalog			Reviewer's Recommendation <input type="checkbox"/> Release Without Comment <input type="checkbox"/> Consider Comments <input type="checkbox"/> Resolve Comments and Reroute for Review <input type="checkbox"/> Comments Have Been Addressed <i>Signature of Reviewer and Date</i> <input type="checkbox"/> Comment Resolution Satisfactory <i>Signature of Author and Date</i> <input type="checkbox"/> Comment Resolution Unsatisfactory <i>Signature of Reviewer and Date</i>		
Author Sally Shell					
Author's Organization Administration		Author's Phone 3333			
Reviewer Red Reader					
Reviewer's Organization Quality Assurance		Reviewer's Phone 7777			
Item No.	Reviewer's Comments and Recommendations	Reqd. (Y/N)	Item No.	Author's Response (if required)	Author's Initials
1	Typo as indicated on page 2.	Y			
2	Need the current organizational flow chart.	Y			

Figure 3. Example of a Record of Review

GJO 1696-497

GJO

Standard Practice for Field Documentation Processes

1. Scope

1.1 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 logbooks, field notebooks, data sheets, and other records.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the Health and Safety Plan for a particular project.

3. Referenced Documents

3.1 *MACTEC-ERS General Administrative Procedures Manual (MAC-1000)*, Section 3, "Records Management Procedure"

3.2 *GJO Quality Assurance Standards (GJO 1) Criterion 4, "Documents and Records"*.

3.3 *WASTREN-Grand Junction Management Policy Manual*

3.4 U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Vol. II, Field Manual, Physical/Chemical Methods*, SW-846, Office of Solid Waste and Emergency Response, November 1986, 3rd Edition.

4. Terminology

4.1 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 but are not limited to include data sheets, logbooks, field notebooks, maps, drawings, photographs, and electronic data-recording media.

4.2 *Technical record books*—For purposes of this practice, technical record books will refer to logbooks and field notebooks. These books are to be bound and the pages consecutively numbered.

5. Significance and Use

5.1 This practice will be used to document results of tasks performed using the *GJO Environmental Procedures Catalog (GJO6)*, unless the project Work Plan provides an alternate practice.

5.2 This practice includes the use of technical record books for direct data entry or as journals referring to the location of associated supporting documents for activities.

5.3 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.

6. General Procedures for Records

6.1 All records produced from work performed according to procedures in the *GJO Environmental Procedures Catalog (GJO 6)* must meet the following requirements:

6.1.1 Records must clearly describe the work performed. Enough detail must be provided to enable someone of equivalent skill and experience in the technology to repeat the work as originally performed.

6.1.2 Records must be clear, legible, and reproducible. Black ink is preferred. Reproducible photocopies of penciled documents are acceptable as records.

6.1.3 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.

6.1.4 Records must specify the activity conducted, the program sponsor, and the method used, if applicable. The signature of the person who performed the work and the date it was performed must appear on each page of a record and on any attached sheets. (Initials are acceptable if an initials log identifies the person.)

6.1.5 For short-term tasks, the Work Plan will define the records to be maintained for each task conducted and the disposition of the records. The following are suggested records of a short-term task:

- 6.1.5.1 Operational check data.
- 6.1.5.2 Data sheets.
- 6.1.5.3 Technical record books.
- 6.1.5.4 Official correspondence.
- 6.1.5.5 Planning documents.
- 6.1.5.6 Electronically or magnetically stored data.

6.1.6 For ongoing programs, a Working Records File Index defines what records will be generated, how long they will be retained, and the disposition of the records (see References 3.1 and 3.3).

6.1.7 Records must be protected against damage, deterioration, and loss while in the field, during data review, and until they are submitted to a storage facility. Records must be isolated from any source of contamination.

6.1.8 An independent reviewer will review data sheets or data contained in technical record books, as well as electronic data collection and data entry, as described in Section 7.5.

6.1.9 All data will be reviewed before personnel leave a remote site. The review will ensure that no additional sampling or data acquisition is required before departure.

6.1.10 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 that applicable spaces are completed.

7. Procedures for Technical Record Books

7.1 Technical record books will be bound books with sequentially numbered pages. Each book will be given a unique identifier.

7.2 *Issue and Control of Technical Record Books*—A technical record book will be assigned to an activity or a person for use on a project. The technical record book will be transmitted to the Project Manager or designee upon completion. If a technical record book contains information on more than one activity or project, the technical record book will clearly identify the portion associated with each activity or project. Reproducible copies of applicable sections of these books may be submitted to the Project Manager or designee as records.

7.2.1 The Project Manager shall determine the following and make a written record of the decisions:

7.2.1.1 Who will issue technical record books.

7.2.1.2 The number of each technical record book and the person to whom the book is issued.

7.2.1.3 The expected location for each technical record book when not in use (building and room number).

7.2.1.4 The reviewer of each technical record book and the frequency of reviews.

7.2.1.5 Whether support organizations are to use technical record books dedicated to the project or whether they will be required to furnish copies of applicable pages from technical record books supporting several projects.

7.2.2 The person to whom a technical record book is issued shall take the following steps upon receipt of a new technical record book:

7.2.2.1 Review general information on maintenance of the technical record book.

7.2.2.2 Complete the information block (if any) on the first sheet inside the front cover.

7.2.2.3 Identify the technical record book by entering the project number and title and the applicable task or subtask numbers as appropriate.

7.2.2.4 Determine whether to reserve specific pages for a Table of Contents and for the names of people who make entries and who will review the technical record book.

7.2.2.5 The first entry in the book shall describe the work covered and, as appropriate, the name of the sponsor, the Work Order or Statement of Work number, and the objectives of the work.

7.2.2.6 Prepare and maintain a list of the printed name, written signature, and initials used by each person who is authorized to make entries, including review entries.

7.3 Rules for Data Entry

7.3.1 Pages shall be kept intact. No page is to be left completely blank or removed from the book.

7.3.2 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.

7.3.3 Record all data as required by procedures for the activity being performed. Enter all data directly in a technical record book when practical. If loose sheets, such as test data sheets, photocopies, or photographs must be added to a technical record book, proceed as follows:

7.3.3.1 Glue, tape, or staple each sheet or part of a sheet to the next blank page or blank space, according to the amount of space needed.

7.3.3.2 Enter on the page of the technical record book a description of the material that is attached, and enter on each attachment the technical record book number and page number. This information will allow identification of the attachment if it comes loose.

7.3.4 Describe or reference in the technical record book any other permanent written or visual records generated for the project and not readily available in the open literature or that cannot be directly inserted because of size or bulk (e.g., data sheets, computer printouts, films, or magnetic media). Any project records that are cited must be filed and controlled as records. Records that are readily available in the open literature need only be referenced. The purpose is to provide a clear, complete record of activities and supporting documents.

7.3.5 The last entry in a technical record book shall be either a statement that the work was concluded or a reference to a sequential technical record book.

7.4 *Content of Technical Record Books*—The following information may be entered in technical record books, as applicable:

7.4.1 Table of Contents, consisting of pages with continuing entries.

7.4.2 What work was done and how it was done, including such information as a description of the facility, test design, measuring and test equipment (by serial number), and a reference by number and title to any standard procedure used.

7.4.3 Instrument numbers or equipment used, if not specified in a referenced procedure.

7.4.4 Field checks or calibrations that are not documented elsewhere.

7.4.5 Identification of personnel and responsibilities or duties of each person.

7.4.6 Why the work was done, including any Statement of Work under which the work was done and with what objective.

7.4.7 What results were obtained. Observations made, the review of the results, and nonconformances and deficiency reports may be included.

7.4.8 Temperature, weather, humidity, wind speed and direction, or other environmental influences that might affect the results.

7.4.9 Documentation of variances from planned activities. A variance is considered to be a deviation from "shall", "must", or "will" statements of a procedure.

7.4.10 Location of the activity, including site and sample or test location.

7.4.11 Name and address of field contact.

7.4.12 Sampling entries:

7.4.12.1 Purpose of sampling.

7.4.12.2 Description of sampling point and sampling methodology.

7.4.12.3 Number of samples taken and volume.

7.4.12.4 Date and time of sample collection.

7.4.12.5 Sample destination (name of laboratory) and how transported (hand carried or name of carrier, such as United Parcel Service or Federal Express).

7.4.12.6 References such as maps or photographs of the sampling site.

7.4.13 Entries relating to waste:

7.4.13.1 Producer of waste and address, if different for that location.

7.4.13.2 Type of process (if known) that produced the waste.

7.4.13.3 Type of waste (e.g., sludge, wastewater).

7.4.13.4 Suspected composition and concentrations of waste.

7.4.14 Other appropriate entries such as calculations, problems encountered and actions taken to resolve them, or interfaces with agencies.

7.5 Review of Technical Record Books—An independent reviewer will review technical record books for content, accuracy, legibility, calculations, error correction, and reproducibility (see Reference 3.2).

7.5.1 A reviewer will review electronic data collection or data entry for correctness and accuracy by comparison of originals with printed data or by review of the graphic representation of the data.

7.5.2 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.

7.5.3 When the reviewer is satisfied that the recorded information is complete and correct, the reviewer will sign and date the technical record

book and indicate the pages and supporting documents that were reviewed.

7.5.4 Written comments by a reviewer that are clearly identified as review comments will not require review by a second reviewer.

7.6 Storage of Technical Record Books—Technical record books shall be stored in fire-resistant metal file cabinets or otherwise protected from damage when not directly in use. Records shall not be left unprotected overnight or on holidays, vacations, or weekends (see Reference 3.2).

8. Keywords

8.1 Data sheets, documentation, field documentation, field notebooks, logbooks, records, and technical records books.

Standard Practice for Sample Labeling

1. Scope

1.1 This procedure addresses labeling requirements and recommended practices for labeling samples that are collected in the field and intended for analysis at a later time. The materials sampled may include, but are not limited to, solids such as soils and cores, liquids and sludges, and gases.

1.1.1 This procedure does not address labeling practices for any in situ measurements.

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

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

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the Health and Safety Plan for a particular project.

3. Referenced Documents

3.1 GJO *Environmental Procedures Catalog* (GJO 6)

GT-1(P), "Standard Practice for Field Documentation Processes"

GT-3(P), "Standard Practice for Chain-of-Sample-Custody Control and Physical Security of Samples"

4. Terminology

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

4.2 *Field*—Any place where the material for analyses or testing is collected.

4.3 *Duplicate samples*—More than one sample collected from the same source location, but placed in separate containers. Also called multiple samples.

4.4 *In situ*—In place; not removed from the point of original deposition.

4.5 *Sample (n)*—A portion of material collected from a larger mass that represents the characteristics of that mass.

4.6 *Sample (v)*—To select and collect a sample.

4.7 *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 1.

Grand Junction Office 2597 B 3/4 Road Grand Junction, CO 81503 970/248-6000	
Sample No. _____	Date _____
Sampler _____	Time _____
Project Site _____	Location _____
Sample Type _____	
Comments _____	

Figure 1. Example of Sample Label

4.8 *Sample log*—A document that lists all samples collected during a field visit or visits. A Chain-of-Sample-Custody form or sample ticket book are examples of sample logs.

4.9 *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 and will have both eye-readable and bar-code portions (Figure 2).

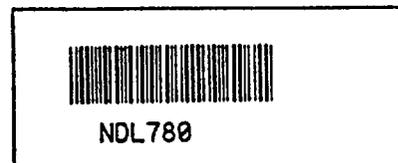


Figure 2. Example of a Sample Number

4.10 *Sample Plant*—the facility at the Grand Junction Office where samples are prepared for analysis.

4.11 *Sample ticket book*—A soft-bound book consisting of 25 sample numbers, one number per page. Each page is backed by two duplicating no-carbon required (NCR) sheets. For each sample number, a separate page containing 27 duplicate numbers is included. The duplicate number labels are self-adhesive.

4.12 *Split sample*—A sample that has been subdivided into two or more parts, each representative of the original sample.

5. Significance and Use

5.1 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 information identified in Section 8.4.

6. Materials

6.1 Preprinted Contractor sample labels with adhesive backing.

6.2 Preprinted sample numbers with adhesive backing or a sample ticket book (GJPO 1854) with preprinted adhesive-backed sample numbers.

6.3 Ballpoint pen with reproducible, water-proof ink.

6.4 Clear plastic tape (normally 2 inches wide).

6.5 Sample log.

7. Procedure for Obtaining Contractor Sample Numbers

7.1 Bar-coded sample numbers are printed by the Wastren Information Management Services group. To avoid duplication of numbers, the computer software that produces the numbers will prompt the user with the starting number for the new series to be printed.

7.2 The sample numbers are printed on a roll to be attached to sample labels to be bound into the sample ticket books.

7.3 Sample numbers and labels are obtained from the Field Services administrative staff. If appropriate, obtain sample ticket books from the Contractor's Sample Plant.

7.4 The issuing organization will maintain a log of the sample numbers or ticket books issued, the requester's name, and the date of issue.

7.5 The issuing organization shall obtain a new stock of sample numbers as needed from Wastren's Information Management group.

8. Procedure for Using Sample Labels

8.1 Complete the sample label before or after attachment to the sample container. If labels are not available, write the required information directly onto the sample or sample container. Never write directly on a sample that is to be chemically analyzed.

8.2 Use waterproof, reproducible ink to complete the required label information.

8.3 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.

8.4 The minimum information required on the sample label shall include

8.4.1 *Sample number*.

8.4.2 *Date*—The date the sample was collected.

8.4.3 *Sampler identification*—The name or initials of the person who collected the sample.

8.4.4 *Project site*—The area or property defined in project documents containing one or more sample locations. The property may be identified by a number.

8.4.5 *Sample location*—The location at which the sample was collected. Examples of sample locations include well numbers, grid locations, or surveyed coordinates.

8.5 Additional information that may be appropriate on the label includes

8.5.1 *Time*—The time at which the sample was collected.

8.5.2 *Sample type (matrix)*—One or more terms that describe the type of sample. This description may cover sample material such as soil, water, sludge, air, or core. It may also include the type of sample, such as composite, grab, or wipe.

8.6 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.

8.7 Maintain a record of sample numbers and other pertinent information on a sample log. See Procedure GT-1(P), "Standard Practice for Field Documentation Processes" and Procedure GT-3(P), "Standard Practice for Chain-of-Sample-Custody Control and Physical Security of Samples," reference 3.1.

8.8 When needed, protect the completed sample labels from moisture and abrasion by placing a piece of clear plastic tape over the label.

9. Procedure for Using Sample Ticket Books

9.1 Sample ticket books contain preprinted numbers for labeling multiple sample fractions (e.g., water samples from one well) or split samples. A copy of a page from a sample ticket book (GJPO 1854) is shown in Figure 3.

9.2 If multiple sample fractions or duplicate samples are taken at the same location or if split samples are made in the field, the sampler shall identify each sample by removing an adhesive-backed sample number from the book and attaching it to the sample label or container. The sample number shall be identical for each sample in the entire group of duplicates or splits.

9.3 Duplicate samples or split samples each may be assigned a unique sample number for purposes of documenting the precision of the sampling and analysis process. These samples are commonly referred to as "blind duplicates" or "field duplicates."

9.4 The information required on the sample ticket is summarized on the inside flap cover of the ticket book, as shown in Figure 4.

When completing the ticket, the cardboard cover should be inserted after the pink page of the current ticket to prevent copying information onto the next ticket. A ballpoint pen should be used with sufficient pressure to ensure duplication onto all copies of the NCR sheets.

9.5 Normally, the white copy of the ticket is retained by the project manager, the canary copy is forwarded to the Sample Plant or analytical laboratory with the samples, and the pink copy remains in the ticket book. This distribution may vary depending upon the needs of the project.

10. Keywords

10.1 Label, sample, sample labeling, sample log, sample number, and ticket book.


 NDG 851

Project UGW
 Site Tuba City Location 945
 Date 9-16-98 Time 1445 Matrix water
 Interval NA Sampler Sellers/Kempel
 Comments _____

Analyte(s)	Container Type	Number Collected	Filtered	Preservative
metals	300ml HDPE	1	YES	HNO ₃ / HCl
Gross α	1L HDPE	1		↓
TDS	125ml HDPE	1		cool
anions	↓	1		↓
NH ₃ NO ₃	↓	1	↓	cool / H ₂ SO ₄ /H ₂ O

While copy to Project Manager, carry to laboratory with remaining in ticket book

Figure 3. Example of a Sample Ticket GJPO 1854

Required Information

Project: Name of Project or Project Number. "GJ-12345"
Site: Site location. "Landfill 3, Unit 6"
Location: Exact location of sample such as borehole number, monitor well number, or distance to permanent landmarks. "MW-018"
Date: Date sample was collected.
Time: Time sample was collected "1420" or "2.20 p.m."
Interval: Beginning and ending depth interval of sample or time duration of sample "2 feet to 3.8 feet," or "0800 to 1622" - dependent on sample type.
Matrix: Type of sample. soil, water, air, product, tissue, etc.
Sampler: Name(s) initials of sampling personnel. Initials should be listed in project file for identification.

Optional Information

Project documentation may replace optional information to avoid unnecessary writing in the field. For example, a Sampling Plan may state "all VOC samples will be collected in 40 mL glass vials" thus avoiding the need to write this for each sample. If all filtered samples use a 40 micron filter, simply put a "Y" in the filtered field. Only variances from the Sampling Plan would need to be noted on the ticket. Information duplicated on many samples may be completed on the first ticket of the series and referred to subsequently "Same as PHN 230" or "PHN 230"

Comments: Area, weather conditions, radiation levels, composite sample/grab sample, reason for sample, additional location information or any factors that may affect analysis. Brief location maps with a scale and north indicator are useful.
Analyte: Type of analysis to be performed. "KUT," "VOC's," "Metals," "Asbestos"
Type/Size: Describe type of container. Glass, HDPE, Amber, LDPE/500 mL, "1L ILM Glass," "WVG/250 mL"

IM	Narrow Mouth	A	Amber Glass or Plastic
VM	Wide Mouth	G	Glass
HDPE	High-Density Polyethylene	P	Plastic
LDPE	Low-Density Polyethylene		

Number Collected: Number of containers of each analyte
Filtered: Was sample filtered/size. Y/ "0.45 micron filter."
Preservative: Cool, HCL, HNO₃, Frozen, etc.
Completion of Sample Label: Complete sample label as required. Remove Bar Code from ticket book and cover the "Sample Number" area on the sample label.

Figure 4. Example of a Sample Ticket (Back Cover of GJPO 1854)

Standard Practice for Chain-of-Sample-Custody Control and Physical Security of Samples

1. Scope

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

1.2 Control, storage, and disposal of samples should be addressed in the Work Plan for a particular project.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the Health and Safety Plan for a particular project.

3. Referenced Documents

3.1 *GJO Environmental Procedures Catalog* (GJO 6):

GT-2(P), "Standard Practice for Sample Labeling"

4. Terminology

4.1 *Chain-of-sample-custody record*—A form such as the Chain of Sample Custody (GJPO 1512), or equivalent, used to document sample custody and receipt. GJPO 1512, Chain of Sample Custody, is a four-part no-carbon-required (NCR) form available as a contractor Stores issue item (Figure 1).

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

4.3 *Custody seals or tags*—Adhesive-backed strips, or metal or plastic tags, 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.

4.4 *Duplicate samples*—More than one sample collected from the same source location but

placed in separate containers. Also called multiple samples.

4.5 *Physical security*—Synonymous with custody but emphasizes the measures taken to prevent tampering with the samples or sampling process.

4.6 *Sample (n)*—A portion of material collected from a larger mass.

4.7 *Sample (v)*—To select and collect a sample.

4.8 *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 and will have both eye-readable and bar-code portions. See Procedure GT-2(P), "Standard Practice for Sample Labeling," Section 3.1, on how to obtain sample numbers.

4.9 *Split sample*—A sample that has been subdivided into two or more parts, each part representative of the original sample.

5. Significance and Use

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

5.2 Projects that do not require sample custody documentation may use other types of sample logs for documenting sample information.

6. Materials

6.1 Chain of Sample Custody form (GJPO 1512) or equivalent.

6.2 Ballpoint pen with waterproof, reproducible ink.

6.3 Custody seals or tags.

6.4 Clear plastic tape (normally 2 inches wide).

6.5 Padlocks, receptacles, containers, and/or enclosures as appropriate to provide physical security of the samples.

7. Chain-of-Sample-Custody Procedure

7.1 The sampler shall complete the chain-of-sample-custody record during or after sample collection. Use the current version of GJPO 1512 unless a project specifies a different form or specifies that no chain-of-sample-custody is required.

7.2 Use waterproof, reproducible ink to complete the form.

7.3 The initiator of the form is responsible for legibility of all entries other than signatures.

7.4 General instructions for completing GJPO 1512 are printed on the back of the form (Figure 2). The following items provide additional information to the instructions.

7.4.1 The preservation method may be specified in the remarks column.

7.4.2 *Condition Received*—Examples of conditions to note could include broken container, lid off, leaking fluid, etc.

7.4.3 *Relinquished by/Received by*—When the samples are physically transferred from one person to another, or from a person to a shipper, the relinquisher and receiver shall sign the appropriate block, with the date and time of sample transfer. The relinquishers, by signing, verify that the samples have been within their custody.

7.4.3.1 It is each signatory's responsibility to write the signature legibly.

7.4.3.2 The relinquisher retains a copy of the form.

7.4.3.3 Noncontractor employees are not required to sign the form (e.g., employees of shipping companies).

7.5 The following is the minimum information required on the form to ensure sample identification:

7.5.1 Date chain-of-sample-custody form was prepared;

7.5.2 Project name;

7.5.3 Sampler's printed name; and

7.5.4 Sample number.

7.6 Complete all information blocks or label the blocks "NA" for "not applicable". Line through unused portions of items 6 through 13 with a single line, and initial and date the line (Figure 3).

7.7 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.

7.7.1 When seals are applied to the sample container, they must not obscure the information on the sample label.

7.7.2 Securely wrap or fasten shipping containers prior to 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.

7.7.3 Enter the date the samples are sealed and sign the custody seals or tags as shown below. Clear plastic tape may be applied over the seals for protection.

CUSTODY SEAL	
Date	_____
Signature	_____

Example of Custody Seal

7.8 The original chain-of-sample-custody record shall accompany the samples until they are received by the laboratory.

7.9 Unless otherwise specified by the project, the chain-of-sample-custody record shall be maintained as part of the project records.

Chain-of-Sample Custody

1. **Page _____ of _____:** Indicates sequence and total number of pages.
2. **Date:** Date the chain-of-custody record was prepared.
3. **Project Name:** The project name or title.
4. **Site Location:** The location of the project site.
5. **Sampler:** The printed name of the person who collected the samples.
6. **Sample No.:** The unique three-letter, three-digit number generated by GJO.
7. **Date:** Date the sample was collected.
8. **Time:** The time the sample was collected.
9. **Sample Location:** The location at which the sample was taken; e.g., well number, grid location, or survey coordinate.
10. **Sample Matrix:** The sample matrix, e.g., soil, sludge, water, air, or filler.
11. **Container:** The type of container; e.g., write 40-mL glass in the slanted column. Write the number of containers of a given type on the corresponding horizontal line.
12. **Remarks:** Any remarks, as appropriate; preservation method required, e.g., acidified < 2 pH.
13. **Condition Received:** For use by laboratory personnel, to note any damage to sample or container.
14. **Relinquished by/Received by:** Signatures of relinquishers and receivers, with date and time of sample transfer.
15. **Method of Shipment:** The method of shipment, e.g., Federal Express, bus line, etc.
16. **Laboratory/Destination:** The place the samples were shipped for analysis, storage, or other purposes.
17. **Airbill or Receipt Number:** For use with airbills or receipts from contract shippers.
18. **For Use by Contract Laboratories Only:** For use by laboratories other than the Grand Junction Office (GJO). Receiver to sign, date, and return this form to GJO by mail or with analytical data package.

General: The purpose of this form is to document sample custody and receipt. GJO assumes no responsibility for samples not in the custody of GJO personnel.

The users of this form are responsible for completing the form by using a waterproof, reproducible ink.

The users of this form are responsible for legibility of all entries.

All information blocks must be completed or marked as "NA" for "Not Applicable." Unused portions of the form must be lined out with a single line, initialed, and dated.

Figure 2. Instructions for Completing Chain-of-Sample-Custody Form (Reverse Side of GJPO 1512)

Grand Junction Office

2597 B 3/4 Road
Grand Junction, Colorado 81503
Telephone (970) 248-6000

Chain-of-Sample Custody

1. Page 1 of 1

2. Date 12/3/98

3. Project Name OU1

4. Site Location Monticello, Wt

5. Sampler (print name) Sam Samples

11. Containers

1L Plastic	3
1.5L Plastic	1
2.5L Glass	3
40ml Glass	1

6. Sample No.	7. Date	8. Time	9. Sample Location	10. Sample Matrix	11. Containers	12. Remarks	13. Condition Received
NAA 001	12/3/98	1:00 pm	Well SA	Water	3	Re-226 pH < 2 HNO ₃	ok
					1	metals pH < 2 HNO ₃ Unfiltered	
					3	PCB, Unfiltered, Cool	
					1	BOD, Cool	
Signature and Date 12/3/98							

14. Relinquished by (signature) <u>Sam Samples</u>	Date <u>12/3/98</u>	Time <u>1:30 p</u>	Relinquished by (signature)	Date	Time	Relinquished by (signature)	Date	Time
Received by (signature) <u>Regan Receipt</u>	Date <u>12/3/98</u>	Time <u>1:30 p</u>	Received by (signature)	Date	Time	Received by (signature)	Date	Time
15. Method of Shipment			16. Laboratory/Destination			17. Airbill or Receipt Number		
18. For Contract Laboratories Only—Receiver to sign, date, and return form by mail or with analytical data package								
Company Name _____			Received by _____			Date _____		

Preparation instructions on back of form.

Distribution: Original accompanies shipment, copies to relinquisher.

Figure 3. Example of Completed Chain-of-Sample-Custody Form

8. Physical Security of Samples and Sampling Process

8.1 The sampler must maintain physical security of the samples, sampling process, and equipment by physical possession, visual contact, or seals or locks to prevent tampering. Because the procedures for physical security are unique to each sampling situation, only guidelines can be given.

8.1.1 Lock the sampling device when unattended. For example, when using an unattended autosampler to collect samples for a period of time, the device must be locked or secured to maintain physical security.

8.1.2 Store samples in a locked storage area. For example, when collecting samples for a period of time before transporting to the laboratory, lock the samples in a secure storage area or in an area with controlled access such as a locked vehicle or locked field office.

8.1.3 Use security seals where appropriate. Although security seals do not provide physical security, the seals are evidence that the samples or sampling process was not tampered with while unattended.

8.1.4 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.

8.2 Document in field logs, or other project documents, the type of physical security used.

9. Keywords

9.1 Chain-of-sample-custody record, form, laboratory, physical security, samples, and shipper.

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

Introduction

Water-level measurements shall be taken prior to any sampling or well purging. These measurements are needed to determine the casing volume of water in the well; the data are used to interpret the monitoring results. High water levels could indicate recent recharge to the system, which would dilute the sample. Low water levels could reflect the influence of nearby production wells. Documentation of nonpumping water levels also provides historical information on the hydraulic conditions at the site (see reference 3.7).

1. Scope

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

1.2 Three methods are provided in this test method for water-level measurement.

1.2.1 The first method uses an electric water-level sounder with a conductivity cell. When the cell contacts water, it completes an electrical circuit, activating an audio and/or visual alarm.

1.2.2 The second method uses an interface probe. This instrument has an optical liquid sensor and a conductivity cell and can distinguish between the presence of a nonconductive layer and a conductive layer. For example, oils, fuels, and many organics are nonconductive and are immiscible with water. With an interface probe, the sampler can measure the thickness of a light non-aqueous-phase liquid (LNAPL) layer, which floats on the water's surface, or a dense non-aqueous-phase liquid (DNAPL) layer, which sinks to the bottom of the well.

1.2.3 The third method uses an electronic/pneumatic water-level meter in conjunction with a dedicated water-level probe. The water-level meter measures the pressure it takes to force the water out of the dedicated water-level probe and converts that pressure to the submersion depth of the probe. This depth is then subtracted from the total probe length (obtained during installation), giving the depth to water.

	Section
Method A — Water-Level Measurements Using an Electric Sounder	6-8
Method B — Water-Level Measurements Using an Interface Probe	9-11
Method C — Water-Level Measurements Using a Well Wizard Model 6010E Electronic/Pneumatic Water-Level Meter with a Dedicated Water-Level Probe	12-15

2. Hazard Analysis

2.1 Site-specific controls (e.g., radiological controls in a contaminated area, respirators, personal protective equipment, and decontamination) are available in the planning documents, such as the Health and Safety Plan, for a particular project. These documents should be consulted before beginning work on a project.

2.2 This test method uses methanol for decontaminating the apparatus. Methanol is a Department of Transportation (DOT)-regulated material; its hazard class is Flammable Liquid. Methanol has an Occupational and Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL)-Time-Weighted Average (TWA) of 200 parts per million (ppm) and a PEL-Short Term Exposure Limit (STEL) of 250 ppm (see reference 3.2). Methanol can also potentially enter the body through the skin.

2.2.1 Some of the effects of methanol by inhalation or skin absorption include dizziness, nausea, weakness, shooting pain in the arms or legs, gastric pain, blurred vision, changes in color perception, double vision, and blindness (see reference 3.3).

2.2.2 Avoid eye and skin contact by wearing eye protection and nitrile (including thin Best

N-Dex), butyl, or neoprene gloves. Avoid breathing vapors by using only in a well-ventilated area. Keep away from heat, sparks, and flames.

2.3 Method C involves use of an air compressor to charge the internal tank of the water-level meter. Safety precautions include:

2.3.1 Air compressors that are belt-driven shall have a belt guard in place.

2.3.2 Air compressors shall not be operated above the rated capacities and shall be configured to avoid having any dead-end fittings above 20 pounds per square inch (psi). Carefully check for loose connections before operating.

2.3.3 Use proper lifting techniques when lifting air compressors.

2.3.4 Ensure that the air compressor is equipped with an over-pressure relief valve and regulator.

2.3.5 The air compressors used for Method C are gasoline-powered.

2.3.5.1 Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid. Gasoline has an OSHA PEL-TWA of 300 ppm and a PEL-STEL of 500 ppm (see reference 3.2).

2.3.5.2 Avoid eye and skin contact by wearing eye protection and nitrile or butyl gloves. Avoid breathing vapors by using only in a well-ventilated area. Keep away from heat, sparks, and flames.

2.3.5.3 Some of the symptoms of gasoline exposure include dizziness, intoxication, blurred vision, headache, skin irritation, and flushed facial skin tone (see reference 3.3).

2.3.5.4 Gasoline shall be stored in Factory Mutual-approved safety cans. Safety cans shall be well secured in the vehicle during transport. Gasoline-powered compressors must be cool before filling, and care shall be taken to avoid spilling any gasoline.

2.3.5.5 A 10-pound dry chemical fire extinguisher should be available when fueling the compressor.

3. Referenced Documents

3.1 *American Society for Testing and Materials, 1990 Annual Book of ASTM Standards, Section 11, "Water and Environmental Technology," Vol. 11.04, Pesticides; Resource Recovery;*

Hazardous Substances and Oil Spill Responses; Waste Disposal; Biological Effects:

ASTM D 4448-85a—Standard Guide for Sampling Groundwater Monitoring Wells.

3.2 *Code of Federal Regulations (CFR), Title 29, "Labor":*

29 CFR 1910, Occupational Safety and Health Standards.

3.3 Micromedex, Inc., *TOMES Plus*, CD-ROM Database, Vol. 13, Chicago, IL, 1992.

3.4 QED Environmental Systems, Inc. *Well Wizard Model 6010E Electronic/Pneumatic Water Level Meter Installation and Operation Instructions*. Ann Arbor, MI, 1991.

3.5 U.S. Department of Energy, *The Environmental Survey Manual, Appendix E, "Field Sampling Protocols and Guidance,"* Office of the Assistant Secretary, Environment, Safety and Health, Vol. 4, DOE/EH-0053, 1987.

3.6 U.S. Environmental Protection Agency, *Handbook of Groundwater*, EPA/625/6-87/016, 1987.

3.7 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

4. Terminology

4.1 *Conductivity cell*—A simple electrical circuit that, when completed, causes electrical current to flow.

4.2 *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.

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

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

4.5 *Interface probe*—A probe designed to detect conductive and nonconductive layers in a well.

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

5. Significance and Use

5.1 Accurate measurements of water depth are necessary in the calculation of well bore volumes; measurements to the nearest 0.01 foot (ft) are routine.

Method A Water-Level Measurements Using an Electric Sounder

6. Apparatus

6.1 Electric sounder. (There are many adequate electric sounders available. This procedure covers most models.)

6.2 Kimwipes or equivalent lint-free tissue.

6.3 Distilled or deionized water in a squeeze wash bottle.

6.4 Measuring tape with an engineering scale.

7. Procedure

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

7.1.1 Check the sounder to ensure the batteries are charged.

7.1.2 Clean the probe of the sounder with distilled or deionized water and wipe dry with a lint-free tissue.

7.1.3 Slowly lower the probe into the well until the indicator sounds.

7.1.4 Raise the probe slightly until the indicator stops sounding.

7.1.5 Carefully lower the probe until the indicator sounds again and read the depth to water to the nearest 0.01 ft, using a measuring tape with an engineering scale if necessary.

7.1.6 Repeat steps 7.1.4 and 7.1.5 until a repeatable measurement is achieved.

7.1.7 Record the depth to water to the nearest 0.01 ft.

7.1.8 Slowly withdraw the probe from the well while wiping the cable with a lint-free tissue moistened with distilled or deionized water.

7.1.9 Clean the probe with distilled or deionized water and wipe dry with a lint-free tissue.

8. Procedure Bias

8.1 With this method, water-level measurements must be repeatable to ± 0.01 ft. The accuracy of the probe shall be routinely checked against a steel measuring tape to ensure that the cable has not stretched or twisted.

Method B Water-Level Measurements Using an Interface Probe

9. Apparatus

9.1 Soiltest Model 447-000 Interface Probe or equivalent.

9.2 Kimwipes or equivalent lint-free tissue.

9.3 Distilled or deionized water in a squeeze wash bottle.

9.4 Methanol

10. Procedure

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

10.1.1 Clean the probe with methanol, followed by a distilled or deionized water rinse, and wipe dry with a lint-free tissue.

10.1.2 Check the battery level and replace if low.

10.1.3 Slowly lower the probe into the well until the probe comes in contact with liquid. A steady audible alarm indicates an immiscible, nonconductive liquid, while an oscillating alarm indicates a conductive liquid (water).

10.1.4 When the alarm sounds, raise the probe slightly until the alarm stops. Carefully lower until the alarm sounds again and note the depth. Repeat as necessary until a repeatable measurement of ± 0.01 ft is achieved. Record this measurement.

10.1.5 If a LNAPL layer is present as indicated by a steady audible alarm, the thickness can be measured by recording the point at which the steady alarm begins and the point at which the oscillating alarm begins. The difference between the two measurements is the thickness of the LNAPL layer.

10.1.6 If a DNAPL layer is suspected, it can be measured by slowly lowering the probe to the bottom of the well. If a DNAPL layer is present, the thickness can be measured by recording the difference between the point at which the steady alarm begins and the point at which the probe reaches the bottom of the well.

10.1.7 Carefully withdraw the probe from the well while wiping the cable with a lint-free tissue moistened with distilled or deionized water. If the well contained any LNAPL layers, the cable shall be rinsed with methanol followed by a distilled or deionized water rinse and wiped dry with a lint-free tissue as it is being removed from the well.

10.1.8 Clean the probe with methanol, followed by a distilled or deionized water rinse, and dry with a lint-free tissue.

11. Procedure Bias

11.1 When using the interface probe for liquid level measurements, readings of ± 0.01 ft can be achieved. The accuracy shall be routinely checked using a steel measuring tape to determine if the cable has stretched or twisted.

Method C

Water-Level Measurements Using a Well Wizard Model 6010E

Electronic/Pneumatic Water-Level Meter with a Dedicated Water-Level Probe

12. Apparatus

12.1 Well Wizard Model 6010E electronic/pneumatic water-level meter.

12.2 Well Wizard Model 6111 stainless steel water-level probe and associated polyethylene tubing, fittings, and cap assembly.

12.3 Well Wizard Model 6015 calibration assembly.

12.4 Well Wizard 41000 series oil-free compressor or equivalent.

13. Procedure

13.1 The following procedure is supplemental to the instruction found in the instrument-specific operating manual (see reference 3.4):

13.1.1 Rapid temperature changes will adversely affect the water-level meter operation. The meter must equilibrate to ambient temperature conditions for a minimum of 45 minutes before use.

13.1.2 Charge the internal tank of the water-level meter to 100 psi by attaching an oil-free air supply to the fitting marked "TANK RECHARGE."

13.1.3 Move the "SENSOR" switch to the "ON" position.

13.1.4 Wait for the liquid crystal display (LCD) message to read "ATTACH TO WELL."

13.1.5 Attach the meter air tubing from the water-level meter fitting marked "TO AIR PROBE" to the white air fitting on the well cap.

13.1.6 Move the "AIR" switch forward to the "ON" position.

13.1.7 Press the "START" button once.

13.1.8 Press the "AIR PRECHARGE" until the LCD display shows the highest reading.

13.1.9 Leave the "AIR" switch in the "ON" position. The LCD message will read "PROBE SUBMERSION DEPTH B," and the reading shall be recorded when the depth stabilizes.

13.1.10 Move the "AIR" and "SENSOR" switches back to the "OFF" position.

13.1.11 To determine the depth to water, subtract the probe submersion depth from the probe length determined during installation.

13.1.12 When the batteries begin to get low, the LCD message will read "WARNING! LOW BATTERIES" after pressing the "START" button. Pressing the "START" button again will allow additional limited use, but the batteries must be replaced soon.

13.1.13 If the LCD message reads "BATTERY TOO LOW! TURN SYSTEM OFF," the meter shall not be used until the batteries are replaced.

14. Calibration

14.1 This calibration procedure shall be performed before each round of water-level measurements.

14.1.1 Place water in the calibration test tube to a convenient level on the scale marked on the side of the tube.

14.1.2 Charge the internal tank of the water-level meter to 100 psi by attaching an oil-free air supply to the fitting marked "TANK RECHARGE."

14.1.3 Move the "SENSOR" switch to the "ON" position.

14.1.4 Wait for the LCD message to read "ATTACH TO WELL."

14.1.5 Attach the meter air tubing from the water-level meter fitting marked "TO AIR PROBE" to the air fitting on the top of the calibration test tube.

14.1.6 Move the "AIR" switch forward to the "ON" position.

14.1.7 Press the "START" button once.

14.1.8 Press the "AIR PRECHARGE" button until the LCD display reads the highest number.

14.1.9 Move the "AIR" switch back to the "OFF" position.

14.1.10 Wait for the LCD message to read "PROBE SUBMERSION DEPTH" and for the depth reading to stabilize.

14.1.11 Compare the meter reading to the actual water level in the calibration test tube. If the meter does not read the actual water level observed in the calibration test tube, remove the "CALIBRATION" panel screw and the epoxy seal from the internal calibration screw.

14.1.12 Slowly adjust the internal calibration screw until the meter reading matches the actual water level observed in the calibration test tube.

14.1.13 Repeat steps 14.1.3 through 14.1.11 to check the calibration.

14.1.14 Apply a small amount of epoxy or a similar locking compound to the calibration screw to lock it into position.

14.1.15 Reinstall the meter "CALIBRATION" panel screw.

15. Procedure Bias

15.1 The accuracy of this system of water-level measurements is ± 0.01 ft between 40 °F and 120 °F, and ± 0.02 ft between -20 °F and 40 °F.

16. Quality Assurance

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

16.1.1 Date and time of measurements.

16.1.2 Well identification and site.

16.1.3 Name of person performing the measurement.

16.1.4 Reference point if not top of casing.

16.1.5 Remarks if necessary, e.g., wells pumping nearby, recent heavy rains, ice in well.

16.1.6 Depth to water.

16.1.7 Depths to top of LNAPLs and DNAPLs and thicknesses of layers (Method B only).

16.1.8 Length of dedicated water-level probe (Method C only).

16.1.9 Depth of submersion of water-level probe (Method C only).

16.1.10 Date and time of calibration and any calibration adjustments made (Method C only).

17. Keywords

17.1 Calibration test tube, conductivity cell, dedicated water-level probe, electric sounder, electronic/pneumatic water-level meter, interface probe, monitoring well, and probe submersion depth.

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.

1. Scope

1.1 The four 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 Section 7, "Well Purging Strategies," General Considerations for the Sampling of Liquids [LQ-1(G)] (reference 3.2), provides guidance for selecting the proper method.

	Section
Method A—Well Purging Using a Peristaltic-Type Pump	6-8
Method B—Well Purging Using a Bladder-Type Pump	9-11
Method C—Well Purging Using a Bailer	12-14
Method D—Well Purging Using a Submersible Pump	15-17

2. Hazard Analysis

2.1 These procedures use gasoline-powered electric generators, gasoline-powered air compressors, and battery-powered pumps and accessories. The following safety precautions shall be followed.

2.1.1 Air compressors that are belt driven shall have a belt guard in place.

2.1.2 Care shall be taken when connecting and disconnecting equipment powered by lead-acid batteries to avoid generating sparks that have the potential of creating an explosive hazard.

2.1.3 Gasoline shall be stored in Factory Mutual (FM)-approved safety cans. Safety cans shall be well secured in the vehicle during transport. Gasoline-powered equipment shall be cool before filling and care shall be taken not to spill any gasoline.

2.1.4 Air compressors shall not be operated above rated capacities and shall be configured to avoid having any dead end fittings above 20 pounds per square inch (psi). Carefully check for loose connections before operating.

2.1.5 Gasoline is a Department of Transportation (DOT)-regulated material; its hazard class is Flammable Liquid. Avoid eye and skin contact by wearing eye protection and disposable gloves. Avoid breathing vapors. Use only in a well-ventilated area and keep away from heat, sparks, and flames.

2.1.6 Gasoline-powered generators shall not be operated above their rated capacity.

2.1.7 Care shall be used when lifting generators and air compressors. Proper lifting techniques shall be used when lifting heavy equipment.

2.1.8 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448-S5a, 1986.

3.2 Geotech, *Environmental Procedures Catalog* (Manual 116):

General Considerations for the Sampling of Liquids [LQ-1(G)].

Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells (LQ-2(T)).

Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

3.3 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053 1987.

3.4 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

3.5 U.S. Environmental Protection Agency, *Handbook Groundwater*, EPA/625/6-87/016, 1987.

4. Significance and Use

4.1 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

5. Calculation of Volume of Standing Water in a Well

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

$$r^2 \times \pi \times (h_1 - h_2) \times 7.48 = \text{gallons per casing volume,} \quad (1)$$

where

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

h₁ = depth of well (feet) from the top of the well casing (the depth of the well is obtained from the well completion logs), and

h₂ = depth to water (feet) measured from the top of the well casing (the depth of water is measured using the Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)]).

Method A

Well Purging Using a Peristaltic-Type Pump

6. Apparatus

6.1 Peristaltic-type pump.

6.2 Silicone, C-FLEX, or neoprene tubing for the pump head.

6.3 Silicone, Teflon, polyethylene, or vinyl tubing for placing in the well.

6.4 Generator or other source of electricity.

6.5 Gasoline for generator. (Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid.)

7. Procedure

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

7.1.1 Place the suction line in the well so it is just below the liquid surface.

7.1.2 Connect the suction line to the pump.

7.1.3 Connect the pump outlet to the in-line flow cell, see reference 3.2, or place the pump outlet hose into an open container to be used to make the field measurements.

7.1.4 Place calibrated pH, conductivity, and temperature electrodes into the in-line flow cell or the open container.

7.1.5 Initiate pumping and follow the water level down the well bore if the recovery rate of the well is below the pumping rate.

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

7.1.6 Routinely monitor and record the volumes purged and the readings for the pH, conductivity, and temperature.

7.1.7 When these readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

7.1.8 Remove the suction line from the well, and clean and decontaminate the suction line and pump tubing, as required.

8. Procedure Bias

8.1 The advantages of purging with a peristaltic pump are that (1) a peristaltic pump is relatively portable, inexpensive, and convenient; (2) it requires a minimum of down-hole equipment; and (3) it can be cleaned easily or the entire tubing can be changed between wells.

8.2 The disadvantages of purging with a peristaltic pump are that (1) purging is limited to situations where the water levels are less than about 25 feet and (2) degassing occurs whenever there is a head difference between the pump and the water level.

Method B Well Purging Using a Bladder-Type Pump

9. Apparatus

9.1 Bladder-type pump.

9.2 Air compressor.

9.3 Teflon, polyethylene, or vinyl tubing for the air and sample lines.

9.4 Gasoline for the air compressor. (Gasoline is a DOT-regulated material; its hazard class is Flammable Liquid.)

10. Procedure

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

10.1 Lower the pump gently to a position just above the screened interval.

10.2 Connect the air line to the pump controller.

10.3 Connect the pump outlet to an in-line flow cell; see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

10.4 Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.

10.5 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.

10.6 When these readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

10.7 Remove the pump from the well; clean and decontaminate as required.

11. Procedure Bias

11.1 The advantages of using a bladder-type pump for purging are that (1) the system is not damaged by dry pumping, (2) there is no air/water contact, and (3) the entire assembly can be made of Teflon or stainless steel.

11.2 The disadvantages of using a bladder-type pump are that (1) pumping rates are relatively slow, (2) there is a high rate of air consumption during prolonged pumping, and (3) cleaning and decontamination are more difficult than with the apparatus used in methods A or C.

Method C Well Purging Using a Bailer

12. Apparatus

12.1 Teflon or stainless steel bailer.

12.2 Teflon or stainless steel cable or line.

12.3 Bailer reel.

13. Procedure

13.1 Attach the bailer to the cable or line.

13.2 Lower the bailer slowly until it contacts the liquid.

13.3 Allow the bailer to sink until it is totally submerged.

13.4 Slowly raise the bailer to the surface.

13.5 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.

13.6 Routinely monitor and record the pH, conductivity, temperature, and volume purged.

13.7 When the readings have stabilized to ± 10 percent for two successive well volumes, sampling can begin.

13.8 Clean and decontaminate the bailer, as required.

14. Procedure Bias

14.1 The advantages of using bailers for well purging are that (1) bailers can be constructed of a variety of materials, (2) external power sources are not needed, (3) bailers are inexpensive, (4) bailers are easily cleaned and decontaminated, and (5) bailers can be used in wells of virtually any depth.

14.2 The disadvantages of using bailers are that (1) evacuating large amounts of stagnant water is labor intensive; (2) aeration, degassing, and turbulence will occur; (3) it is difficult to determine the depth to which the bailer has been submerged; and (4) bailer check valves may not operate properly under conditions of high suspended solids.

Method D
Well Purging Using a Submersible Pump

15. Apparatus

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

16. Procedure

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

16.2 Set up the pump according to the operating manual.

16.3 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.

16.4 Connect the pump outlet to an in-line flow cell; see Standard Practice for the Use of a Flow Cell for Field Measurements ([LQ-10(P)]).

16.5 Place calibrated pH, conductivity, and temperature electrodes in the flow cell or the open container.

16.6 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.

16.7 When pH, conductivity, and temperature have stabilized for two successive well volumes, sampling can begin.

16.8 Remove the pump from the well; clean and decontaminate.

17. Procedure Bias

17.1 The advantages of using a submersible pump for well purging are that (1) relatively high pumping rates are possible, (2) some designs are relatively portable and easy to use, and (3) these pumps can pump from greater depths than the pumps used in methods A or B.

17.2 The disadvantages of using a submersible pump are that (1) high pumping rates and the mechanical actions cause turbulence, aeration, and degassing of the water; (2) pumps are easily damaged by dry pumping; and (3) these pumps can be difficult to clean and decontaminate.

18. Quality Assurance

18.1 All of the methods listed above require the following information to be logged for quality-assurance documentation.

- 18.1 Depth to water.
- 18.2 Depth of well.
- 18.3 Well diameter or radius.
- 18.4 Depth of water.
- 18.5 Calculated water volume.
- 18.6 Type of mechanism used to evacuate the well.
- 18.7 Date.
- 18.8 Well identification.
- 18.9 Name of person performing the purging.
- 18.10 Volume purged.
- 18.11 Conductivity, pH, and temperature measurements.

19. Keywords

19.1 Bailer, bladder-type pump, peristaltic-type pump, submersible pump, and well purging.

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.

1. Scope

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

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents of a particular project.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, D1293-78, 1984.

3.2 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater: American Public Health Association*, Washington, D.C., 1980.

3.3 Geotech, *Environmental Procedures Catalog*, Manual 116:

Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

3.4 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.5 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

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

4.2 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.

5. Interferences

5.1 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.

5.1.1 *Temperature*—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.

5.1.2 *Atmospheric Contamination*—Atmospheric contamination can be a significant problem for groundwater samples. Dissolved oxygen 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 Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(P)].

5.1.3 *Ionic Strength*—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 prior to the reading. Even then, it may require several minutes for the reading to stabilize.

5.1.4 *High Sodium and Alkalinity*—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.

6. Apparatus

6.1 Numerous pH meters are available; the meter used should have a temperature-compensating device, have a slope adjustment, and be capable of reading pH to ± 0.01 units.

6.2 A flow cell to be used for continuous-flow measurements.

6.3 Standard pH-buffer solutions of 4.00, 7.00, and 9.00 or 10.00.

6.4 Combination pH electrode.

6.5 Temperature-measuring device capable of reading temperatures to ± 0.1 °C.

6.6 Distilled or deionized water in a squeeze wash bottle.

6.7 Kimwipes or equivalent lint-free tissue.

6.8 Disposable beakers, test tubes, or centrifuge tubes.

7. Calibration

7.1 In each case, samplers shall follow the manufacturer's instructions for the pH meter and electrode used. Electrodes shall be kept wet when not in use. Recommended solutions for storage are the pH 4.00 or pH 7.00 buffer.

7.2 Before use, remove the electrode from the storage solution, rinse with distilled water, and blot dry with a lint-free tissue.

7.3 Adjust buffer solution and electrode to ± 10 °C of the sample temperature. This can be done by storing the buffer solutions and electrode in an ice chest or by letting sample water run over the buffer bottles and electrode until the temperatures have equilibrated.

7.4 Place the electrode in the pH 7.00 buffer, adjust the temperature compensation control to the temperature of the buffer (or use an automatic temperature compensator), and adjust the calibration control to read the pH of the buffer. The pH of the buffer is equal to 7.00 only at 25 °C; therefore, it is necessary to use the temperature-correction curve supplied by the manufacturer of the buffer.

7.5 Remove the electrode from the 7.00 buffer, rinse with distilled water, and blot dry. Place the electrode in either pH 4.00 or pH 10.00 buffer, bracketing the expected pH of the sample. Allow the reading to stabilize before making adjustments. Adjust the slope control to read the correct pH, again consulting the temperature-correction curve supplied by the manufacturer.

7.6 Rinse the electrode with distilled water and blot dry. Recheck value of the pH 7.00 buffer. The value shall be within ± 0.02 pH of the correct value. If not, repeat steps 7.4, 7.5, and 7.6.

8. Procedure

8.1 The following general procedure supplements the instruction in the instrument-specific operating manual.

8.1.1 Rinse the calibrated electrode (see Section 7) with distilled water, blot dry, and immerse electrode in the solution.

8.1.2 Use of a flow cell is recommended for making pH measurements; this reduces the interferences that are due to atmospheric contamination. If possible, in situ measurements are the best.

8.1.3 Allow the measurement to stabilize and record the reading.

8.1.4 Remove the electrode from the solution, rinse with distilled water, blot dry, and store in pH 4.00 or pH 7.00 buffer solution.

9. Quality Assurance

9.1 The following information about the field measurement of pH shall be logged for quality-assurance documentation.

9.1.1 Time of the last two-buffer calibration. The two-buffer calibration shall be performed a minimum of once each hour.

9.1.2 Buffer temperature at time of calibration.

9.1.3 Sample temperature at time of measurement.

9.1.4 Measurement conditions (i.e., in situ, open container, or air-exclusion container).

9.1.5 Source and expiration date of buffers used.

9.1.6 Instrument manufacturer and model number.

9.1.7 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision of ± 0.02 pH units and an accuracy of ± 0.05 pH units can be achieved. However, ± 0.1 pH units represent the limit of accuracy under normal conditions.

11. Keywords

11.1 Electrode, flow cell, pH, and pH meter.

Standard Test Method for the Field Measurement of Specific Conductance

Introduction

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

1. Scope

1.1 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.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater: American Public Health Association*, Washington, D.C., 1980.

3.2 Korte, N. and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 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 KCl. Samplers shall consult operating instructions for the specific instrument used for the determination of the cell constant. This conductivity is expressed in micromhos per centimeter (μ mhos/cm).

5. Interferences

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

5.1.1 *Temperature*—The conductivity of a solution increases with temperature at approximately 2 percent per degree celsius. Significant errors can result from inaccurate temperature measurements.

5.1.1.1 If the conductivity meter does not have automatic temperature correction, the sampler can use the following formula to correct the conductivity reading for temperature:

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

where

K = corrected conductivity in μ mhos/cm,

E_m = measured conductivity in μ mhos/cm, and

t = temperature in °C.

5.1.2 *Ionic Strength*—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 μ mhos/cm. As conductivity increases above 5,000 μ mhos/cm, the line curves significantly; beyond 50,000 μ mhos/cm, the conductivity is an unsatisfactory index of ionic concentration.

5.1.3 *Cell Constant*—The cell constant shall be checked and verified on a regular basis. A significant change in the cell constant indicates that the electrode needs cleaning or changing. Consult the instrument operating manual for procedures to check the cell constant, or see Section 7 of this procedure.

6. Apparatus

6.1 Specific conductance meter capable of measuring conductivity in the range of 0 to 100,000 μ mhos/cm. This meter should also measure temperatures in the range of -5°C to 50°C .

6.2 Conductivity check solutions. Normally, 0.001 N, 0.01 N, and 0.1 N KCl solutions will cover the range of expected sample conductivity.

6.3 Distilled or deionized water in a squeeze bottle.

6.4 Disposable beakers, test tubes, or centrifuge tubes.

6.5 Kimwipes or equivalent lint-free tissue.

7. Calibration

7.1 An actual calibration of the instrument is not performed. The cell/instrument calibration is confirmed by use of standard check solutions as described below.

7.1.1 Connect the temperature probe and conductivity cell to the instrument.

7.1.2 Rinse the temperature probe and conductivity cell with distilled water and blot dry with a lint-free tissue.

7.1.3 Place the temperature probe and conductivity cell in the 0.001 N KCl standard and allow the readings to stabilize. Record the temperature and conductivity reading in the field logbook.

7.1.4 Repeat steps 7.1.2 and 7.1.3 for the 0.01 N and the 0.1 N KCl standards.

7.1.5 Correct the readings to 25°C using the formula in Section 5.1.1.1 and compare these readings to the standard values. If these readings are within ± 10 percent of the accepted value, the cell instrument-calibration check is acceptable.

7.1.6 If the cell/instrument calibration check is unacceptable, consult the instrument operation manual for cell cleaning and instrument troubleshooting procedures.

8. Procedure

8.1 The following general procedure is supplemental to the instructions in the instrument-specific operating manual.

8.1.1 Rinse the conductivity cell and temperature probe with several volumes of sample water.

8.1.2 Immerse the probe and cell in the sample.

8.1.3 Allow the readings to stabilize and record the temperature and conductivity readings on the field log form.

8.1.4 Remove the probes from the solution, rinse with distilled water, blot dry, and store according to the manufacturer's recommended procedures.

9. Quality Assurance

9.1 The following information about the field measurement of specific conductance shall be logged for quality-assurance documentation.

9.1.1 Source and expiration date of standards.

9.1.2 Instrument manufacturer and model number.

9.1.3 Date and time of calibration check.

9.1.4 Temperature and conductivity of standards used to check calibration.

9.1.5 Sample temperature and conductivity reading.

9.1.6 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision and accuracy of ± 5 percent can be achieved with this procedure at conductivity readings between 100 and 5,000 μ mhos/cm.

Readings between 0 and 100 μ mhos/cm and above 5,000 μ mhos/cm should provide \pm 10 percent precision and accuracy. Readings above 20,000 μ mhos/cm shall not be attempted with this procedure.

11. Keywords

11.1 Conductivity, ionic strength, and specific conductance.

Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential (ORP) 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 oxidation-reduction potential (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.

1. Scope

1.1 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.

2. Hazard Analysis

2.1 This test method uses a ZoBell solution for an Eh reference. This solution contains small concentrations of potassium cyanide. Potassium cyanide is a poison and should be handled with care. Samplers shall wear eye protection and disposable gloves to avoid eye and skin contact and shall keep the solution away from strong acids that will liberate hydrogen cyanide gas, which is extremely toxic.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

- 3.1 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, D1498-76, 1984
- 3.2 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983
- 3.3 "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable

Constituents", in *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976

4. Significance and Use

4.1 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:

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

where

E = standard potential of the reaction,

R = gas constant,

T = absolute temperature,

n = number of electrons involved in the half-cell reaction, and

F = Faraday constant.

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

5. Interferences

5.1 **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 $\pm 10^\circ\text{C}$ of the sample temperature for the readings to be valid.

5.2 Reproducible **ORP** measurements cannot be obtained for chemical systems that are not reversible. Samples containing dissolved oxygen above 0.01 part 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 dissolved oxygen, all sample measurements shall be taken in a closed, flow-through container or in situ.

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

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

6. Apparatus

6.1 Most field pH meters have the capability of measuring **ORP** by substitution of an appropriate set of electrodes. The meter should be capable of measuring **ORP** to ± 1 mV.

6.2 Combination **ORP/Eh** electrode.

6.3 ZoBell reference solution.

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

6.4 Temperature-measuring device capable of reading temperatures to $\pm 0.1^\circ\text{C}$.

6.5 A flow cell. See Standard Practice for the Use of a Flow Cell for Field Measurements (LQ-10(P)).

6.6 Distilled or deionized water in a squeeze wash bottle.

6.7 Kimwipes or equivalent lint-free tissue.

6.8 Disposable beakers, test tubes, or centrifuge tubes.

7. Calibration

7.1 An actual calibration of the **ORP** electrode system is not performed. Instead, samplers shall make a performance check to determine if the electrode and meter are functioning properly. The performance check is as follows:

7.1.1 Record temperature of ZoBell solution. This solution should be within $\pm 10^\circ\text{C}$ of sample temperature.

7.1.2 Place electrode in the ZoBell solution and compare the reading with the theoretical value for the ZoBell solution (see Figure 1). The reading should be within ± 10 mV of the theoretical value.

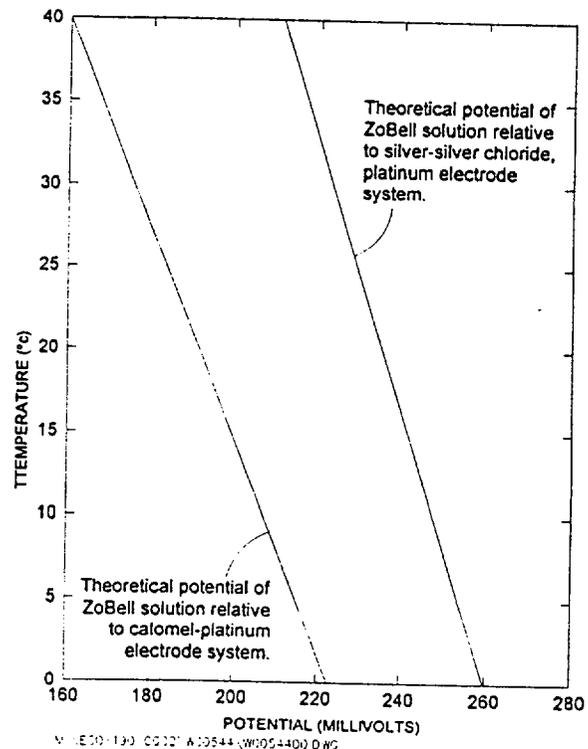


Figure 1. The potential of ZoBell Solution Relative to Reference-Electrode Systems at Various Temperatures

7.1.3 If the reading is not within ± 10 mV, one of the following steps will usually solve the problem.

7.1.3.1 Check reference-electrode filling solution; fill or replace.

7.1.3.2 Polish the platinum end of the electrode (see manufacturer's instructions).

7.1.3.3 Replace electrode.

7.1.4 Rinse electrode with distilled water, blot dry, and store according to manufacturer's suggestions.

8. Procedure

8.1 Check electrode performance according to section 7.1.2.

8.2 Rinse electrode with distilled water and blot dry with a lint-free tissue.

8.3 Place electrode in flow-through cell and pump sample through cell for several minutes to exclude air.

8.4 Turn function switch on meter to the millivolt mode.

8.5 Allow the readings to stabilize. Stabilization should occur within 20 minutes. Turn off sample flow to prevent any streaming potential.

8.6 Record the ORP reading and temperature.

8.7 Remove the electrode from the cell, rinse with distilled water, blot dry, and store according to manufacturer's suggestion.

9. Quality Assurance

9.1 The following information about the ORP measurement shall be logged for quality-assurance documentation.

9.1.1 Temperature of sample.

9.1.2 Temperature of ZoBell solution.

9.1.3 ORP of ZoBell solution.

9.1.4 Name of person performing the measurement.

10. Calculation

10.1 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,

A = Observed ORP of sample,

B = Observed ORP of ZoBell solution, and

C = Theoretical Eh of ZoBell solution relative to the standard hydrogen electrode (Figure 2)

Report D to the nearest ± 10 mV.

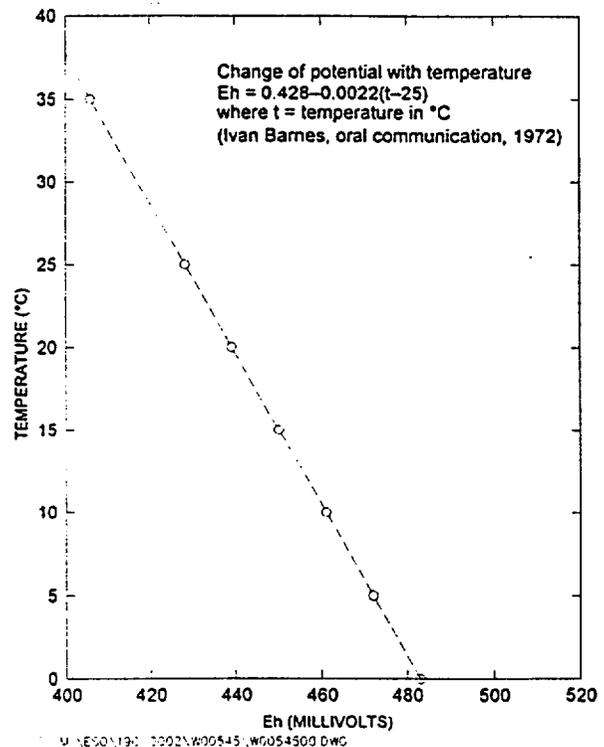


Figure 2. The Eh of Zobell Solution, Relative to the Standard Hydrogen Electrode at Various Temperatures

11. Precision and Bias

11.1 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 mentioned in section 5. In the absence of substances that coat or poison the electrode, the precision is ± 10 mV.

12. Keywords

12.1 Eh, flow cell, oxidation-reduction potential, and ZoBell solution

Standard Test Method for the Field Measurement of Alkalinity

Introduction

The alkalinity of a water sample is a quantitative measurement of the ability of the sample to react with a strong acid to a designated pH. The alkalinity of natural waters is primarily a measure of the carbonate, bicarbonate, and hydroxide content. It is also a general indicator of groundwater quality.

1. Scope

1.1 This method describes the field measurement of alkalinity of aqueous samples. It is a measure of the aggregate property of the sample and can be interpreted in the terms of specific substances, such as carbonate and bicarbonate, only when the chemical composition of the sample is known.

1.2 The sample is titrated with a standard acid solution to a designated pH, and the end point is determined by a color change of an internal indicator.

2. Hazard Analysis

2.1 This test procedure uses sulfuric acid (H_2SO_4). Sulfuric acid is a corrosive material and is a Department of Transportation (DOT)-regulated material; its hazard class is Corrosive Liquid. Avoid contact with eyes, skin, and clothing. Adequate ventilation, eye protection, and disposable gloves are required. First aid for eye and skin contact is to immediately flush with water for 15 minutes, remove contaminated clothing, and call a physician.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, *Standard Methods for the Examination of Water and Wastewater*, American Water Works Association, and Water Pollution Control Federation, Washington, D.C., 1980.

3.2 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, 1984.

3.3 Geotech, *Environmental Procedures Catalog* (Manual 116):

Standard Test Method for the Field Measurement of pH [LQ-4(T)].

3.4 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.5 Wood, W. W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 The alkalinity of natural water is commonly used to obtain a value for the carbonate and bicarbonate concentrations. Carbonate and bicarbonate determinations shall be made in the field at the time of sampling if the concentrations are to accurately reflect those concentrations originally present in the sample.

4.2 The following equations govern the reactions involved:

$$\text{CO}_3^{2-} + \text{H}^+ = \text{HCO}_3^- \quad (\text{this reaction is complete near pH } 8.3),$$

$$\text{HCO}_3^- + \text{H}^+ = \text{H}_2\text{O} + \text{CO}_2 \quad (\text{this reaction is complete near pH } 4.5).$$

The end point of pH 8.3 is determined by the color change of the phenolphthalein indicator, and the end point of pH 4.5 is determined by the color change of the bromocresol green-methyl red indicator.

NOTE: If the measured pH of the sample is less than 4.5, there is no carbonate or bicarbonate alkalinity and this test method is not applicable.

5. Interferences

5.1 The measured values may include contributions from borates, phosphates, or silicates if these are present in the sample.

5.2 Natural color or the formation of precipitate while titrating the sample may mask the color change of the indicator, or waste materials may interfere chemically with the color change by destroying the indicator.

5.3 Varying results may be experienced with samples containing oxidizing or reducing substances.

6. Apparatus

6.1 Hach alkalinity test kit Model AL-DT. (This kit contains sulfuric acid, which is a DOT-regulated material; its hazard class is Corrosive Liquid.)

6.2 Distilled or deionized water in a squeeze bottle.

6.3 Kimwipes or equivalent lint-free tissue.

7. Procedure

7.1 Attach a clean, straight-stem delivery tube to a sulfuric acid titration cartridge. If the expected alkalinity is below 100 milligrams per liter (mg/L) as CaCO_3 , use a 0.16 N H_2SO_4 cartridge; if it is above 100 mg/L as CaCO_3 , use a 1.6 N H_2SO_4 cartridge; or if it is above 1,000 mg/L, use an 8.0 N H_2SO_4 cartridge. Twist the cartridge onto the titrator body.

7.2 Flush out the delivery tube by turning the small knob until a few drops of titrant are ejected from the tube. Wipe the tip and reset the counter to zero. Ensure that there are no air bubbles in the cartridge.

7.3 Take a sample by filling a clean 100-mL graduated cylinder to the 100-mL mark with water that has been filtered through a 0.45 micrometer (μm) filter. Pour the sample into a clean 250-mL Erlenmeyer flask.

7.4 Measure the pH of the sample; see Standard Test Method for the Field Measurement of pH [LQ-4(T)]. If the pH of the sample is less than 8.3, proceed to step 7.8; if the pH of the sample is greater than 8.3, proceed to step 7.5.

7.5 Add the contents of one phenolphthalein indicator Powder Pillow and swirl to mix.

7.6 If the color turns pink, titrate with the sulfuric acid standard solution to a colorless end point. If the pink color does not develop, proceed with step 7.8.

7.7 Read and record the amount of acid used. This is the amount of carbonate alkalinity, sometimes referred to as phenolphthalein alkalinity. See section 8 for calculations.

7.8 Add the contents of one bromocresol green-methyl red indicator Powder Pillow to the sample and swirl to mix.

7.9 Titrate the sample with the sulfuric acid standard solution until a light pink color is obtained. Read and record the amount of acid used. This is the amount of total alkalinity. See section 8 for calculations.

7.10 Pour the titrated sample into a properly labeled disposal container, rinse the Erlenmeyer flask and the graduated cylinder with distilled or deionized water, and place the items back in the kit.

8. Calculations

8.1 The results are reported in mg/L as CaCO_3 . The calculation depends on the normality of the sulfuric acid titration cartridge used. The calculations are performed as follows.

8.1.1 When using the 0.16 N H_2SO_4 titration cartridge, the digital readout from the titrator is multiplied by 0.1 to obtain alkalinity results in mg/L as CaCO_3 .

8.1.2 When using the 1.6 N H_2SO_4 titration cartridge, the results from the digital readout of the titrator are equivalent to mg/L as CaCO_3 .

8.1.3 When using the 8.0 N H_2SO_4 titration cartridge, the results from the digital readout of the titrator are multiplied by 5.0 to obtain alkalinity in mg/L as CaCO_3 .

9. Quality Assurance

9.1 The following information about the field measurement of alkalinity shall be logged for quality-assurance documentation.

9.1.1 Normality of the titration cartridge.

9.1.2 Phenolphthalein alkalinity.

9.1.3 Total alkalinity.

9.1.4 Name of person performing the measurement.

10. Precision and Bias

10.1 Under normal conditions, precision and accuracy of ± 15 percent can be expected from this procedure.

11. Keywords

11.1 Alkalinity, bicarbonate, carbonate, and titration.

**GJO Environmental Procedures Catalog
Document Addition/Revision**

Procedure Title: Standard Test Method for the Field Measurement of Alkalinity

Requester: Sam Campbell

Justification: To provide consistency with historical procedures for the UMTRA Ground Water Project

Proposed Changes (list here or attach copies): Alkalinity tests will be conducted on unfiltered water instead of filtered water as specified in the procedure.

New Document Change to Procedure Adopt Procedure

Procedure Number Assigned _____

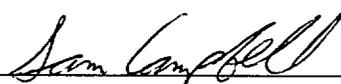
Procedure Title _____

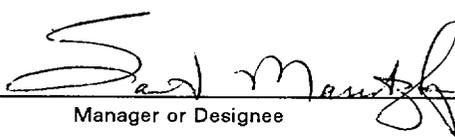
Approval for Inclusion in Environmental Procedures Catalog:

Manager, Compliance Management Date

Project Specific Change for UMTRA Ground Water Project
Project

Effective Date June 1, 1997

Reviewed By  5-23-97
Technical Author or Senior Proficient Designee Date

Approved By  5-27-97
Manager or Designee Date

Standard Test Method for the Field Measurement of Temperature

Introduction

Temperature readings are important for numerous applications. They are used in the measurement of Eh, pH, conductivity, and dissolved oxygen 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. Temperature readings of $\pm 1^\circ\text{C}$ are necessary for the above applications.

1. Scope

1.1 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.

2. Hazard Analysis

2.1 No hazards requiring controls have been identified. Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater*, Washington, D.C., 1980.

3.2 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations of the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D. C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 Temperature is a basic physical property that is measured by the response of matter to heat. There are many devices that, once calibrated, are acceptable for taking temperature measurements. These devices include liquid in glass (mercury in glass), thermocouples, bimetallic, and electrical-resistance thermometers. At a minimum, the device should measure temperature to $\pm 0.1^\circ\text{C}$ readability.

5. Interferences

5.1 The instrument-operating manual shall be consulted to identify any interferences particular to the device being used.

5.2 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.

6. Apparatus

6.1 Temperature-measuring device.

6.2 Distilled or deionized water in a squeeze wash bottle.

6.3 Kimwipes or equivalent lint-free tissue.

7. Calibration

7.1 The instrument-operating manual shall be consulted for specific calibrating procedures.

8. Procedure

8.1 Rinse the thermometer with distilled or deionized water and blot dry.

8.2 Immerse the thermometer in the sample.

8.3 Allow the reading to stabilize and record the temperature.

9. Quality Assurance

9.1 The following information about the temperature measurement shall be logged for quality-assurance documentation.

9.1.1 Instrument used.

9.1.2 Temperature of sample.

9.1.3 Name of person performing the measurement.

10. Precision and Bias

10.1 Precision is instrument dependent. Most measurement devices for field use are accurate to ± 0.1 °C.

11. Keywords

11.1 Temperature and thermometer.

Standard Test Method for the Field Measurement of Dissolved Oxygen

Introduction

Dissolved oxygen (DO) is required for the survival and growth of many aquatic organisms and the absence of dissolved oxygen may permit anaerobic decay of organic matter and the production of toxic and esthetically undesirable materials in the water. The measurement of dissolved oxygen is needed to accurately characterize the oxidation-reduction potential of a hydrologic system and can be an indicator of atmospheric contact of water before recharge to an aquifer.

1. Scope

1.1 This method contains the field procedures used to determine dissolved oxygen 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.

2. Hazard Analysis

2.1 This test method uses sodium sulfite and cobaltous chloride for the preparation of the zero-oxygen check solution. These chemicals are toxic in the concentrated form and the following precautions must be taken in the preparation of this solution. Avoid contact with the eyes and skin. Avoid breathing suspended particles. Adequate ventilation, eye protection, and disposable gloves are required. First aid for eye contact is to flush the eyes with water for 15 minutes and contact a physician. First aid for skin contact is to wash the area thoroughly with soap and water.

2.2 Site-specific controls are available in the planning documents for a particular project.

3. Referenced Documents

3.1 American Public Health Association, American Water Works Association, and Water Pollution Control Federation, *Standard Methods for the Examination of Water and Wastewater: American Public Health Association*, Washington, D.C., 1980.

3.2 American Society for Testing and Materials, *Annual Book of ASTM Standards*, Section 11, Volume 11.01, 1984.

3.3 Geotech, *Environmental Procedures Catalog*, Manual 116:

Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(T)].

3.4 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses for Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983.

3.5 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents," *Techniques of Water-Resources Investigations for the United States Geological Survey*, Chapter D2, Book 1: U.S. Government Printing Office, Washington, D.C., Stock Number 024-001-02879-4, 1976.

4. Significance and Use

4.1 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 dissolved oxygen in the sample. This current is converted to concentration units during the calibration.

5. Interferences

5.1 Membrane electrodes are sensitive to temperature variations. Most DO meters have automatic temperature compensators that correct for these variations. If not, thermal equilibrium must be established between the sample being measured and the calibrating solution.

5.2 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.

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

6. Apparatus

6.1 Dissolved oxygen meter, Yellow Springs Instruments (YSI) Model 57.

6.2 Yellow Springs Instruments (YSI) 5739 dissolved-oxygen probe.

6.3 Bottle of electrolyte and extra membranes for probe.

6.4 Sodium sulfite and cobaltous chloride.

6.5 Distilled or deionized water in a squeeze wash bottle.

6.6 Kimwipes or equivalent lint-free tissue.

6.7 Flow cell; see Standard Practice for the Use of a Flow Cell for Field Measurements [LQ-10(T)].

7. Calibration

7.1 The following steps describe the calibration of the YSI Model 57 meter and the YSI 5739 probe in water-saturated air.

7.1.1 Adjust the mechanical ZERO with the instrument turned OFF.

7.1.2 Turn the control knob to the "red line" position and adjust if necessary.

7.1.3 Plug probe into instrument and wait about 15 minutes for the probe to polarize.

7.1.4 Turn the control knob to ZERO and adjust if necessary.

7.1.5 Turn the salinity knob to FRESH. A salinity correction will not be needed because the calibration is performed with distilled water.

7.1.6 Insert the probe about 4 centimeters (cm) into the open end of the bottomless plastic storage bottle containing a small sponge soaked with deionized water. Ensure that there is a tight fit between the probe and bottle and that there are no droplets of water on the probe membrane.

7.1.7 Allow at least 10 minutes for the system to reach constant temperature and 100 percent relative humidity. Be careful that this step is carried out in a constant temperature environment. Typically, bathe the bottle in a stream of the water to be tested or at least keep the bottle in the shade during equilibration.

7.1.8 Turn the meter control knob to TEMP position and read the temperature inside the bottle to the nearest 0.5 °C.

7.1.9 Determine the DO saturation value in parts per million (ppm) for that temperature from Table 1.

Table 1. Dissolved Oxygen Saturation Values at Various Temperatures

Temp (°C)	Sat. Value (ppm)						
0	14.6	12	10.8	35	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		

7.1.10 Determine the correction factor from Table 2 on the basis of either the atmospheric pressure (most accurate method) or the altitude above sea level. (Tables 1 and 2 are also available on the back of the YSI 57).

Table 2. Correction Factors for Dissolved Oxygen Saturation Values as Determined by Pressure or Altitude

Pressure (mm)	Altitude (ft)	Correction Factor
775	-540	1.02
760	0	1.00
745	542	0.98
730	1094	0.96
714	1688	0.94
699	2274	0.92
684	2864	0.90
669	3466	0.88
654	4082	0.86
638	4756	0.84
623	5403	0.82
608	6065	0.80
593	6744	0.78
578	7440	0.76
562	8204	0.74
547	8939	0.72
532	9694	0.70
517	10472	0.68
502	11272	0.66

7.11 Multiply the correction factor by the saturation value to obtain the calibration value.

7.12 Turn the meter control knob to the desired range and adjust the calibration knob to set the meter to the calibration value.

7.13 Perform zero oxygen check as follows. Prepare a solution containing 1 gram of sodium sulfite (Na_2SO_3) and about 1 milligram of cobaltous chloride (CoCl_2) in 1 liter of deionized water. Insert the probe into this solution and measure the dissolved oxygen. The instrument will read less than 0.2 milligram per liter (mg/L) if the probe is functioning properly.

Caution: These chemicals are toxic in the concentrated form. Avoid eye and skin contact by wearing eye protection and disposable gloves.

7.14 Leave the meter turned on during the entire day on which measurements are being taken.

8. Procedure

8.1 The following steps outline the field measurement of dissolved oxygen using the YSI Model 57.

8.1.1 Remove the probe from the storage bottle and place it in the solution to be measured. An in situ measurement is preferred. If the sample is being pumped from a well, the measurement shall be made in an air-exclusion cell.

8.1.2 Move the probe through the water or pump through a flow cell to ensure a velocity of at least 1 foot per second past the probe. This prevents depletion of oxygen at the membrane-water interface.

8.1.3 Turn the meter control knob to TEMP position and record the temperature to the nearest 0.5 °C.

8.1.4 Turn the meter control knob to the proper DO scale; after the meter reading has stabilized, record DO concentration to the nearest 0.1 mg/L.

8.1.5 Remove the probe, rinse with distilled water, blot dry, and return the probe to the storage bottle.

9. Quality Assurance

9.1 The following information about the field measurement of dissolved oxygen shall be logged for quality-assurance documentation:

9.1.1 Date and time zero check was last performed.

9.1.2 Atmospheric pressure or altitude.

9.1.3 Temperature of calibration chamber.

9.1.4 DO saturation from table.

9.1.5 Correction factor used for altitude or pressure.

9.1.6 Calibration value.

- 9.1.7 Sample temperature.
- 9.1.8 Measured DO.
- 9.1.9 Instrument manufacturer and model number.
- 9.1.10 Name of person performing the measurement.

10. Precision and Bias

10.1 Under normal conditions, precision and accuracy of ± 0.5 mg/L can be expected from this procedure.

11. Keywords

10.1 Altitude, atmospheric pressure, and dissolved oxygen.

**GJO Environmental Procedures Catalog
Document Addition/Revision**

Procedure Title: Standard Test Method for the Measurement of Dissolved Oxygen

Requester: Sam Campbell

Justification: The current procedure is applicable to a specific model of dissolved oxygen meter manufactured by YSI. Additional procedures are necessary to operate other models of YSI dissolved oxygen meters.

Proposed Changes (list here or attach copies): Addition of procedures to operate a YSI model 55 Dissolved Oxygen meter will be appended to the current procedure.

New Document Change to Procedure Adopt Procedure

Procedure Number Assigned _____

Procedure Title _____

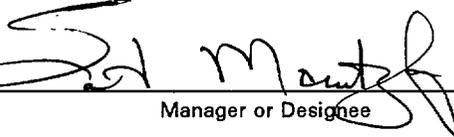
Approval for Inclusion in Environmental Procedures Catalog:

Manager, Compliance Management Date

Project Specific Change for UGW Project _____
Project

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Reviewed By  5-28-97
Technical Author or Senior Proficient Designee Date

Approved By  6-18-97
Manager or Designee Date

MANUFACTURER'S INSTRUCTIONS FOR DISSOLVED OXYGEN MEASUREMENTS USING THE YSI MODEL 55

Dissolved Oxygen Measurements using the YSI Model 55

The following steps have been summarized from the YSI Model 55 Handheld Dissolved Oxygen System Operations Manual.

The Model 55 simultaneously displays temperature in °C and dissolved oxygen in either mg/l or % air saturation. The system requires only a single calibration regardless of which dissolved oxygen display is used. You can switch back and forth between % to mg/l by pressing the **MODE** key.

A calibration chamber is built into the instrument. A small sponge in the chamber can be moistened to provide a water saturated air environment that is ideal for air calibration procedures. This chamber is also designed for transporting and storing the probe. When the probe is stored in the chamber, the moist environment will prolong effective membrane performance and probe life.

The instrument is powered by six AA-size alkaline batteries. A new set of batteries will provide approximately 100 hours of continuous operation. When batteries need to be replaced, the LCD will display a "LO BAT" message. The instrument is splash resistant and can be operated in steady rain without damage. It also floats.

Specifications:

Operating Environment

-5 to +45 °C

Storage Environment

-10 to 50 °C

Temperature

Sensor Type: thermistor

Range: -5 to 45 °C

Accuracy: ± 0.4 °C

Resolution: 0.1 °C

Dissolved Oxygen % Saturation

Sensor Type: membrane covered polarographic

Range: 0 to 200 % air saturation

Accuracy: ± 2 % air saturation

Resolution: 0.1 % air saturation

Dissolved Oxygen mg/l

Sensor Type: calculated from % air saturation, temperature, and salinity

Range: 0 to 20 mg/l

Accuracy: ± 0.3 mg/l

Resolution: 0.01 mg/l

Principles of Operation

The sensor consists of an acrylic body with a circular gold cathode embedded in the end. Inside the gold ring there is a small chamber containing a porous silver anode. In operation, this chamber is filled with a solution of KCl electrolyte containing a small amount of surfactant to improve wetting action.

A thin permeable membrane, stretched over the sensor, isolates the electrodes from the environment, while allowing gases to enter. When a polarizing voltage is applied to the sensor electrodes, oxygen, which has passed through the membrane, reacts at the cathode causing a current to flow.

The membrane passes oxygen at a rate proportional to the pressure difference across it. Since oxygen is rapidly consumed at the cathode, it can be assumed that the oxygen pressure inside the membrane is zero. Hence, the force causing the oxygen to diffuse through the membrane is proportional to the partial pressure of oxygen outside the membrane. As the oxygen partial pressure varies, so does the oxygen diffusion through the membrane. This causes the probe current to change proportionally.

It is important to recognize that oxygen dissolved in the sample is consumed during the test. **It is essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, the reading will be artificially low.** Stirring may be accomplished by mechanically moving the sample around the probe tip, or by rapidly moving the probe through the sample. The rate of stirring should be at least 1 foot per second.

Membrane Selection

The YSI Model 5775 Standard Membrane Kit is supplied with the YSI Model 55. This contains thirty 1 mil (.001") membranes and a bottle of KCl solution. YSI recommends the 5775 membranes for most applications.

For special applications, a 0.5 mil (.0005") membrane is available. This half-thickness membrane improves measurement time at low temperatures and helps suppress background current at very low dissolved oxygen levels. When data is routinely collected at sample temperatures below 15 °C and at dissolved oxygen levels below 20% air saturation, the low signal current resulting from the use of the standard membranes tends to magnify the probes inherent constant background signal. Using the high sensitivity membranes in this situation will decrease the percentage of error due to the probes background current.

Probe Operation and Precautions

1. Membrane life depends on usage. Membranes will last a long time if installed properly and are treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and KCl solution. The average replacement interval is two to four weeks.
2. If the membrane is covered with oxygen consuming (e.g. bacteria) or oxygen evolving organisms (e.g. algae), erroneous readings may occur.
3. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the probe. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.
4. Avoid any environment that contains substances that may attack the probe materials. Some of these substances are concentrated acids, caustics, and strong solvents.
5. For correct probe operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases) or plated with silver (which can result from extended use with a wrinkled or loose membrane), the gold surface must be restored. To restore the cathode the instrument can be returned to YSI or the YSI Model 5680 Probe Reconditioning Kit may be used. Never use chemicals or abrasives not supplied with this kit.
6. It is also possible for the silver anode to become contaminated, which will prevent successful calibration. To clean the anode, remove the O-Ring and membrane and soak the probe overnight in 3% ammonium hydroxide. Next, rinse the sensor tip and KCl reservoir with deionized water, add new KCl solution, and install a new membrane and O-Ring. Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, return the YSI 55 to an authorized service center for repair.
7. To keep the electrolyte from drying out, store the probe in the calibration chamber with a small piece of moist towel or sponge.

Calibration

To accurately calibrate the YSI Model 55, you will need to know the following information:

1. The approximate altitude of the region where the dissolved oxygen measurements will be taken.

2. The approximate salinity of the water you will be analyzing. Fresh water has a salinity of approximately zero. Seawater has a salinity of approximately 35 parts per thousand.

Calibration Process

1. Ensure that the sponge inside the calibration chamber is wet. Insert the probe into the calibration chamber.
2. Turn the instrument on by pressing the ON/OFF button. Wait for the dissolved oxygen and temperature readings to stabilize (usually a few minutes).
3. Use two fingers to press and release the two ▲▼ keys at the same time.
4. The LCD will prompt you to enter the local altitude in hundreds of feet. Use arrow keys to increase or decrease the altitude. EXAMPLE: Entering the number 12 indicates 1200 feet. When the proper altitude appears on the LCD, press the **ENTER** key once to view the calibration value in the lower right of the LCD; and a second time to move to the salinity compensation procedure.
5. The LCD will prompt you to enter the approximate salinity of the water you are about to analyze. You can enter any number from 0 to 40 parts per thousand of salinity. Use the arrow keys to increase or decrease the salinity compensation. When the correct salinity appears on the LCD, press the **ENTER** key.

Once the calibration process is complete, the only keys which will remain operational are the **MODE** key, the **LIGHT** key, and the **ON/OFF** key. You can move back and forth from reading dissolved oxygen in the mg/l mode or the % air saturation mode by pressing the **MODE** key.

Each time the YSI Model 55 has been turned off, it may be necessary to re-calibrate before taking measurements. All calibrations should be completed at a temperature that is as close as possible to the sample temperature. Dissolved oxygen readings are only as good as the calibration.

Probe operation may be checked by submersing the calibrated probe in a solution containing one gram of sodium sulfite and about one milligram of cobaltous chloride in one liter of water. The instrument should read less than 0.2 mg/l if the probe is operating correctly.

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

Introduction

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

1. Scope

1.1 This procedure describes the use of a closed flow-through cell for monitoring selected chemical parameters in groundwater. The cell is used when monitoring the purging of stagnant water from monitor wells before sample collection and for the measurement of pH, ~~oxidation-reduction potential~~ conductivity, temperature, and dissolved oxygen under conditions as close to in situ as practical. A flow-through cell can be purchased from various suppliers or can be constructed as described in references 3.1 and 3.2.

2. Hazard Analysis

2.1 Refer to project safety plan for site- or task-specific hazards and control methods.

3. Referenced Documents

3.1 Garske, E., and R. Schock, "An Inexpensive Flow-Through Cell and Measurement System for Monitoring Selected Chemical Parameters in Ground Water", *Ground Water Monitoring Review*, Summer 1986

3.2 Korte, N., and D. Ealey, *Procedures for Field Chemical Analyses of Water Samples*, Technical Measurements Center, U.S. Department of Energy, Grand Junction Area Office, GJ/TMC-07(83), 1983

3.3 Wood, W.W., "Guidelines for Collection and Field Analysis of Ground-Water Samples for Selected Unstable Constituents", Chapter D2 in *Techniques of Water-Resources Investigations of the United States Geological Survey*, Book 1, 1976

4. Significance and Use

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

5. Apparatus

5.1 Flow-through cell.

5.2 Stoppers, fittings, valves, and tubing, as required.

6. Procedure

6.1 Establish temperature equilibrium between the sample water and calibrated electrodes. Solutions must be within $\pm 0.5^\circ\text{C}$ of the sample temperature.

6.2 Calibrate the electrodes.

6.3 Connect the pump outlet to the inlet of the flow cell.

6.4 Insert the calibrated electrodes into the flow cell and connect tubing to the output of the flow cell.

6.5 Recheck electrode calibration as necessary during the purging of the well and just before sampling.

6.6 Turn off the pump, disconnect the tubing, and remove the electrodes from the flow cell.

Standard Practice for the Sampling of Liquids

Introduction

The type of sampling equipment shall depend on the sample to be collected, which analytes the sample is being collected for, and the site-specific requirements such as depth to water or depth of well. Because each sampling situation is unique, the equipment used and its application may have to be modified to ensure that a representative sample is collected and its physical and chemical integrity is maintained.

1. Scope

1.1 The procedures listed here are used to collect liquid samples. There are eight methods that can be used to collect liquid samples. Some sampling situations use a combination of these methods. For example, a peristaltic pump could be used to collect the inorganic samples and a bailer used to collect the organic samples. The eight methods are

	Section
Method A—Sampling With a Peristaltic Pump	5-7
Method B—Sampling With a Bladder Pump	8-10
Method C—Sampling With a Bailer	11-13
Method D—Sampling With a Submersible Pump	14-16
Method E—Sampling With a Composite Liquid Waste Sampler (Coliwasa)	17-19
Method F—Sampling With a Dip-Type Sampler	20-22
Method G—Sampling by Container Immersion	23-25
Method H—Sampling From Taps, Valves, or Faucets	26-28

2. Hazard Analysis

2.1 These procedures use gasoline-powered electric generators, gasoline-powered air compressors, and battery-powered pumps and accessories. The following safety precautions shall be followed.

2.1.1 Air compressors that are belt driven shall have a belt guard in place.

2.1.2 Care shall be taken when connecting and disconnecting equipment powered by lead-acid batteries to avoid generating sparks that have the potential of creating an explosive hazard.

2.1.3 Gasoline is a Department of Transportation-regulated material; its hazard class is Flammable Liquid. Gasoline shall be stored in Factory Mutual-approved safety cans. Safety cans shall be well secured in the vehicle during transport. Gasoline-powered equipment shall be cool before filling, and care should be taken not to spill any gasoline.

2.1.4 Air compressors shall not be operated above rated capacities and shall be configured to avoid having any dead-end fittings above 20 pounds per square inch (psi).

2.1.5 Care shall be taken when lifting heavy equipment; proper lifting techniques shall be used.

2.1.6 Site-specific controls are available in the planning documents for a particular site.

3. Referenced Documents

3.1 American Society for Testing and Materials, *Standard Guide for Sampling Groundwater Monitoring Wells*, D4448-85a, 1986.

3.2 Geotech, *Environmental Procedures Catalog*, Manual 116:

Standard Practice for Sample Labeling [GN-8(P)].

Standard Practice for Equipment Decontamination [GN-13(P)].

General Considerations for the Sampling of Liquids [LQ-1(G)].

3.3 U.S. Department of Energy, *The Environmental Survey Manual*, Appendix E, Volume 4, DOE/EH-0053, 1987.

3.4 U.S. Environmental Protection Agency, *Handbook of Groundwater*, EPA/625/6-87/016, 1987.

3.5 U.S. Environmental Protection Agency, *Practical Guide for Groundwater Sampling*, EPA/600/2-85/104, 1985.

3.6 U.S. Environmental Protection Agency, *SW-846, Test Methods for Evaluating Solid Waste*, Volume 2, 1986.

4. Significance and Use

4.1 The usefulness and limitations for each of the first four sampling methods are listed in General Considerations for the Sampling of Liquids [LQ-1(G)], Table 1 through Table 5. Coli-wasa samplers are useful to obtain representative samples of multiphase materials from drums or other containerized vessels. Limitations are their relative high costs and the difficulty of decontaminating the sampler. Dip samplers only collect grab samples with a limited vertical extent. The sampler must be aware of this limitation and also exclude surface debris or films from liquid surfaces if this is not desired. Contamination from plumbing is a primary concern when sampling taps, valves, or faucets.

Method A Sampling With a Peristaltic Pump

5. Apparatus

- 5.1 Peristaltic-type pump.
- 5.2 Silicone, C-FLEX, or Norprene tubing for the pump head.
- 5.3 Silicone, Teflon, polyethylene, or vinyl tubing for placing in the liquid to be sampled (suction line).
- 5.4 Generator or other source of electricity.

6. Procedure

6.1 The following procedure supplements the instruction in the instrument-specific operating manual.

6.1.1 Place the suction line in the liquid to be sampled. If sampling a monitoring well, place the tubing inlet just above the screened interval.

6.1.2 Connect the suction line to the pump.

6.1.3 Turn on the pump and adjust the flow rate so sample turbulence is at a minimum. Allow several liters to flow and recheck stability parameters (i.e., pH, conductivity, and temperature).

6.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.

6.1.5 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].

6.1.6 Remove the tubing from the liquid and clean and decontaminate as required by Standard Practice for Decontamination [GN-13(P)].

7. Procedure Bias

7.1 Sampling organics using a peristaltic pump is not recommended. The suction lift action will strip volatiles and degas the sample. The silicone tubing tends to absorb some organics and slowly release them, contaminating subsequent samples.

Method B Sampling With a Bladder Pump

8. Apparatus

- 8.1 Bladder-type pump.
- 8.2 Air compressor.
- 8.3 Teflon, polyethylene, or vinyl tubing for the air and sample line.

9. Procedure

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

9.1.1 Lower the pump gently to a position just above the screened interval.

9.1.2 Connect the air line to the pump controller.

9.1.3 Initiate pumping and allow several liters of water to be pumped prior to sample collection (recheck stability parameters, i.e., pH, conductivity, and temperature).

9.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.

9.1.5 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].

9.1.6 Remove the pump from the well and clean and decontaminate as required by Standard Practice for Decontamination [GN-13(P)].

10. Procedure Bias

10.1 Bladder-type pumps constructed of stainless steel, Teflon, or both provide superior performance for most applications. The use of Teflon sample- and air-line tubing allows the bladder pump to be used for the collection of organics. The main disadvantage is the slow pumping rate, large consumption of compressed air, and difficulty in cleaning and decontaminating.

Method C Sampling With a Bailer

11. Apparatus

- 11.1 Teflon or stainless steel bailer.
- 11.2 Teflon or stainless steel cable or line.
- 11.3 Bailer reel.

12. Procedure

- 12.1 Attach a properly cleaned bailer to the cable or line.
- 12.2 Lower the bailer slowly until it contacts the liquid.
- 12.3 Allow the bailer to sink until it reaches the screened interval of the well or the desired sampling point.
- 12.4 Slowly raise the bailer to the surface.
- 12.5 Tip the bailer or use a bottom-emptying device and fill a container to recheck the stability parameters (i.e., pH, conductivity, and temperature).
- 12.6 Repeat steps 12.2 through 12.5 as many times as necessary to fill the sample bottles.
- 12.7 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].
- 12.8 Clean and decontaminate the bailer as required by Standard Practice for Decontamination [GN-13(P)].

13. Procedure Bias

13.1 Bailers constructed of Teflon, stainless steel, or both provide adequate performance for most applications. Bailers expose part of the sample to the atmosphere during sample withdrawal and

should not be used to collect samples where contact with the atmosphere is important (i.e., field measurement of dissolved oxygen and Eh). A bottom-emptying device is recommended for the collection of volatile organics using a bailer.

Method D Sampling With a Submersible Pump

14. Apparatus

- 14.1 Submersible-type pump.
- 14.2 Discharge tubing of vinyl, polyethylene, or Teflon.
- 14.3 Power source of generator or batteries.

15. Procedure

- 15.1 The following procedure is supplemental to the instructions provided in the instrument-specific operating manual.
 - 15.1.1 Set up the pump according to the operating manual.
 - 15.1.2 Gently lower the pump to a position just above the screened interval.
 - 15.1.3 Initiate pumping and allow several tubing volumes of liquid to be pumped prior to sample collection. Recheck stability parameters, (i.e., pH, conductivity, and temperature).
 - 15.1.4 Fill the necessary sample bottles by allowing the pump discharge to flow gently down the side of the bottle with minimal turbulence.
 - 15.1.5 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].
 - 15.1.6 Remove the pump and clean and decontaminate as required by Standard Practice for Decontamination [GN-13(P)].

16. Procedure Bias

16.1 Considerable sample agitation results when using a submersible pump. Submersible pumps are not recommended for the collection of dissolved gases, organics, or oxidation/reduction-sensitive samples. They also have a higher potential of sample contamination because of the construction material.

Method E
Sampling With a Coliwasa Sampler

17. Apparatus

- 17.1 Coliwasa-type sampler constructed of stainless steel, Teflon, polyethylene, or glass.
- 17.2 Teflon, stainless steel, or nylon suspension line.
- 17.3 Disposable gloves.
- 17.4 Kimwipes or equivalent lint-free tissue.

18. Procedure

- 18.1 Slowly lower the sampler into the liquid to be sampled. Lower the sampler at a rate that permits the levels of liquid inside and outside the sample tube to be about the same.
- 18.2 When the sample interval has been reached, seat the bottom check valve.
- 18.3 Slowly withdraw the sampler with one hand while wiping the outside of the sampler using a disposable tissue.
- 18.4 Carefully discharge the sample into the sample container.
- 18.5 Repeat steps 18.1 through 18.4 as many times as necessary to fill all the sample bottles.
- 18.6 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].
- 18.7 Clean and decontaminate the sampler as required by Standard Practice for Decontamination [GN-13(P)].

19. Procedure Bias

- 19.1 The Coliwasa-type sampler is appropriate for collecting samples of containerized liquids. The material of construction should be considered for the particular type of liquid to be sampled. A Coliwasa sampler is also difficult to decontaminate adequately.

Method F
Sampling With a Dip-Type Sampler

20. Apparatus

- 20.1 Dip-type sampler constructed of Teflon, stainless steel, polypropylene, or glass.

21. Procedure

- 21.1 Assemble the sampler.
- 21.2 Slowly submerge the sampler into the liquid to be sampled causing minimal surface disturbance.
- 21.3 Retrieve the sampler from the liquid causing minimal surface disturbance.
- 21.4 Slowly empty the sampler into the sample bottle allowing the sample to flow gently down the side of the bottle.
- 21.5 Repeat steps 21.2 through 21.4 as many times as necessary to fill all of the sample bottles.
- 21.6 Label, preserve, and document the samples as required by Standard Practice for Sample Labeling [GN-8(P)].
- 21.7 Clean and decontaminate the sampler as required by Standard Practice for Decontamination [GN-13(P)].

22. Procedure Bias

- 22.1 A dip-type sampler is appropriate for surface liquids such as ponds, open tanks, pits, lagoons, and sewers. It can only be used for a grab-type sample, and its material of construction shall be compatible with the liquid to be sampled and the analytes of interest.

Method G
Sampling by Container Immersion

23. Apparatus

- 23.1 Sample container.

23.2 Disposable gloves.

23.3 Distilled or deionized water in a squeeze bottle.

23.4 Kimwipes or equivalent lint-free tissue.

24. Procedure

24.1 After putting on the appropriate gloves, submerge the sample bottle below the liquid surface. If the liquid is flowing, point the bottle upstream.

24.2 Allow the container to fill to the desired volume.

24.3 Remove the container, cap and rinse the container's outside surface with clean water, and dry with a tissue.

24.4 Label, preserve and document the sample as required by Standard Practice for Sample Labeling [GN-8(P)].

25. Procedure Bias

25.1 The container-immersion method can only be used to collect samples from shallow streams, near the shore of ponds or lakes, or from open-top containerized liquids. It can only be used for a grab-type sample and requires immersing the hands; it is not acceptable for highly polluted or hazardous liquids.

Method H

Sampling From Taps, Valves, or Faucets

26. Apparatus

26.1 Distilled or deionized water in a squeeze bottle.

26.2 Kimwipes or equivalent lint-free tissue.

26.3 If the sample bottle cannot be placed under the tap, valve, or faucet, a hose or other device shall be attached to the outlet to allow the sample to be collected.

27. Procedure

27.1 Turn on the tap, valve, or faucet and allow sufficient liquid to flow to ensure that any rust or

residue is removed from the lines and that fresh liquid is flowing.

27.2 Remove the cap from the sample container and place the container under the source.

27.3 Fill the sample bottle to the desired volume.

27.4 Repeat steps 27.2 and 27.3 as many times as necessary to fill all of the sample containers.

27.5 Shut off the tap, valve, or faucet; clean the outside of the sample container using clean water and wipe dry.

27.6 Label, preserve, and document the sample as required by Standard Practice for Sample Labeling [GN-8(P)].

28. Procedure Bias

28.1 This procedure is used to collect grab-type samples from piped systems. Strainers, aerators, and hose attachments should be removed prior to sample collection. The material of construction for the piping system influences sample impurities and should be documented in the field logbook.

29. Quality Assurance

29.1 All of the methods listed above require the following information to be logged for quality-assurance documentation.

29.1.1 Date of sample collection.

29.1.2 Location of sample.

29.1.3 Sample number.

29.1.4 Type of sampling mechanism used.

29.1.5 Container type, size, and number of samples collected.

29.1.6 Preservatives used.

29.1.7 Signature of sampler.

30. Keywords

30.1 Bailer, coliwasa, liquid samples, sampler, and sampling.

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

1. Scope

1.1 This procedure addresses the collection, filtration, and preservation of liquid samples. Section 7 gives the general collection procedures. Sections 8 and 9 are specific to the collection of organics. Section 10 provides the procedure for sample filtration. Section 11 provides guidelines for sample preservation. Table 1 summarizes the generally accepted bottle types, volume requirements, preservatives, and holding times for most analytes.

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

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

2. Hazard Analysis

2.1 This procedure uses a variety of chemicals for preserving the samples. The sampler shall have a copy of and review the Material Safety Data Sheets (MSDS) for each of the chemicals that will be used at a particular site. Most of the preservatives can be categorized as strong acids or strong bases.

2.2 The personal protective measures for strong acids (hydrochloric [HCl], nitric [HNO₃], and sulfuric [H₂SO₄]) and strong bases (such as sodium hydroxide [NaOH]) are to avoid eye and skin contact and avoid breathing vapors by wearing eye protection and disposable gloves, providing adequate ventilation, and taking first aid measures to flush eyes or skin immediately with water for 15 minutes and contacting a physician.

2.3 Site-specific controls are available in the Health and Safety Plan for a particular project.

3. Referenced Documents

3.1 *GJO Environmental Procedures Catalog*, (GJO 6): Procedure GT-2(P), "Standard Practice for Sample Labeling"

3.2 U.S. Environmental Protection Agency, *Specifications and Guidance for Contaminant-Free Sample Containers*, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/540/R93/051, NTIS stock number PB93/963316, December 1992

4. Terminology

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

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

4.3 *Organic*—A compound that contains carbon.

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

5. Significance and Use

5.1 The procedures listed here are general guidelines. Site-specific requirements vary and no one 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.

6. Apparatus

6.1 Sample bottles

Table 1. Guidelines for Preservation of Samples

Analytical Parameter	Container Type/Size ^a	Preservation	Holding Time
Inorganic Anions			
Chloride (Cl), sulfate (SO ₄), fluoride (F), bromide (Br), and orthophosphate	P/125 mL	Filtered 0.45 µm, cool to 4 °C	Cl, SO ₄ , FL, 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, H ₂ SO ₄ pH <2	28 days
Ammonia, NO ₃ , NO ₂	P/125 mL	Filtered 0.45 µm, H ₂ SO ₄ pH <2	28 days
Ammonium	P/125 mL	Filter, cool, H ₂ SO ₄ pH <2	28 days
Inorganic Cations			
Dissolved metals	PA/500 mL	Filtered 0.45 µm, HNO ₃ pH <2	6 months (except mercury is 28 days)
Total metals	PA/500 mL	HNO ₃ pH <2	6 months
Radioisotopes			
Uranium-234/uranium-238	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Thorium-230	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Polonium-210	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Lead-210	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Radium-226	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Radium-228	P/1 L, 3 each	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Gross alpha/beta	P/1 L	Filtered 0.45 µm, HNO ₃ pH <2	6 months
Radon	G/40 mL with Teflon specta, 3 each	Cool to 4 °C	Not established; analyze ASAP
Organics			
Volatile organics	GA/40 mL with Teflon specta, 3 each	Cool to 4 °C, HCL 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
Chlorinated herbicides	GA/1 L with Teflon lined cap	Cool to 4 °C	7 days extraction, 40 days analysis
Total organic halides (TOX)	GA/1 L	Cool to 4 °C	28 days
Total organic carbon (TOC)	GA/125 mL	H ₂ SO ₄ pH <2, cool to 4 °C	28 days
Phenals	GA/1 L	H ₂ SO ₄ pH <2, cool to 4 °C	28 days
Oil and grease	GA/1 L	H ₂ SO ₄ pH <2, cool to 4 °C	28 days
Other			
Biochemical oxygen demand (BOD)	GA/1 L	Cool to 4 °C	48 hours
Chemical oxygen demand (COD)	GA/1 L	Cool to 4 °C, H ₂ SO ₄ pH <2	28 days
Total dissolved solids	P/125 mL	Cool to 4 °C	7 days
Cyanide	P/1 L	NaOH pH >12, cool to 4 °C	14 days
Sulfide	P/1 L	2 mL zinc acetate, NaOH pH >9, cool to 4 °C	7 days

^aP = polyethylene; G = glass; A = amber; mL = milliliter; L = liter.

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

6.2 Sample labels

6.3 Sample ticket books (GJPO 1854), example shown below.

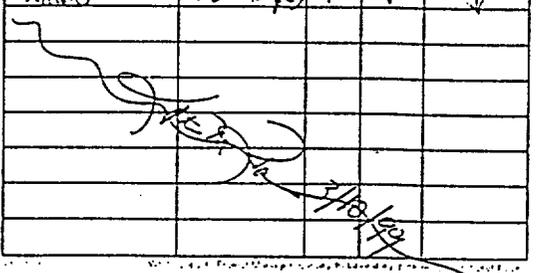
Analyte(s)	Container Type	Number Collected	Filtered	Preservative
Pg-226	1 liter (pl)	2	Y	HNO ₃ ; pH < 2
Gross alpha	1 liter (pl)	1	Y	
Dissolved metals	500 mL (pl)	1	Y	
TDS	250 mL (pl)	1	Y	acid, 4°C
Ammonia	125 mL (pl)	1	Y	
				

Figure 1. Example of a Sample Ticket (GJO 1854)

6.4 Water Sampling Field Data Sheet (GJO 1805), Figures 2a and 2b

6.5 Preservative solutions as required by the planning documents.

6.6 Dispensers for preservative solutions.

6.7 Coolers and ice for cooling collected samples.

6.8 In-line filter holders and filter sheets of 0.45 micrometer (μm) pore-size or in-line disposable 0.45- μm pore-size filters.

6.9 Pump and tubing

6.10 Distilled water and lint-free tissue

6.11 Project logbook

7. General Sample Collection Procedures

7.1 Collect all samples as close to the source as possible.

7.2 Choose the appropriate bottles for the analytes needed (see Table 1). Visually inspect the bottles for cleanliness, breaks, and missing parts prior to sampling. Sample bottles should be pre-cleaned to guidelines established by the U.S. Environmental Protection Agency (EPA) in reference 3.2.

7.3 Complete the sample ticket (Figure 1) and label the bottles as required by the planning documents or Standard Practice for Sample Labeling [GT-2(P)], reference 3.1.

7.4 Preservatives may be added at this time, or they may be added after sample collection. (Samples collected without headspace must be pre-preserved.)

7.5 Collect the samples by allowing the liquid to flow gently down the side of the bottle with minimal turbulence. Collect unfiltered samples prior to filtered samples.

7.6 Collect unfiltered samples in the following order:

7.6.1 Volatile organics and total organic halides

7.6.2 Dissolved gases and total organic carbon

7.6.3 Large-volume samples for organic compounds

7.6.4 Sensitive inorganics, such as nitrogen dioxide, ammonium, and ferrous oxide

7.6.5 Total metals

7.7 Collect filtered samples in the following order:

7.7.1 Alkalines

7.7.2 Trace metals

7.7.3 Major cations/anions

Water Sampling Field Data

Date 3-18-99 Project Location LaKEVIEW Well / Location No. 504
 Sequence Number 18 Sample Number  NDG 597

Well Purging Information

Depth to water 6.97 Casing Diameter 2"
 Depth of well 79.92 Casing Volume 1X 12 3X 36 10X (gal.) 2"=.163, 4"=.653gft
 Depth of water 72.95 Borehole Volume NA Low Flow Purge Volume NA
 Sampling Equipment Grundfos 12V Submersible Peristaltic Other: _____
 Measurement Equipment YSI 3500, Hach 2100P Turbidimeter, Hach alkalinity, Other: _____

Calibration Information

Conductivity
 Time of calibration check 0940 pH
 Temperature of calibration standard 6.7 Time of two-buffer calibration 0940
 Conductivity reading 661 Temperature of buffer solutions 6.7
 Conductivity reading at 25°C 1042 Buffers used for calibration 7, 10

Turbidity

Time of operational check 0945
 Gelex Standards

Assigned Value	Actual Reading
<u>5.30</u>	<u>5.30</u>
<u>61.6</u>	<u>61.8</u>
<u>574</u>	<u>575</u>

Dissolved Oxygen

Time of last check with NaSO₃ solution _____
 Atmospheric pressure _____ mmHg. Altitude _____
 Temperature of calibration chamber _____
 DO saturation _____
 Correction Factor _____
 Calibration Value _____

Eh

Temperature of Zobell solution 0940
 Eh of Zobell solution 255 mV

Final Sample Data

Measurement conditions: In situ () Open container () Air exclusion ()

Time	Temp	Conductivity	Conductivity ATC	pH	Eh	Turbidity	D.O.
<u>1023</u>	<u>11.0</u>	<u>958</u>	<u>1331</u>	<u>7.42</u>	<u>-14</u>	<u>0.11</u>	<u>NA</u>

Alkalinity

Time 1027 Unfiltered Total alkalinity 108 ppm as CaCO₃
 Time 1030 Filtered Total alkalinity 110 ppm as CaCO₃

Hach kit method: Titration cartridge 1.6 N H₂SO₄

Phenolphthalein alkalinity (for pH 8.3 or greater) Unfiltered: NA Filtered: NA

Filters

Number of 0.45 μ disposable filters used 1

Figure 2a. Example of a Water Sampling Field Data Sheet, Front (GJO 1805)

Grand Junction Office
2537 B 3/4 Road
P.O. Box 14000
Grand Junction CO 81502

Sample Nu



Well / Location No. 504

Date 3-18-99

Purge Data

Time Start at:	Total Volume Purged (gal)	Temp. (° C)	Conductivity (µmhos/cm)	Conductivity ATC (µmhos/cm)	pH	Eh (mV)	Turbidity (NTU)	DO (mg/L or %)
<u>0950</u>								
<u>0956</u>	<u>6</u>	<u>10.7</u>	<u>913</u>	<u>1283</u>	<u>7.40</u>	<u>112</u>	<u>0.76</u>	<u>NA</u>
<u>1001</u>	<u>12</u>	<u>10.9</u>	<u>952</u>	<u>1328</u>	<u>7.41</u>	<u>75</u>	<u>0.45</u>	
<u>1006</u>	<u>18</u>	<u>10.9</u>	<u>954</u>	<u>1329</u>	<u>7.42</u>	<u>45</u>	<u>0.28</u>	
<u>1011</u>	<u>24</u>	<u>11.0</u>	<u>956</u>	<u>1331</u>	<u>7.42</u>	<u>13</u>	<u>0.27</u>	
<u>1018</u>	<u>30</u>	<u>11.0</u>	<u>957</u>	<u>1331</u>	<u>7.42</u>	<u>4</u>	<u>0.06</u>	
<u>1023</u>	<u>36</u>	<u>11.0</u>	<u>958</u>	<u>1331</u>	<u>7.42</u>	<u>-14</u>	<u>0.11</u>	

Note: if low flow purging was performed, water level after optimizing pump rate NA and a final water level must be noted after purging is complete. WL NA Time NA

Well Inspection

Well Label	Guardposts	Concrete Pad	Protective casing	Riser Cap	Lock
<u>OK</u>	<u>NA</u>	<u>NA</u>	<u>OK</u>	<u>OK</u>	<u>OK</u> <small>NO LOCK</small>

Sample Preservation: Is ice in cooler (YES) (NO) Weather: cloudy, cool

Comments: _____

Signature of Sampler Jan Campbell Date Signed 3-18-99
Checked by Charles E. Palmer Date checked 3/18/99

Figure 2b. Example of a Water Sampling Field Data Sheet, Back (GJO 1805)

7.7.4 Radionuclides

7.8 Add preservative as required, if not pre-preserved.

7.9 Cap the bottle securely.

7.10 Store as required. Some samples may require storing at 4 °C immediately after collection. Use a cooler with ice for storing these samples.

7.11 Complete the Water Sampling Field Data Sheet (Figures 2a and 2b) as shown.

8. Nonvolatile Organics Sampling Procedure

8.1 Follow steps 7.1 through 7.3.

8.2 Add preservatives to the bottle, if required.

8.3 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.

8.4 Cap the bottle securely.

8.5 Store as required. Most organic samples require storage at 4 °C.

9. Volatile Organics Sampling Procedure

9.1 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-milliliter (mL) glass vial that has a Teflon-lined, silicone-septum cap.

9.2 Label the vial.

9.3 Add preservative (if required).

9.4 Slowly fill the vial to overflowing.

9.5 Hold the vial level or carefully set it on a level surface.

9.6 Place the cap with septum, Teflon-side down on the convex water meniscus and seal by screwing the cap to the bottle.

9.7 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 9.3 through 9.7.

10. Sample Filtration Procedure

10.1 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.

10.2 Start the pump and discard the first 100 mL of sample to flush the filter.

10.3 Place the sample bottle directly under the filter outlet and fill to the desired volume.

10.4 Preserve the sample (if not pre-preserved), as required.

10.5 Stop the pump, and disconnect the filter.

10.6 Discard the used filter after each sample. If a filter holder is used, clean all surfaces of the filter holder with distilled water and wipe dry with a lint-free tissue.

10.7 If a filter holder is used, place a new filter in the holder and reassemble.

11. Sample Preservation Guidelines

11.1 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 (1) retard biological effects, (2) retard hydrolysis, (3) reduce sorption effects, and (4) reduce volatility of constituents.

11.2 Preservation methods are generally limited to pH control, chemical addition, refrigeration,

and protection from light. The following guidelines shall be considered during sample preservation.

11.2.1 Preservation of samples uses a variety of strong acids and bases. Care shall be taken in their storage and use; see section 2.

11.2.2 Preserve samples prior to or as soon after collection as possible.

11.2.3 Take care not to cross-contaminate samples with preservatives.

11.2.4 Place samples requiring cooling to 4 °C in an ice chest with ice immediately after collection.

11.2.5 Consult Table 1 or the planning documents for recommended sample preservation techniques for each parameter. Generally, the laboratory performing the analysis will determine the bottle type, volume, and preservative to be used for a particular sampling event.

12. Quality Assurance

12.1 In the sample ticket book (Figure 1) or Water Sampling Field Data Sheet (Figures 2a and 2b), record the following information about the sample collection, filtration, and preservation for quality-assurance documentation.

12.1.1 The number and type of filter used for filtration.

12.1.2 The bottle size, bottle type, and number of samples collected.

12.1.3 The type of sample filtration, if any.

12.1.4 The preservative used.

12.1.5 The name of the person performing the sampling.

13. Keywords

13.1 Bottles, collection, filtration, liquid samples, organics, and preservation

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 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 upon data collected from that well may be adversely affected. This procedure provides a standard practice for maintaining a record of the condition of a well and remediating wells that have deteriorated.

1. Scope

1.1 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 includes correcting deficiencies in the surface components of the well and redeveloping the well.

1.2 This procedure shall be applied only to groundwater monitoring wells. Groundwater production wells, used for water supply, are beyond the scope of this procedure. Because of the limitations associated with the redevelopment methods described in this procedure, the redevelopment section is not applicable to wells exceeding 6 inches in diameter. This procedure shall not be applied to multi-port, single-string monitoring wells.

1.3 This procedure shall be executed by a designated well-maintenance technician on all monitoring wells under the control of ~~Grand Junction Office personnel~~. At the discretion of the Project Manager and appropriate regulatory agencies, inactive monitoring wells may be excluded from redevelopment ~~activities~~. At the discretion of the Project Manager, the procedure may be implemented in conjunction with routine groundwater sampling and data collection

activities. In such a case, the inspection portion of the procedure shall be conducted before groundwater sampling and other data collection activities. All well-maintenance activities shall be conducted after groundwater sampling activities to eliminate the potential for contaminating samples or altering the chemistry of groundwater samples.

2. Hazard Analysis

2.1 This procedure may involve the use of ~~sopropanol~~ or methanol for decontaminating water-level measurement devices and well redevelopment equipment. ~~Methanol is an~~ Occupational Safety and Health Administration (OSHA)-listed toxic and hazardous substance. Avoid eye and skin contact by wearing indirectly vented chemical goggles and disposable nitrile gloves. Avoid breathing vapors. Use only in well-ventilated areas. Keep away from heat, sparks, and flames.

2.2 Monitoring wells that penetrate contaminated subsurface environments may contain toxic or hazardous vapors at pressures exceeding atmospheric pressure. These vapors can be expelled from the well bore when the riser cap is removed. If a well penetrates highly contaminated subsurface materials or groundwater, the off-gassing of vapors could continue for an extended period of time. If previous air-monitoring data have shown that the concentration of organic vapors exceeds the action level specified in the project Health and Safety Plan, ~~respirators shall~~ be worn before the well is opened. The respirators

shall continue to be worn throughout the rest of the procedure or until current air-monitoring data indicate organic vapor concentrations have dropped below the action level. For all other wells, stand upwind of the well when removing the riser cap and performing inspection and maintenance activities. ~~As appropriate, allow the well riser to ventilate after~~ opening before initiating inspection and maintenance activities. If the degree of contamination at the well site is unknown, or if the well has never been monitored for vapors, the air in the well bore shall be checked for the presence of volatile organic vapors before continuing with the procedure. Use a calibrated organic vapor analyzer (OVA) or photoionization detector (PID) to measure the total concentration of organic vapors. If the concentration indicated on the OVA or PID exceeds the action level specified in the project Health and Safety Plan, allow off-gassing to continue until the OVA or PID indicates that the concentration has dropped below the action level. If the concentration continues to exceed the action level, ~~respirators shall~~ be worn during the inspection and maintenance procedure.

2.3 This procedure may involve the use of compressed nitrogen gas for redeveloping monitoring wells. Compressed nitrogen is supplied in steel tanks and injected into the well through a regulator, a flexible hose, and a series of threaded polyvinyl chloride (PVC) pipes. Improper use of equipment or failure of equipment could cause an explosive rupture of the redevelopment apparatus. Safety glasses, a hard hat, and steel-toed safety shoes shall be worn at all times when using a compressed nitrogen apparatus for the redevelopment of monitoring wells. Because the valve on a compressed nitrogen bottle is susceptible to breakage, the valve cover shall be screwed tightly in place during transport in vehicles, transport on hand trucks, or manual transport by well maintenance personnel. In addition, the line pressure set on the regulator shall not be set in excess of 50 percent of the minimum-rated bursting pressure of either the flexible hose or the PVC pipe.

3. Referenced Document

3.1 Environmental Procedures Catalog ~~(C-6-6)~~

Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)].

4. Significance and Use

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

4.2 *Use*—This procedure shall be used (1) to maintain an ongoing permanent record that documents the condition of groundwater monitoring wells, (2) to identify when monitoring wells require maintenance, and (3) 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 1), ~~the Water Level and Well Maintenance Data Sheet (Figure 2)~~, or a project-specific well maintenance checklist form shall be completed and filed in the ~~project records~~. ~~The project manager shall be notified in writing of any well maintenance discrepancies~~. If the procedure is executed by a sampling team, the inspection portion of the procedure shall be performed before sampling a well. Any required maintenance activities shall be performed after sampling a well. This procedure shall not be applied to water-supply wells. Application of this procedure shall be limited to monitoring wells 6 inches in diameter or less.

5. Apparatus

5.1 ~~Well location map~~

5.2 Well Maintenance Checklist (Figure 1) ~~or the Water Level and Well Maintenance Data Sheet (Figure 2)~~

5.3 Electric water-level sounder.

5.4 Interface probe (optional).

Well Maintenance Checklist

Site Identification _____ Well Number _____

Date _____ Field Technician _____

Surface Components Inspection	(circle one)	Action Required/Taken		
Lock Working	Yes No	_____		
Cap on Surface Casing Present	Yes No	_____		
Surface Casing Intact	Yes No	_____		
Riser Cap Present	Yes No	_____		
Guard Posts Adequately Painted for High Visibility	Yes No	_____		
Concrete Surface Pad Present	Yes No	Intact	Yes	No
Well Clearly and Correctly Numbered	Yes No	_____		
Organic Vapor Monitoring Conducted	Yes No	_____		

Subsurface Inspection	Upper or Single Completion	Middle Completion	Lower Completion
Reported Depth of Well (below top of casing)	_____	_____	_____
Reported Bottom of Screened Interval (below top of casing)	_____	_____	_____
Static Depth to LNAPL (below top of casing)	_____	_____	_____
Static Depth to Water (below top of casing)	_____	_____	_____
Static Depth to DNAPL (below top of casing)	_____	_____	_____

Redevelop if measured well depth is less than or equal to depth of bottom of screened interval.

Redevelopment Conducted Yes No Method Used _____

Comments/Recommendations _____

Completed by _____ Verified by _____

Figure 1. Well Maintenance Checklist

- 5.17 Suction-lift pump (optional).
- 5.18 Surge block (optional).
- 5.19 PVC hose (optional).
- 5.20 Foot valve (optional).
- 5.21 High-visibility spray paint.
- 5.22 Steel stamp (for numbering wells).
- 5.23 Black permanent marking pen.
- 5.24 Black ink pen.

5.25 Personnel protective equipment/clothing (e.g., safety glasses, vented chemical glasses, steel-toed safety shoes, hard hats, respirators, gloves, monitoring equipment, etc.) may be required based on site conditions and as specified in the project Health and Safety Plan.

6. Procedures

6.1 This procedure is composed of three sections: Section 6.2, Inspection and Documentation; Section 6.3, Maintenance Criteria and Corrective Action; and Section 6.4, Redevelopment Procedures.

6.2 Inspection and Documentation

6.2.1 Each item on the Well Maintenance Checklist or the Water Levels and Well Maintenance Data Sheet shall be completed as the inspection is conducted. Corrective action to eliminate deficient aspects of a well installation is described in Section 6.3. For multi-completion monitoring wells (multiple-well casings in a single borehole), a single Well Maintenance Checklist or the Water Levels and Well Maintenance Data Sheet may be completed for a group of completions in a common borehole.

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

6.2.2.1 Check for presence of a lid on the steel security casing. If damaged, describe damage in "Comments/Recommendations" section of the Well Maintenance Checklist.

6.2.2.2 Check the lock on the steel security casing for proper operation.

6.2.2.3 Inspect the steel security casing for damage. If a drain or vent hole is present in the security casing, check to ensure that it is not plugged with debris. Clean the hole if necessary.

6.2.2.4 Check for presence of a casing-riser cap. If the well is a flush-mount well, note whether the casing-riser cap is a water-tight cap, slip-on cap, or a threaded cap.

6.2.2.5 Inspect the casing riser for damage. No contamination should be able to enter the well through openings in the side of the casing riser. Note that some casing risers have a "weep" hole drilled just below the riser cap. This hole allows air pressure in the well to equilibrate with atmospheric pressure as water levels or the atmospheric pressure fluctuates. This weep hole should not be closed. If the well is a flush-mount installation and the riser has a weep hole, note this fact in the "Comments/Recommendations" section of the Well Maintenance Checklist. Weep holes are generally not recommended for flush-mount wells as they permit liquids to enter the well if the flush-mount vault becomes flooded. Weep holes in the risers of flush-mount wells are permissible if the vault of the flush-mount installation has been installed to permit drainage from the vault or the vault has a water-tight cover.

6.2.2.6 Check for the presence of guard posts. If present, note whether guard posts are adequately painted for high visibility. If guard posts are not present, note this on the Well Maintenance Checklist.

6.2.2.7 Check for the presence of a concrete surface pad surrounding the security casing. If the concrete surface pad is absent or damaged, note this information on the Well Maintenance Checklist.

6.2.2.8 Check the well number or well identification to determine if it is clearly marked and in agreement with the well location map.

6.2.3 *Subsurface Inspection*—The second step of the inspection is to determine the subsurface condition of the well. This includes measuring the depth to water and the depth to the bottom of the well. ~~These measurements should be recorded to the nearest 0.01 foot below the top of the casing.~~

The measured depth to the bottom of the well, when compared to the recorded well depth and screened interval depth, will indicate the amount of sediment in the well. If sediment has accumulated to a level above the bottom of the screened interval, the well should be redeveloped. If a well is located near storage tanks or transmission lines that contain fuels, solvents, or other immiscible organic liquids, liquid levels in wells should be measured with an interface probe that is capable of detecting light non-aqueous-phase liquids (LNAPLs or floaters), water, and dense non-aqueous-phase liquids (DNAPLs or sinkers). The procedure for measuring liquid levels in wells is described in Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)]. Disposable gloves should be worn when conducting the subsurface inspection on wells with organic contaminants in the groundwater.

6.2.3.1 ~~If there are reasons~~ to suspect severe organic chemical contamination in the subsurface near the well, the off-gases escaping from the well head should be monitored with an OVA or PID before making measurements. In such a case, the OVA or PID shall be calibrated each day before use. The casing-riser cap shall be removed and the well allowed to ventilate ~~as appropriate~~. If the well is a flush-mount installation, all water standing in the vault shall be bailed before removing the riser cap. Place the intake nozzle of the OVA or PID just inside the well bore. Note the reading on the checklist. If the reading exceeds the action level specified in the project Health and Safety Plan, allow the well head to continue off-gassing for several minutes and then repeat the OVA or PID measurement. Record the reading on the checklist. Once the OVA or PID indicates the concentration is less than the action level, proceed with the inspection procedure. If the organic vapor concentration does not drop below the action level, ~~respirators shall~~ be worn for the remainder of work performed at the well. If the air contained in the well bore is known to contain no toxic vapors, no OVA or PID measurement is required.

6.2.3.2 Clean the water-level sounder or interface probe before inserting in the well, following the procedure presented in Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)].

6.2.3.3 Measure the depth to water to the nearest 0.01 foot and record on the checklist. The depth shall be measured from the top of the casing riser; see Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)]. If the well has contained NAPLs in the past, if it is located near NAPL storage or transmission equipment, or if the OVA or PID reading was unusually high, an interface probe should be used to measure an LNAPL-air interface depth, an LNAPL-water interface depth, and a water-DNAPL interface depth. On the Well Maintenance Checklist record the depth to the air-LNAPL interface after "Static Depth to LNAPL", record the depth to the LNAPL-water interface after "Static Depth to Water", and record the depth to the water-DNAPL interface after "Static Depth to DNAPL".

6.2.3.4 Measure the total depth of the well by gently lowering the probe to the bottom of the well. After the probe reaches the well bottom, slowly raise and lower it several times to accurately determine the depth to the top of any sediment column that may have accumulated in the well. Record the depth to the nearest 0.01 foot on the Well Maintenance Checklist.

6.2.3.5 Use lint-free tissue, ~~isopropanol or~~ methanol (if organic contaminants are known or suspected to be present in the groundwater), and distilled or deionized water to clean the cable as it is removed from the well. The cable should first be cleaned with ~~isopropanol or~~ methanol (if necessary), followed by deionized or distilled water. When the probe is removed from the well, rinse it first with ~~isopropanol or~~ methanol (if necessary), then deionized or distilled water. Wipe the probe dry with a lint-free tissue. If non-aqueous-phase liquids are present in a well, the cable and probe should be cleaned with Alconox (or equivalent) before cleaning with ~~isopropanol or~~ methanol and deionized water. During decontamination, care should be taken to prevent decontamination fluids from dripping into the well.

6.3 Maintenance Criteria and Corrective Action

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

6.3.2 If the lid on the security casing is missing or damaged to the point of permitting access to the well, arrange a temporary cover, if possible, and make arrangements to have a new lid fixed to the security casing (commonly by welding).

6.3.3 If the lock on the steel security casing is missing, it should be replaced. If all monitoring-well locks currently in use at a site are keyed identically, a similarly keyed lock should be used to replace a missing one. However, if a lock of the same key type as other security casing locks is not immediately available, any strong lock should be installed for temporary well protection. In such a case, note the need for a new lock on the checklist. If a lock has become difficult to operate because of exposure, a lubricant should be added to the tumbler assembly. **Do not over lubricate** as these actions will give rise to contamination of the well or sampling equipment that will be used at the well in the future. Note all corrective action on the checklist.

6.3.4 If the entire steel security casing is missing, make arrangements to replace it. The bottom of the security casing should be set 3 feet below the ground surface in concrete. The concrete should extend to the surface and be sloped away from the well. Repairs should be made if the security casing is in place but is damaged and allows liquids to drain into the annular space around the well casing or is preventing proper access to the well. If repairs cannot be made, the need for these should be noted on the checklist.

6.3.5 If the casing-riser cap is missing, replace it. If the well is not a flush-mount well and the casing riser does not have a small drilled hole just below the cap, the riser cap should **not** be installed in an air-tight manner. If the well is a flush-mount well, the riser cap should be a water-tight cap. The water-tight cap should be installed securely in the

well to prevent liquids that collect in the vault from entering the well casing. Flush-mount wells with vaults that permit drainage from the vault or those with water-tight vault lids do not need water-tight riser caps.

6.3.6 If the casing riser is damaged to the extent that standing liquids inside the security casing can enter the well, the damaged section should be cut off below the point of breakage and a new section of riser installed. The new riser should have a weep hole drilled in it just below the cap to allow air pressure equilibration within the well bore. Care should be taken to ensure that the new casing riser is fitted with a casing-riser cap. This corrective action should be noted on the checklist and the well should be scheduled for a new elevation survey.

6.3.7 If the well is not a flush-mount installation and is in a location subject to equipment or vehicle traffic, guard posts should be present. If guard posts are not present but are needed, make arrangements for installation as soon as possible. To be effective, three guard posts should be installed in the shape of an equilateral triangle centered at the well with each post 2 to 3 feet from the well. The guard posts should be painted with a highly visible paint, such as Day-Glo orange or safety yellow. Approval of the manager of the site should be obtained before installing and painting guard posts.

6.3.8 If the concrete surface pad is damaged or is missing, a new concrete surface pad should be installed or arrangements should be made for the installation of a concrete surface pad. The pad should extend 1 foot below the ground surface and 3 feet horizontally from the security casing. The pad should be sloped away from the well.

6.3.9 If the well is not numbered or marked with a well identification label, or if the number on the well does not match the well location map, a correct well identification number must be marked on the well. First, the correct well identification must be conclusively determined. This can be done by (1) consulting the well location map, if it has been certified to be correct; (2) consulting original field logs and completion records relating to the well's installation; and (3) consulting logs from other previous field activities such as sampling, episodes, and water-level measurements. Project personnel may also be interviewed in an effort to establish well identification. Once the identity of the well has been conclusively

established, the well should be labeled with this number using a permanent method. Stamping the well identifier into the steel security casing with a steel stamp is recommended. The identifier should be stamped in the lid on the security casing and on the security casing itself, just below the lock. The identifier should also be written on the bottom side of the security casing lid using a permanent ink pen. Multiple-completion wells should have the top of each riser cap marked with a letter designating the completion, such as "U" and "L" for "upper" and "lower", respectively. The casing risers in a multiple-completion well should then be marked in a similar manner. Take care to ensure that the label on the casing riser is below the position occupied by the cap or the weep hole, if present.

6.4 Redevelopment Procedures

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

6.4.2 Possible redevelopment techniques include (1) compressed-nitrogen jetting and air-lift pumping, (2) surge blocking and pumping or bailing, (3) suction-lift pumping, (4) submersible pumping, and (5) foot-valve pumping.

6.4.3 Successful redevelopment requires that water be forced from the casing into the formation, and from the formation into the casing. This is best accomplished through the use of a surge block. Compressed-nitrogen jetting can also accomplish this flow reversal to some extent. Techniques 3, 4, and 5 (Section 6.4.2) are not effective in achieving flow reversal and are, therefore, best used in conjunction with nitrogen jetting or surge blocking.

6.4.4 Before placing any redevelopment equipment in a monitoring well, the equipment shall be cleaned by washing with soapy water (Alconox or equivalent), rinsing with ~~isopropanol~~ or methanol followed by deionized water, and wiping dry with a lint-free tissue. After removing redevelopment equipment from a well, the equipment shall be cleaned again.

6.5 Nitrogen-Jetting Redevelopment Procedure

6.5.1 If site conditions require that purge water from the well be contained, a discharge-control apparatus should be installed on the well riser. This apparatus typically consists of a compression-sleeve coupling with a discharge port that is connected to the well riser. A compression-type seal for the jetting pipe is rigged at the top of the discharge-control apparatus. Even if site regulations do not require discharge water to be collected and stored, a discharge-control apparatus should be used at sites that may have contaminated groundwater. Use of the discharge-control apparatus will prevent the splashing of discharge water on well-maintenance technicians.

6.5.2 A jetting-T is connected to a series of PVC pipes (the jetting pipe) and lowered to the top of the screened interval. The top of the jetting pipe is then connected to a compressed nitrogen source via a flexible compressed gas transmission hose. The flexible hose is connected to a two-stage regulator on the nitrogen source. The first stage of the regulator displays the pressure in the nitrogen tank. The second stage displays the pressure at the flexible hose when the regulator is opened. To prevent injury caused by the nitrogen tank falling over, the tank must be either secured in an upright position with a chain or placed on its side and secured by wheel chocks.

6.5.3 Set the line pressure on the regulator at a maximum of 60 pounds per square inch (psi). Jet the well screen by quickly opening the line valve, allowing the water to rise in the well, and then closing the line valve. As air (or nitrogen) escapes from the water column, the water in the well will fall back to near static levels and give rise to a flow reversal from the well into the formation. This pulsed jetting should be repeated for the entire length of screened interval by lowering the jetting pipe in small increments. The pulsed jetting will loosen sediment from the screen, the filter pack, and the well bottom.

6.5.4 As material is loosened during the pulsed jetting, the well should be air-lift pumped to remove the dislodged sediment. Air-lift pumping is accomplished by slowly but steadily opening the line valve. This action will discharge nitrogen into the water column within the well. The water will rise in the well as the nitrogen is introduced and

expands. If the water level reaches the top of the well before the injected nitrogen reaches the top of the water column, "successful" air-lift pumping will occur. Air-lift pumping can continue as long as water is entering the well at a fast enough rate to maintain an aerated water column that extends to the top of the well.

6.4.5.5 Repeat the combination of pulsed jetting over the length of the well screen and air-lift pumping at least once. If the capacity of the well is not returned to near-original levels, or if the clarity of the well water fails to improve after the second cycle, the nitrogen-jetting redevelopment process shall be continued until the capacity of the well and the clarity of the water cease to improve.

6.4.6 *Surge-Blocking Redevelopment Procedure*

6.4.6.1 Lower the surge block into the well to a position below the water level in the well but above the top of the screened interval, if possible. Surging action should be initiated gently to loosen obstructing sediment. As the circulation improves during the redevelopment, more vigorous surging should be undertaken.

6.4.6.2 After operating the surge block in a given depth increment for several minutes, lower it to the next interval and repeat the surging action. This process should be repeated until surge blocking has been conducted in the entire screened interval.

6.4.6.3 After surge-blocking the entire screened interval, the surge block should be removed. Install a suction-lift pump intake and a submersible pump or a foot-valve pump, and pump water from the well to remove the dislodged sediment. An effort should be made to pump accumulated sediment from the bottom of the well. Pumping should continue until the discharged water is clear and several bore volumes have been removed.

6.4.6.4 The process of surge blocking and then pumping should be repeated at least once. If the capacity of the well is not restored to near-original levels, or if the clarity of the well water fails to improve after only two surge-and-pump cycles, the complete process should be continued until the capacity of the well and the clarity of the water cease to improve.

6.4.7 *Suction-Lift Pumping*

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

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

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

6.4.8 *Submersible Pumping*

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

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

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

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

6.4.9 Foot-Valve Pumping

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

6.4.9.2 When using a foot-valve pump in conjunction with surging or jetting, the sediment in the bottom of the well should be removed before

initiating surging or jetting activities. Install the foot-valve pump so that the lower end of the unit (the valve end) is at the bottom of the well. Commence pumping by rapidly raising and lowering the discharge line. As the line fills with water, its weight will increase. For shallow wells, this operation of the pump can be accomplished manually. For deep wells, the weight of the discharge line will require a mechanical means of raising and lowering the unit. Such mechanical devices typically consist of a specially made jack handle or a commercially made apparatus.

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

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

7. Precision and Bias

7.1 This standard practice presents guidelines for maintaining high-quality monitoring-well installations. Therefore, statements regarding precision and bias are not applicable, except in the context of such statements that might be included in Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells [LQ-2(T)].

8. Quality Assurance

8.1 To maintain quality control standards, the Well Maintenance Checklist for the Water Levels and Well Maintenance Data Sheet must be completed for each well that undergoes inspection and maintenance. The checklist and data sheet must be signed by the person completing the forms. Any discrepancies should be corrected by the well-maintenance technician. The checklist and data sheet should then be filed in the project files.

9. Keywords

9.1 Air-lift pumping, foot-valve pumping, monitoring well, nitrogen jetting, submersible pumping, surge blocking, well inspection, well-maintenance, and well redevelopment.

Technical Comments on ASTM D 1889-88a
Standard Test Method for Turbidity of Water

Summary of ASTM D 1889-88a

This test method describes the measurement of turbidity in water and wastewater discharges using two types of instrumentation.

Additions Applicable to Operating Contractor and Its Subcontractors

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

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

1. Scope

1.2.1 Turbidities up to 1000 NTU can be accurately measured using the HACH model 2100P portable turbidimeter.

1.3.1 Turbidities greater than 1000 NTU may be measured using the HACH model 2100P portable turbidimeter by serial dilution to below 1000 NTUs.

2. Referenced Documents

2.3 HACH Company Manual, *Model 2100P Portable Turbidimeter Instruction Manual*, Loveland, CO, 1992.

3. Terminology

3.2.2 *Turbidimeter*—An instrument used to measure the turbidity of an aqueous sample.

4. Significance and Use

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

8. Interferences

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

9. Apparatus**9.5 Portable turbidimeter:**

9.5.1 HACH model 2100P portable turbidimeter.

9.5.2 Glass sample cells.

9.5.3 Silicone oil.

9.5.4 AEPA-I styrene/divinylbenzene polymer primary standard or Formazin primary calibration solution.

9.5.5 Gelex secondary turbidity standards.

9.5.6 Battery eliminator.

9.5.7 Logbook.

9.5.8 Kimwipes or equivalent lint-free tissue.

10. Reagents

10.3 Routine primary calibration of the HACH 2100P turbidimeter requires 0, 20, 100, and 800 NTU solutions.

11. Calibration

11.1 A primary calibration of the turbidimeter must be conducted before each sampling event.

11.2.1 Press the input/output (I/O) switch to turn the power on.

11.2.2 Fill a clean sample cell with the same dilution water used to prepare the standards, or the 0 NTU standard.

11.2.4 Close the lid and press the CAL key followed by the READ key. The turbidimeter will read the value of the dilution water or the 0 NTU standard and use this value to calculate a correction factor for the 20 NTU standard.

11.2.5.1 The display will automatically advance to the next standard and show "20 NTU." Remove the dilution water or 0 NTU solution sample from the cell compartment and replace it with a sample cell containing the 20 NTU standard (orientation marks should always be aligned). Press the READ key.

11.2.6.1 The display will automatically advance to the next standard and show "100 NTU." Remove the 20 NTU standard from the cell compartment and replace it with a sample cell containing the 100 NTU standard. Press the READ key.

11.2.6.2 The display again will advance to the next standard and show "800 NTU." Remove the 100 NTU standard from the cell compartment and replace it with a sample cell containing the 800 NTU standard. Press the READ key.

11.2.7.1 After the display reads "SO," press the CAL key to complete the calibration and store the calibration information within the electronics of the turbidimeter.

12. Procedure

12.1 *Operational check with Gelex secondary standards.* When using a HACH model 2100P portable turbidimeter, the following steps replace section 12.1 found in the ASTM procedure.

12.1.1 After every primary calibration, values must be assigned to the Gelex standards for use in operational checks.

12.1.2 Clean the outside of the Gelex cells and apply a thin coating of silicone oil.

12.1.3 Place each of the Gelex standards in the cell compartment with the orientation marks aligned and press the READ key. Record the displayed value in the project logbook and mark the value on the cell above the band.

12.1.4 Before taking measurements, the turbidimeter must be operationally checked by placing the Gelex standards in the cell compartment and pressing the READ key. The displayed value must be within 10 percent of the assigned Gelex value obtained during primary calibration. If the

value falls outside the 10 percent criteria, a new primary calibration must be performed.

12.2.2 Turbidities up to 1000 NTUs can be measured without dilution of the sample using the HACH model 2100P portable turbidimeter.

12.2.3.2 Apply a thin film of silicone oil to the sample cell and wipe with a Kimwipe.

12.2.3.3 Place the sample cell in the instrument cell compartment with the orientation marks aligned.

12.2.3.4 Select manual or automatic range by pressing the RANGE key.

12.2.3.5 If the sample causes the display to change constantly, press the SIGNAL AVERAGE key.

12.2.3.6 Press the READ key. The display will show the turbidity in NTU. Record the value as specified in the project planning documents.

14. Precision and Bias

14.6 Accuracy of ± 2 percent and a repeatability of ± 1 percent, or ± 0.01 NTU (whichever is greater) can be expected using the HACH model 2100P portable turbidimeter.

15. Quality Assurance

15.1 Documentation for quality-assurance purposes when making turbidity measurements includes the following information:

15.1.1 Date and time of the primary calibration.

15.1.2 Manufacturer, expiration date, and NTUs of the primary calibration standards.

15.1.3 Values assigned to the Gelex secondary standards after the primary calibration.

15.1.4 Measurements of the Gelex standards prior to making the turbidity measurement.

15.1.5 Date and time of the turbidity measurement.

15.1.6 Measured sample turbidity.

15.1.7 Instrument manufacturer, model, and serial number of the turbidimeter.

15.1.8 Name of person performing the measurement.

16. Keywords

16.1 Calibration, nephelometric, NTU, turbidity, and turbidimeter.

17. Hazard Analysis

17.1 This test method may use Formazin for the preparation of calibration standards. Avoid contact

with skin and eyes; use adequate eye protection and disposable gloves.

17.2 Site-specific controls are available in the planning documents for a particular project.



Standard Test Method for Turbidity of Water¹

This standard is issued under the fixed designation D 1889; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue that has been adopted by the Department of Defense.

1. Scope*

1.1 This test method covers the determination of turbidity in water and wastewater.

1.2 This test method is applicable to the measurement of turbidities in the range from 0.05 to 40 nephelometric turbidity units (NTU).

1.3 Higher turbidities may be measured using this test method by serial dilution to applicable range.

1.4 This test method was tested on municipal drinking water and final effluent discharges. It is the user's responsibility to ensure the validity of this test method for waters of untested matrices.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. For a specific caution statement, see Note 3.*

2. Referenced Documents

2.1 ASTM Standards:

D 1129 Definitions of Terms Relating to Water²

D 1192 Specification for Equipment for Sampling Water and Steam²

D 1193 Specification for Reagent Water²

D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D-19 on Water²

D 3370 Practices for Sampling Water²

2.2 EPA Standard:

EPA 600/4-79-202 Methods for Chemical Analysis of Water and Wastes³

3. Terminology

3.1 *Definitions*—The terms turbidity, and nephelometric turbidity are defined in Definitions D 1129. For definitions of other terms used in this test method, refer to Definitions D 1129.

3.2 Description of Term Specific to This Standard:

3.2.1 *turbidity*—an expression of the optical properties of a sample that causes light rays to be scattered and absorbed rather than transmitted in straight lines through the sample. (Turbidity of water is caused by the presence of suspended and dissolved matter such as clay, silt, finely divided organic matter, plankton, other microscopic organisms, organic acids, and dyes.)

4. Significance and Use

4.1 Turbidity in water is caused by the presence of suspended and dissolved particles of gas, liquid or solids of organic or inorganic matter. Turbidity is undesirable in drinking water, plant effluent waters, water for food and beverage processing, and for a large number of other water-dependent manufacturing processes. Removal of suspended matter is accomplished by coagulation, settling, and filtration. Measurement of turbidity provides a rapid means of process control for when, how, and to what extent the water must be treated to meet specifications. Methodology for the correlation of a sample NTU to the number or volume of suspended particles is now under evaluation. Specific gravity estimates would then give rapid NTU correlation to the weight concentration of suspended matter.

4.2 This test method is suitable to low and medium turbidity such as that found in drinking water and process water.

5. Summary of Test Method

5.1 Nephelometric Turbidity:

5.1.1 *Photoelectric Nephelometer*—The photoelectric nephelometer operation is based on instrumental comparison of the intensity of light scattered by the contained static water sample under defined conditions to the intensity of light scattered by a reference standard in the sample container. The higher the intensity of scattered light, the higher the turbidity of sample.

5.1.2 *Calibrated Slit Turbidimeter*—The calibrated slit turbidimeter operation is based on a visual comparison of the intensity of light scattered by the contained static water sample under defined conditions to the intensity of light scattered by a reference sample in the same container, the higher the intensity of scattered light the higher the turbidity of sample.

5.1.3 Nephelometric Turbidity Standards:

¹ This test method is under the jurisdiction of ASTM Committee D-19 on Water and are the direct responsibility of Subcommittee D19.07 on Sediments.

Current edition approved June 24, 1988. Published September 1988. Originally published as D 1889 - 61. Last previous edition D 1889 - 88.

² Annual Book of ASTM Standards, Vol 11.01.

³ Available from Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH 45268.

5.1.3.1 A EPA-I styrene/divinylbenzene polymer standard (see Section 2). These standards are used as received from the distributor.⁴

5.1.3.2 Formazin polymer preparation and dilution methods are given in 10.2.2 to 10.2.4.

6. Purity of Reagents

6.1 Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.⁵ Other grades may be used providing it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.2 Unless otherwise indicated references to water shall be understood to mean reagent water conforming to reagent water Type III Specification D 1193.

6.2.1 Standard dilution waters of Type III shall be prepared by filtration through a 0.2 to 0.22 μm membrane or other suitable filter within 1 h of use to reduce background turbidity to less than 0.05 NTU.

7. Sampling and Sample Preservation

7.1 *Collection of Sample*—Collect the sample in accordance with the applicable standard, Specification D 1192 and Practices D 3370 or EPA 600/4-79-202 for EPA compliance.

7.2 *Storage of Sample*—Determine the turbidity on the day the sample is taken. If this is not feasible, store the sample in the dark for up to 24 h and refrigerate at 4°C if possible, but do not freeze. Prolonged storage is not recommended because of irreversible changes.

7.3 *Preparation of Sample*—Bring the sample to room temperature and shake sample vigorously for at least 1 min. Let the sample stand 2 to 3 min to allow air bubbles to disappear, then gently invert the sample several times or swirl mix before examination.

8. Interferences

8.1 Floating or suspended large particles and entrained air bubbles will give false or unstable readings. Certain turbulent motions also create unstable reading conditions of nephelometers.

8.2 Dissolved material that imparts a color to the water may cause serious errors in nephelometric reading unless the instrument has special compensating features.

8.3 Scratches, finger marks, or dirt on the walls of the sample cell may give erroneous readings. Cells should be kept scrupulously clean both inside and outside and discarded when they become etched or scratched. The cells must not be handled where the light strikes them when indexed in the instrument well.

NOTE 1—The same indexed cell should be used first for standardization followed by unknown determination.

NOTE 2—Indexing of the sample cell or tube to the instrument well is accomplished by placing a mark on the top of the glass cell and a similar mark on the upper surface of the well so that the cell can be placed in the well in an exact position each time.

9. Apparatus

9.1 Two types of instruments are available for the nephelometric method, the photoelectric nephelometer and the calibrated slit turbidimeter (Figs. 1 and 2). Both give a greater precision and sensitivity than the Jackson candle turbidity, within their applicable range from 0.05 to 40.0 NTU, to ranges as low as 0.05 to 1.00 NTU.

9.2 The sensitivity of the instruments should permit detection of differences of 0.02 NTU or less in waters having turbidities of less than 1.00 NTU. The instrument should measure the ranges from 0.05 to 1.00 NTU and 0.05 to 40.0 NTU with the additional ranges from 0.05 to 0.10 and 0.05 to 10.0 NTU if possible. Linear calibration charts should be made for each range used. Either of the two accepted standards, A EPA-I or Formazin, (10.2.1 or 10.2.2) can be used for this calibration. See 11.1 for calibration instruments.

9.3 Photoelectric Nephelometer:

9.3.1 This instrument uses a light source for illuminating the sample and one or more photoelectric detectors with a readout device to indicate the intensity of light scattered at right angles (90°) to the path of the incident light. The photoelectric nephelometer should be so designed that little stray light reaches the detector(s) in the absence of turbidity and should be free from significant drift after a short warm-up period.

9.3.2 Differences in physical design of photoelectric nephelometers will cause differences in measured values for turbidity, as will aging of a turbidimeter, even though the same suspension is used for calibrations. To minimize initial differences, the following design criteria should be observed (see Fig. 1).

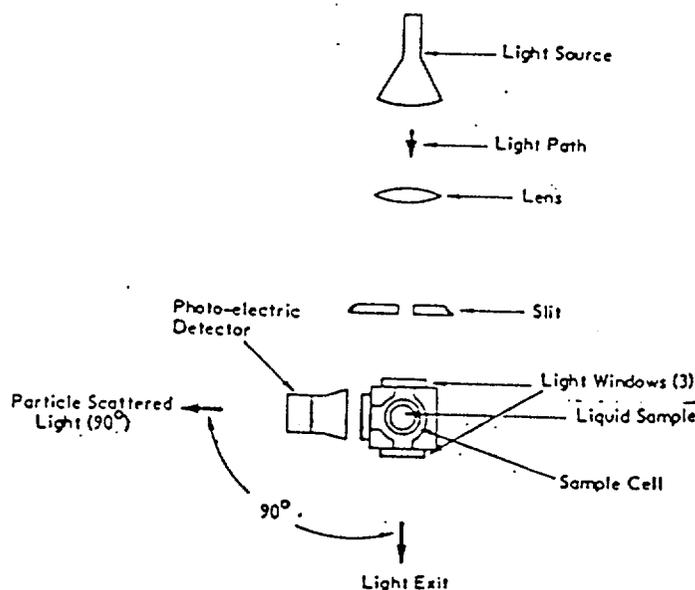


FIG. 1 Photoelectric Nephelometer

⁴ Patents 4,283,143 and 4,291,980, available from, Advanced Polymer Systems, Inc., 3696 Haven Ave., Redwood City, CA 94063, have been found satisfactory for this purpose.

⁵ "Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY, and the "United States Pharmacopoeia."

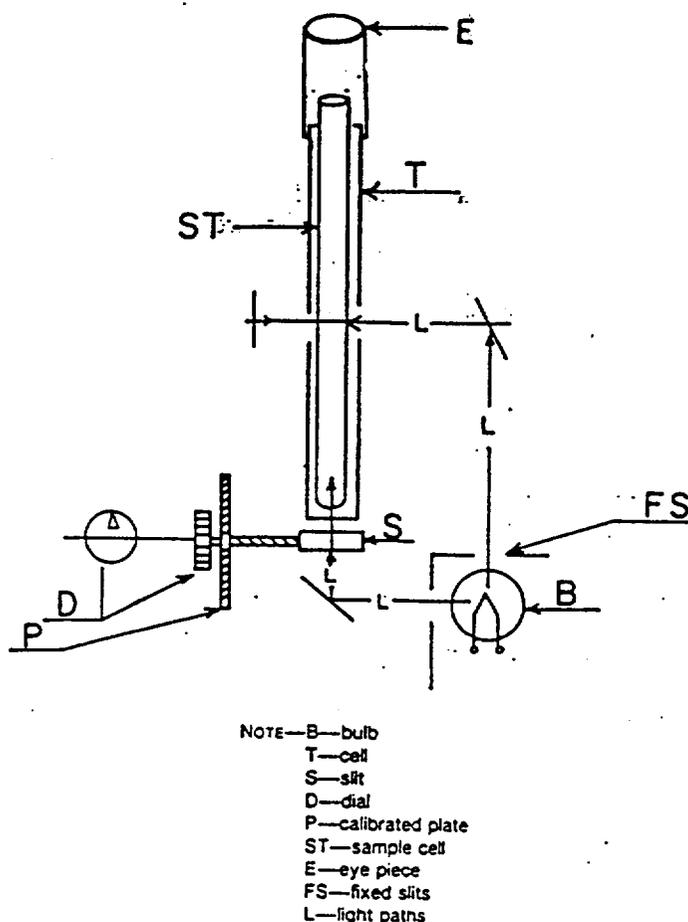


FIG. 2 Calibrated Slit Turbidimeter

9.3.2.1 *Light Source*—Tungsten lamp operated at a color temperature between 2200 and 3000 K.

9.3.2.2 Distance traversed by incident light and scattered light within the sample, total not to exceed 10 cm.

9.3.2.3 *Angle of Light Acceptance to the Detector*—Centered at 90° to the incident light path and not to exceed ±30° from the 90° scatter path center line.

9.3.3 The sample tube used in calibration and sample measurement must be the following:

9.3.3.1 Clear, colorless glass, be kept scrupulously clean, both inside and out, and discarded when it becomes etched or scratched.

9.3.3.2 Index marked so that repeated exact placements into the instrument cuvette well for measurement can be made.

9.3.3.3 Handled where the light path does not pass during measurement. Provision should be made in design to give the tube a proper place in which to handle the tube during calibration or sample measurement procedure. Instrument and sample tube design criteria are given in EPA 600/4-79-202.

9.4 *Calibrated Slit Turbidimeter:*

9.4.1 This instrument uses principles based on the Tyndall effect. A beam of light passing up through the sample is compared to the light scattered upward by suspended particles in the turbid solution which has been

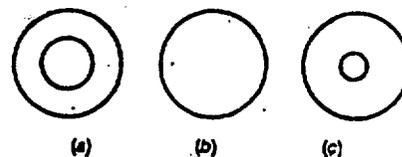


FIG. 3 Eye Piece Fields (Calibrated Slit)

illuminated from the side at 90°.

9.4.2 As shown in Fig. 2, light from the bulb, B, is reflected to illuminate the turbid solution in the cell, T, from the side. Light scattered upward by the suspended particles in the solution is seen through an eye piece as the outer portion of a circular split field (as in Fig. 3). Light also passes through a dial operated adjustable slit, S, and is reflected upward through the sample. In the eye piece this light is seen as the center circular field. Depending on the amount of light permitted through the adjustable slit, the center field will appear higher or darker than the outer portion, as shown in Fig. 3(a) and 3(c). The operator turns the dial controlling the slit until the entire field is of uniform brightness as shown in Fig. 3(b). Dial calibration charts should be based on at least five concentration levels, (across the 0.05 to 40 NTU range) of prepared A EPA-I or in-house fresh preparations and dilutions of Formazin. 40 NTU has been selected by EPA as the maximum concentration or turbidity that is the upper limit of linearity for measuring instruments even though there are some instruments that are linear above 40 NTU.

NOTE 3: Caution—Care should be exercised if Formazin standardization is used as Formazin has a rapid settling rate, so sample should be remixed at least every 15 min.

9.4.2.1 From this prepared chart slit dial reading can be translated into NTU values. Prior to unknown water sample determination, a single standard point determination should be made to check cell cleanliness and other instrument optics, such as lamp operation.

9.4.2.2 Because the eye is used to detect the null-point, the observer can compensate and disregard the presence of sample color and extraneous debris.

10. Reagents

10.1 Dilution and final rinsing water, see 6.2.

10.2 *Turbidity Standards:*

10.2.1 A EPA-I turbidity standards are prepared sealed stable suspensions of styrene divinylbenzene which are opened and used as received from manufacturer. Note that all standard Formazin diluted concentrations of A EPA-I are available from the manufacturer.

NOTE 4—Sealed or solid samples will not standardize nephelometers for the turbidity measurement of water or waste. These two methods (sealed or solid examples) neglect the zeroing out of sample tube (cuvette) prior to making water measurement in the tube.

10.2.2 *Formazin Turbidity Suspension, Stock (400 NTU)*—A stock turbidity suspension for Formazin polymer is prepared by reacting hydrazine sulfate with hexamethylenetetramine under carefully controlled conditions. (See EPA 600/4-79-202.)

10.2.2.1 *Solution 1*—Dissolve 1.00 of hydrazine sulfate $[(NH_2)_2H_2SO_4]$ in dilution water and dilute to mark in a 100-mL volumetric flask.

10.2.2.2 *Solution II*—Dissolve 10.0 of hexamethylenetetramine (practical grade, ACS grade not available) in dilution water and dilute to mark in a 100-mL volumetric flask.

10.2.2.3 Into a third 100-mL volumetric flask, pipet 5.00 mL of Solution I and with a clean pipet add 5.00 mL of Solution II. Mix the two solutions and allow to stand for 24 h at $25 \pm 3^\circ\text{C}$. After reaction, dilute to mark with water and mix. The freshly mixed turbidity of this solution is 400 NTU. This 400 NTU stock has to be prepared monthly.

10.2.3 *Formazin Turbidity Suspension, Standard (40 NTU)*—Pipet 10.0 mL of mixed 400 NTU stock into a 100-mL volumetric flask and dilute with water to mark. The turbidity of this suspension is defined as 40 NTU. This 40 NTU suspension has to be prepared weekly.

10.2.4 *Dilute Formazin Turbidity Suspension Standard*—Prepare dilute turbidity suspension below 4.0 NTU daily. Those above 4.0 NTU have a useful life of one week. Prepare each dilution by pipetting the volume of 40 NTU into a 100-mL volumetric flask and diluting to mark with water; so that 50.0 mL of 40 NTU diluted to 100 mL is 20.0 NTU and 10.0 mL of 40 NTU diluted to 100 mL is 4.00 NTU.

10.2.4.1 To prepare dilute suspensions having turbidities of less than 1.0 NTU use an appropriate volume of 4.0 NTU suspension in a 100-mL volumetric flask and dilute to mark. Prepare dilutions below 4.0 NTU daily.

11. Calibration

11.1 Follow the manufacturer's operating instructions.

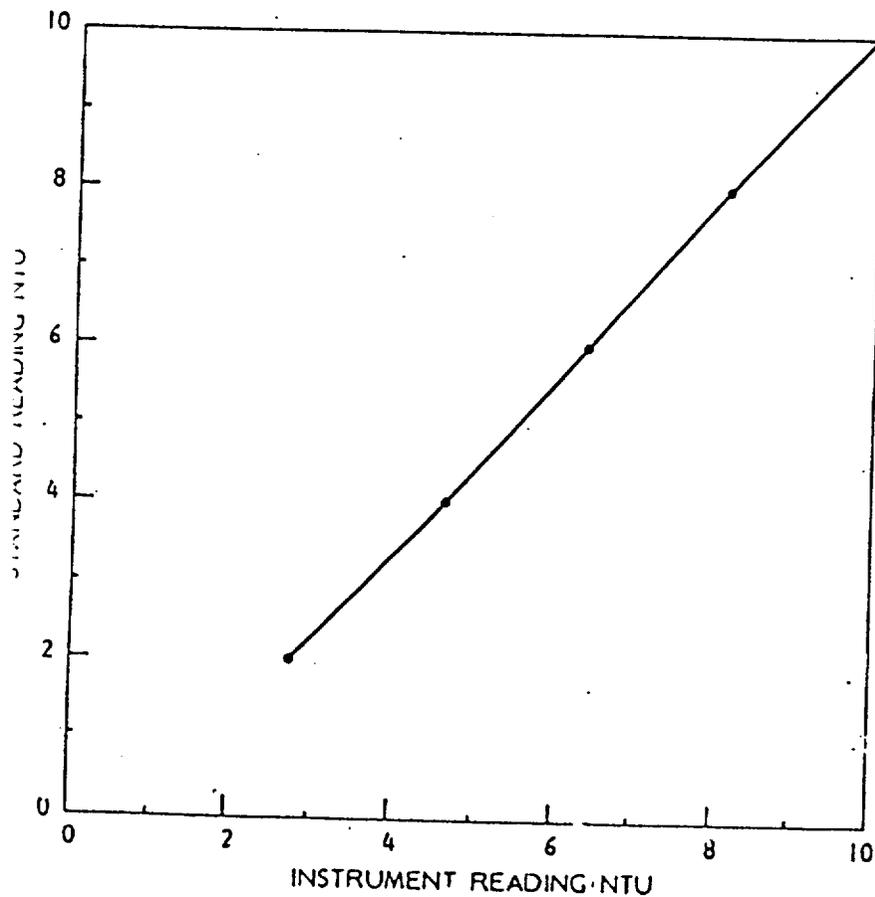
Calibrate the instrument range of interest with standards (see AEPA-I and Formazin standards). If the instrument control dial, meter, or output digital reading is already in NTUs, this procedure and curve will check the accuracy of the instrument output. Use at least three standard concentrations (NTU) to calibrate each instrument range. Photoelectric nephelometers have a calibration adjustment. Set this adjustment to equal the high value of standard for the range of interest. Read the standards used for the calibration of the range in the same tube as was the high level adjustment. Note and graph the instrument value for each standard (instrument reading versus standard value). See Fig. 4 as an example. For daily use of the instrument, one standard in the use range will be all that is required to set the calibration adjustment at the graph reading for that value. The aging drift characteristics of each instrument will determine the recalibration requirement.

11.1.1 Clean the cell after filling with turbidity standard or test water samples as follows:

11.1.1.1 Rinse the clean dry cell twice with the suspension with which it is to be filled.

11.1.1.2 Fill the cell to a level to where the top air-liquid interface will not interfere with the subsequent reading. Check manufacturer recommendations as to cell filling.

11.1.1.3 After the cell is filled, tissue is then used to remove all traces of dirt or fingerprints. Tissue alone does not clean very dirty cells and one of the common nonabrasive glass cleaners may be necessary.



Table

NTU Standard Value	NTU Instrument Reading
10.0	10.0*
8.0	8.1
6.0	6.3
4.0	4.7
2.0	2.8

* Instrument adjusted to read this value

FIG. 4 Linear Calibration LC-10

11.1.1.4 The cleaned cell is handled by its very top and placed in an indexed manner in the instrument.

11.2 Calibration Steps:

11.2.1 Warm up the instrument according to manufacturer's instructions.

11.2.2 Rinse a clean, dry, scratch-free index marked cell with the highest concentration of the standard for the instrument range setting or range of interest, and then fill. Always clean the exterior of the cell after filling in any of the following procedures.

11.2.3 Place the cell in the instrument in an oriented manner ready for reading of turbidity.

11.2.4 For photoelectric nephelometrics, set the calibration adjustment for the labeled value of AEPA-I turbidity standard or the diluted value of Formazin standard. For slit type nephelometers plot the adjusted dial reading at null or uniform field brightness versus NTU value of turbidity standard.

11.2.5 Remove the sample cell and discard the first turbidity standard. Rinse and fill a second value of turbidity standard and place the cell in the instrument in an oriented manner. Without moving the photo-electric calibration adjustment, make a reading. Plot this instrument NTU reading against the NTU value of the turbidity standard. For the slit type nephelometer again plot the adjusted dial reading at null versus NTU value of the turbidity standard.

11.2.6 Repeat for at least one more turbidity standard NTU value which should cover the turbidity range of interest. The greater the number of turbidity standard values used, the greater the reliability of the calibration.

11.2.7 Make the plot of instrument reading or dial setting versus turbidity standard NTU value to where any instrument reading or dial setting within the range calibrated is corrected to values relative to the turbidity standard values. The plot of instrument reading or dial setting versus turbidity standard value is a range calibration curve. Calibration curves for each usable range should be made. See Fig. 4 for an example of a linear calibration curve.

12. Procedure

12.1 Standardize the instrument with one value (NTU) of turbidity standard in the measurement range of interest.

12.1.1 Warm up the instrument according to the manufacturer's instructions.

12.1.2 Rinse a clean, dry, scratch-free index marked (a felt pen dot) cell with a turbidity standard (AEPA-I or Formazin) with a value (NTU) in the range of interest. Fill the cell with this turbidity standard. Clean the cell's exterior.

12.1.3 Place the filled clean cell in an indexed manner in the instrument and read the value. It will be an NTU reading for photoelectric types and a dial reading for slit types nephelometers.

12.1.4 From the calibration curve for this instrument's range, determine the required reading for the turbidity standard in cell.

12.1.4.1 Move calibration adjustment to give the photoelectric nephelometer the required NTU reading.

12.1.4.2 The slit dial reading determined from the calibration curve for the turbidity standard in the cell should be within 5 % of the dial reading. If not, reclean the cell and recalibrate.

12.2 Measurement of Water Turbidity:

12.2.1 Turbidity Less Than 40 NTU.—Shake the sample to thoroughly disperse the solids. Allow air bubbles to disappear, then proceed.

12.2.2 Turbidity Exceeding 40 NTU.—Dilute the sample with one or more equal volumes of reagent water until turbidity is below 40 NTU after mixing and degassing. Then treat this less than 40 NTU turbidity in accordance with 12.2.1. The turbidity of the original sample can then be computed based on dilution data and original sample volume (variations of particle size can affect dilution).

12.2.3 After calibration check or adjustment, empty the cell (do not change cells for measurement) of turbidity standard and rinse the empty cell with the water sample to be tested.

12.2.3.1 The measured NTU value of the water sample is determined using the instrument value and the appropriate calibration curve.

13. Report

13.1 Report results as follows:

NTU	Report to Nearest (NTU)
0.05-1.00	0.05
1.00-10.0	0.1
10.0-40	1.0
40-100	5.0
100-400	10
400-1000	50
>1000	100

14. Precision and Bias⁶

14.1 Round-robin data for this test method were obtained by the use of AEPA-I standards. EMSL (Environmental Monitoring and Support Laboratory, EPA, Cincinnati, Ohio) examined this data for its statistical significance. For other matrices, these data may not apply.

14.2 Formazine was not used in the round-robin test because of its short term stability. Formazine can be used as a fresh short-term calibration mixture but the results might not be applicable to this collaborative test study.

14.3 Polymer suspensions of styrene divinyl-benzene are stable and can be accurately quantitated by gravimetric procedures. Linear calibration of each instrument was performed prior to collaborative study, involving ten laboratories and three nephelometric turbidity unit (NTU) levels.

14.4 Table 1 shows the required statistical treatment of the turbidity round-robin test for nine laboratories and three concentrations of NTUs and one laboratory's results were statistically rejected.

14.5 Table 2 shows that the bias of all NTU levels is insignificant for the round-robin test.

⁶ Supporting data are available from ASTM Headquarters. Request RR: D19-1129.

TABLE 1 Final Statistics^A

True concentration, C	0.92	4.50	18.66
Mean response, \bar{x}	0.972	4.410	18.57
Bias, $\bar{x} - C$	0.052	-0.090	-0.09
Total standard deviation, S_T	0.091	0.361	0.292
Single-operator standard deviation, S_o	0.044	0.174	0.181

^A Represent three concentrations of NTU.

TABLE 2 Bias Results

True concentration, C	0.92	4.50	18.66
Mean response, \bar{x}	0.972	4.410	18.57
Bias = $\bar{x} - C$	0.052	-0.090	-0.09
Total standard deviation, S_T	0.091	0.361	0.292
Number of lab/operators contributing usable data, n	8	8	8
Student's t-value, $t = \text{bias} / (S_T / \sqrt{n})$	1.62	0.71	0.87
Critical t-value from Table X3.8 of Practice D 2777	2.365	2.365	2.365
Is bias significant, is $t >$ critical t ?	no	no	no

SUMMARY OF CHANGES

This section identifies the location of selected changes to these test methods that have been incorporated since the last issue. For the convenience of the user, Committee D-19 has highlighted those changes that may impact the use of these

test methods. This section may also include descriptions of the changes or reasons for the changes, or both.

(1) Former Test Method B (Visual Jackson Candle Turbidity) was deleted.

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This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.

Appendix B

**UMTRA Ground Water Project
DOE-GJO Equivalent Water Sampling Procedures**

UMTRA Ground Water Project DOE-GJO Equivalent Water Sampling Procedures

The following table summarizes a comparison of water sampling procedures contained in the Jacobs Engineering Group (JEG) *TAC Hydrological Standard Operating Procedure (SOP)*, Section 16 (October 13, 1992) and the DOE-GJO *Environmental Procedures Catalog* (DOE continually updated). The DOE-GJO procedures were developed as guidelines for water sampling activities in general, without reference to specific program requirements. Many of the JEG procedures therefore contain additional specifications that would typically be included by DOE-GJO in a program or site-specific Sampling and Analysis Plan. Other differences appear due to the particular emphasis placed by JEG on field parameter measurement (e.g., sample pH and alkalinity). In neither case are the differences regarded as DOE-GJO procedural deficiencies.

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.1.10 Field Measurement of Water Samples for Temperature, Conductivity, pH, Alkalinity, and Total Acid	LQ-8(T) Standard Test Method for the Field Measurement of Temperature	16.1.10 specifies monthly thermometer accuracy check; accuracy check schedule not specified in LQ-8(T)	ASTM does not have a specific procedure for field measurement of temperature.
16.1.10, cont.	LQ-5(T) Standard Test Method for the Field Measurement of Specific Conductance	16.1.10 specifies monthly conductivity cell constant check; LQ-5(T) recommends regular cell constant checks (typically performed at each well)	(1) ASTM D1125 does not specify regular cell constant checks. (2) LQ-5(T) specifies rinsing with several volumes of sample water; ASTM specifies rinsing several times with water and twice with sample water. All other requirements are met.
16.1.10, cont.	LQ-4(T) Standard Test Method for the Field Measurement of pH	(1) 16.1.10 specifies quarterly check of pH meter response to variable temperature; no equivalent performance check in LQ-4(T). (2) 16.1.10 specifies periodic pH meter accuracy check with buffer solutions during well purge; LQ-4(T) specifies accuracy check with buffers once per hour of operation. (3) 16.1.10 specifies pH meter accuracy check with buffers after purge is complete, and specifies continued purging if >0.1 unit difference; no equivalent check at end of purge in LQ-4(T).	(1) ASTM specifies instrument performance standards be performed at an action level specified by the laboratory at an appropriate frequency; (2) ASTM specifies standardization checks every hour; (3) ASTM does not specify end-of-purge checks. All other requirements are met.

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.1.10, cont.	LQ-7(T) Standard Test Method for the Field Measurement of Alkalinity	<p>(1) 16.1.10 specifies measurement of alkalinity on unfiltered sample; LQ-7(T) specifies using filtered sample.</p> <p>(2) 16.1.10 monitors alkalinity titration endpoint with pH electrode; LQ-7(T) specifies use of color indicator solutions to determine titration endpoint.</p> <p>(3) 16.1.10 performs 2 alkalinity measurements by separate individuals and an acceptance criteria of $\pm 10\%$; no LQ-7(T) equivalent.</p> <p>(4) 16.1.10 specifies alkalinity measurements on 3 control samples (frequency not specified); no LQ-7(T) equivalent.</p>	<p>(1) ASTM specifies uses of filters should be evaluated with respect to analytical and control requirements;</p> <p>(2) ASTM has procedures for both electrometric and color-change titration;</p> <p>(3) ASTM does not specify performing separate measurements;</p> <p>(4) ASTM does not specify performing measurements on control samples. All other requirements are met.</p>
16.1.10, cont.	No equivalent DOE-GJO procedure for field measurement of total acid	Measurement of total acid not required per Supplemental Water Sampling and Analysis Plan For All UMTRA Sites, May 14, 1996, Rev. 1	Measurement of total acid not required per Supplemental Water Sampling and Analysis Plan For All UMTRA Sites, May 14, 1996, Rev. 1
16.1.11 Sample Collection for Organic Substances	LQ-11(P) Standard Practice for the Sampling of Liquids and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	16.1.11 requires samples collected for organic compound analysis be received by the laboratory within 24 hours of collection; DOE-GJO ships samples as necessary to preserve specified sample holding times.	ASTM specifies shipment and receipt of samples be coordinated with the laboratory to minimize transit time; samples should arrive at the lab within 1 day after being shipped. All other requirements are met.
16.1.13 Field Measurement of Oxidation/Reduction Potential (ORP) in Water Samples	LQ-6(T) Standard Test Method for the Field Measurement of the Oxidation-Reduction Potential (Eh)	16.1.13 requires temperature of reference solution (ZoBell) to be within $\pm 5^\circ\text{C}$ of sample temperature; LQ-6(T) requires temperature of reference solution and sample be within $\pm 10^\circ\text{C}$.	ASTM does not specify a temperature range for the reference solution. All other requirements are met.
16.1.14 Field Determination of Dissolved Oxygen in Water Samples	LQ-9(T) Standard Test Method for the Field Measurement of Dissolved Oxygen	16.1.14 specifies periodic DO readings during well purge; LQ-9(T) does not address measurement frequency. Field parameter measurement frequency during well purge is typically addressed in a site- or program-specific Sampling and Analysis Plan.	ASTM procedure D888 does not specify measurement frequencies. All other requirements for the instrumental probe procedure are met.
16.1.16 Alternate Method for Determination of Dissolved Oxygen	No DOE-GJO equivalent; we will adopt the use of ASTM D5463-93.	Method describes measurement of DO by colorimetry per HACH DR/2000 Spectrophotometer user manual	ASTM procedure D5463-93 provides procedures for use of test kits for quantitative determination of analytes in water and wastewater.

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.1.21 Measurement of Water Turbidity	LQ-24(T) Standard Test Method for Turbidity of Water	16.1.21 recommends turbidity of <5 NTU for samples requiring total digested analysis (unfiltered); higher values may be acceptable for filtered samples; LQ-24(T) addresses turbidity measurement only and not sample turbidity requirements. Sample turbidity requirements are typically specified in site or program-specific Sampling and Analysis Plan.	ASTM procedure D1889-88a is the test method used in LQ-24(T) with specific procedures addressed in our addendum.
16.2.1 Sample Collection, Preservation, and Shipment of Water Samples, Sections 1 and 2, Purpose and Scope	No DOE-GJO equivalent for 16.2.1 Sections 1 and 2	16.2.1 Sections 1 and 2 contain no procedural information or sampling specifications	Individual ASTM procedures specify sample collection techniques; D3694-95 specifies preparation of sample containers and preservation of organic constituents for water samples; ASTM does not have a specific procedure for shipment of ground water samples. All other requirements for organic sample preservation are met.
16.2.1, Section 3, Equipment and Supplies	Portions of LQ-1(G) General Considerations for the Sampling of Liquids, LQ-11(P) Standard Practice for the Sampling of Liquids, and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	16.2.1 Section 3 lists equipment and supplies for water sampling use. LQ 1(G), 11(P), and 12(P) include equipment and supplies selection criteria/requirements.	ASTM D4448-85a specifies equipment and supplies required for sampling ground water monitoring wells; however, it also stipulates that the equipment and procedures used depend on many factors. DOE-GJO follows the sections of this procedure when applicable.
16.2.1, Section 4, Chemicals and Reagents	Portions of LQ-11(P) Standard Practice for the Sampling of Liquids, and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	16.2.1 Section 4 lists chemicals used for water sample preservation, and specifications for preparing preservative solutions under laboratory conditions if certified solutions are not readily available from commercial suppliers. LQ-11(P) and LQ-12(P) include recommended preservatives but do not include specifications for preparing preservative solutions; standard DOE-GJO practice (unspecified) is to obtain certified solutions from commercial suppliers.	ASTM D3694-95 provides procedures for preparation of preservative solutions if certified solutions are unavailable. D4448 specifies refrigerating or freezing is often the best preservation technique available.

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.2.1, Section 5, Preparation for the Collection of Water Samples	No DOE-GJO equivalent	16.2.1 Section 5 addresses responsibilities of Site Hydrologist, Technical Representative, Water Sampling Manager, and Water Samplers, in preparation of each water-sampling event.	ASTM does not specify responsibilities of personnel involved in the sampling events.
16.2.1, Section 6 Surface Water Sample Collection	No DOE-GJO equivalent specifically for surface water samples Applicable portions of LQ-11(P) Standard Practice for the Sampling of Liquids, and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	16.2.1 Section 6 specifies collecting sample into bulk container for homogenization and parameter measurement prior to dispensing into individual sample containers; no DOE-GJO equivalent (note: parameter measurement should be made in a separate container); surface water collection method is typically specified in site or program-specific Sampling and Analysis Plan.	ASTM D5358-93 specifies collecting a surface sample and not a subsurface sample because mixing and dilution will occur. The sample collected is poured directly into the sample container. ASTM D4687 specifies obtaining a sample from the edge of the pond/lake. ASTM does not have a specific procedure for sampling flowing water.
16.2.1, Section 7 General Ground Water Sampling Rules	Portions of LQ-1(G) General Considerations for the Sampling of Liquids, LQ-11(P) Standard Practice for the Sampling of Liquids, and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	(1) 16.2.1 Section 7 recommends proceeding from least to most contaminated wells/stations; not stated in DOE-GJO procedures but generally followed as standard field practice. (2) 16.2.1 Section 7 specifies minimum purge of 3 well volumes; DOE-GJO procedure recommends evacuation of 3 to 5 casing volumes; actual purge criteria are typically specified in site or program-specific Sampling and Analysis Plan.	(1) ASTM D4687 specifies proceeding from the least to most contaminated well; (2) D4448-85a specifies various methods and purge volumes for wells depending upon the volume of water in the well.
16.2.1, Section 8 Direct Sampling of a Ground Water Sample	LQ-3(P) Standard Practice for Purging of Monitoring Wells, and LQ-10(P) Standard Practice for the use of a Flow Cell for Field Measurements	(1) 16.2.1 Section 8 specifies periodic measurement of temperature, conductivity, and pH to verify parameter stabilization. (2) 16.2.1 Section 8 stability criteria are ill-defined (Section 8.4). (3) See also 16.2.5 (4) DOE-GJO parameter monitoring requirements specified in site or program-specific Sampling and Analysis Plan.	ASTM D4448-85a specifies sampling procedures will be different depending upon analyses required; no analyte specific procedures are described. All other requirements are met.

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.2.1, Section 9 Ground Water Sampling from a Production Well	LQ-3(P) Standard Practice for Purging of Monitoring Wells, and LQ-10(P) Standard Practice for the use of a Flow Cell for Field Measurements	See 16.2.1 Section 8 comments.	Requirements in ASTM D4448-85a that specify various methods for purging wells are met. ASTM does not have a specific procedure for sampling production wells.
16.2.1, Section 10 Ground Water Sampling with a Bailer	LQ-11(P) Standard Practice for the Sampling of Liquids	16.2.1 Section 10 specifies triple rinsing of bailer with formation water prior to filling sample bottles if sufficient water is available; bailer rinsing with formation water not required per DOE-GJO procedure.	ASTM does not specify any requirements for bailer rinsing prior to use. Requirements of D4448 for sampling with a bailer are met.
16.2.1, Section 11 Ground Water Sampling from Seeps and Springs	No DOE-GJO equivalent specifically for seeps and springs Applicable portions of LQ-11(P) Standard Practice for the Sampling of Liquids, and LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	None	ASTM does not have a specific procedure for sampling from seeps and springs.
16.2.1, Section 12 Filtration and Preservation of Water Samples	LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples	16.2.1 Section 12 specifies volumes and concentrations of preservatives; DOE-GJO practice is to add sufficient volume of appropriate preservative to achieve pH requirement, as dictated by variable water chemistry.	ASTM D3694 specifies adding the sufficient volume of appropriate preservative to achieve pH requirements for the analytes being tested. The GJO procedure meets all the requirements of this ASTM.
16.2.1, Section 13 Preparation of Split Samples	Portions of LQ-1(G)	See 16.2.8 comments	ASTM does not specify collection procedures for split samples.
16.2.1, Section 14 Preparation of Sample Splits, Known Solutions, and Archived Samples	No DOE-GJO equivalent	Procedure not applicable.	Procedure not applicable
16.2.1, Section 15 Preparation of Water Samples for Packaging, Labeling, and Transport	Portions of GN-8(P) Standard Practice for Sample Labeling, and GN-9(P) Standard Practice for Chain-of-Sample Custody Control and Physical Security of Samples	None	ASTM D4840 specifies labeling, packaging, and transporting procedures adopted by the DOE-GJO.
16.2.2 Water Sampling for Tritium Analysis	No DOE-GJO equivalent	Measurement of tritium not required per Supplemental Water Sampling and Analysis Plan For All UMTRA Sites, May 14, 1996, Rev. 1	N/A

JEG Procedure	Equivalent DOE-GJO Procedure(s)	Comment	ASTM Procedure
16.2.4 Sampling Radon in Water	No DOE-GJO equivalent	Measurement of radon not required per Supplemental Water Sampling and Analysis Plan For All UMTRA Sites, May 14, 1996, Rev. 1. Sampling for radon-222 analysis by DOE-GJO performed per volatile organic sampling method.	N/A
16.2.5 Monitor Well Sampling with an Electric Submersible Pump 16.2.6 Monitor Well Sampling with a Bladder Pump 16.2.7 Monitor Well Sampling with a Peristaltic Pump 16.2.9 Monitor Well Sampling with a Bailer	LQ-2(T) Standard Test Method for the Measurement of Water Levels in Groundwater Monitoring Wells, LQ-3(P) Standard Practice for Purging of Monitoring Wells, LQ 11(P) Standard Practice for the Sampling of Liquids, LQ-12(P) Standard Practice for the Collection, Filtration, and Preservation of Liquid Samples, and LQ-13(P) Standard Practice for Equipment Decontamination	(1) 16.2 methods specify minimum purge volume of 3 bore volumes, where 1 bore volume equals the standing water volume in well casing. (2) 16.2 methods specify inserting pump intakes and bailer at approximately 2 feet above screen. (3) 16.2 methods recommend the following parameter measurement frequency during purge: each gallon if purge volume <4 gallons; every 2 gallons if purge volume >4 and <40 gallons; and every 5 gallons if purge volume >40 gallons. (4) 16.2 methods provide no contingency for wells that purge dry. (5) DOE-GJO typically addresses items 1 – 4 in site or program-specific Sampling and Analysis Plan	ASTM D4448-85a: (1) specifies various methods for purging wells depending upon the volume of water in the well; (2) has no specifications on where to insert the pump or bailer; (3) has no specifications regarding volume/frequency requirements for parameter measurements; (4) specifies removing all water within the well, allow the well to recover, and purging all the water once again. All other requirements are met.
16.2.8 Quality Control Samples for Water Sampling	No specific DOE-GJO equivalent Applicable portions of LQ-1(G) General Considerations for the Sampling of Liquids	16.2.8 provides specific frequency and method of collection of each QC sample type; DOE-GJO QC sampling criteria typically specified in site or program-specific Sampling and Analysis Plan	ASTM D5283 specifies that the types and frequencies of field QC samples should be defined in project documentation. All other requirements are met.
16.2.10 Packaging, Shipping, and Custody of Environmental Samples	Portions of GN-8(P) Standard Practice for Sample Labeling, and GN-9(P) Standard Practice for Chain-of-Sample Custody Control and Physical Security of Samples	Element of DOE-GJO site-specific SAP	ASTM D4840-88 specifies procedures for packaging, shipping, and chain of custody for environmental samples followed in DOE-GJO procedures.
16.3.1 Inventory and Documentation of Damage and Repair for UMTRA Project Wells	LQ-18(P) Standard Practice for the Inspection and Maintenance of Groundwater Monitoring Wells	None	N/A

Appendix C
UGW Data Validation Guidance

UGW Data Validation Guidance

1.0 Introduction

The function of this document is to provide guidance to Uranium Mill Tailings Remedial Action (UMTRA) Ground Water (UGW) data validation leads when validating data obtained from routine water sampling of UGW and Long-Term Surveillance and Maintenance (LTSM) sites. In addition, this document provides a framework that will allow uniform application of data validation procedures, which will result in a consistent, high quality deliverable to the U.S. Department of Energy (DOE).

In order to maintain consistency with historical data validation efforts, this document incorporates portions of Jacobs Engineering Group's (JEG) data validation procedures, which include *Validation of Chemical Analysis Data* and *Data Management* (JEG 1994). This document also incorporates portions of the U.S. Environmental Protection Agency's (EPA's) *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis* (EPA 1988), and Oak Ridge National Laboratory's *Radiochemical Data Verification and Validation Procedure* (Lockheed 1995).

2.0 Data Validation Package Contents

The following items are required in each data validation package submitted to DOE.

2.1 Team Leader/Site Hydrologist Summary

This section includes answers to the following questions along with the documentation necessary to support the conclusions. If more than one aquifer was sampled, then the applicable questions are to be addressed for each aquifer. The location of the sampling site (upgradient, on-site, downgradient, crossgradient) along with the aquifer (if applicable) should be noted when answering these questions.

- (1) Did concentrations in water from any domestic wells sampled exceed a ground water standard, primary drinking water standard, or health advisory?

Water-sample concentrations of domestic wells are to be compared to UMTRA ground water, state ground water, and/or EPA drinking water standards. DOE must be notified immediately when a standard is exceeded in a sample from a domestic well. Samples exceeding the standards must be listed in response to this question.

- (2) Were standards exceeded at any point-of-compliance wells?

Point-of-compliance wells are to be compared to the standards set by the jurisdictional regulatory agency. Samples exceeding standards must be listed in response to this question.

- (3) As a result of this sampling round, is there any indication of unexpected contaminated ground water movement?

This includes upgradient or cross gradient wells that historically showed no evidence of contamination. In addition, historically clean downgradient wells that show evidence of arrival of the contaminant plume should be addressed. The site hydrologist should be consulted to provide input in answering this question.

- (4) Is there statistical evidence that UMTRA Project related contaminants were detected in a surface body of water in greater concentrations than upstream ambient water quality?

Downgradient sample concentrations are to be compared to a benchmark value derived from historical upgradient data. The following criteria will be used to derive the benchmark value. If more than 50 percent of the upgradient concentrations are below detection, the benchmark is the maximum observed concentration. If more than 50 percent of the concentrations are above detection, then the benchmark is determined by assuming a lognormal distribution and using a statistical application software package that will solve two simultaneous non-linear equations. If there are less than 10 historical upgradient data points, then the benchmark is the maximum observed concentration.

Concentrations of UMTRA project related contaminants (constituents for which there is an UMTRA standard) that exceed the benchmark must be listed in response to this question. Surface water locations addressed in this question should include a description of the type of surface water body (i.e., river, seep, pond).

2.2 Data Package Assessment

This section contains the following items:

- (1) Completed UGW Water Sampling Field Activities Verification Checklist form,
- (2) Completed Data Package Assessment form, and
- (3) Data Assessment Summary.

This subsection contains qualified data that were flagged during the laboratory data validation process. Data flagged on the basis of field data (i.e., F, G, and Q) also should be listed. A summary of potentially anomalous data identified in the Suspected Anomalies Report (SAR) report should be discussed including the corrective action necessary for anomalous data.

Because laboratory nomenclature regarding detection and reporting limits will be used in this procedure, a brief discussion of these terms is included. The Contract Required Detection Limit (CRDL) is a regulatory reporting limit that represents the detection level that the laboratory must be able obtain when reporting analytical results. The CRDL is set well above the typical detection capabilities for a particular analytical method; therefore, a concentration that exceeds the CRDL is considered a reliable number with minimal analytical uncertainty. The instrument detection limit (IDL) represents the lowest concentration an instrument can detect based on statistics derived from repeated

measurements of a standard. IDLs are determined quarterly and are a result of a direct measurement from the instrument. In contrast, the method detection limit (MDL) is used when a process (e.g. sample digestion) is required to obtain results. For example, if sample preparation is required, it adds uncertainty to the analytical process and would require an MDL. The MDL, therefore, is typically higher than the detection capabilities of the instrument. MDLs are statistically based and determined annually. The minimal detectable activity (MDA) is a term used to describe the detection limit for radiological analyses. It is based on factors that include background count rate, counting time, chemical recovery, and detector efficiency. The MDA is variable and is calculated for each sample.

In addition, a discussion of equipment blank and duplicate sample results is to be included. Equipment blank constituents detected above the CRDL, excluding major cations and anions, or MDA should be noted. Major cations and anions (and total dissolved solids [TDS]) detected in equipment blanks are often a reflection of decontamination water chemistry, and therefore are not listed in the data assessment summary unless concentrations are determined to be significant by the validator. Major cations and anions include calcium, sodium, magnesium, potassium, chloride, and sulfate.

Inorganic duplicate sample results will be addressed using the following criteria. A control limit of ± 20 percent relative percent difference (RPD) will be used for sample concentrations greater than 5 times the CRDL. RPD can be calculated using the following formula:

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100$$

Where

S = sample concentration
D = duplicate concentration

For sample concentrations less than 5 times the CRDL, a control limit of \pm the CRDL will be used.

Radiological duplicate results will be addressed using the following criteria. If one or both of the results are above the MDA, then the results must have an overlap of the respective 3σ ranges. The uncertainty (or total error) displayed in the laboratory reports is 2σ ; therefore, 3σ is calculated by multiplying the uncertainty by 1.5. If both results are below the MDA, the results are acceptable.

Duplicate sample results that do not meet criteria should be noted in the data assessment summary.

2.3 SAR Report

The SAR is generated from the SEEPro database.

2.4 Anomalous Data Review Checksheet

The Anomalous Data Review Checksheet lists the subset of data from the SAR that are potentially anomalous and warrant further investigation. Generally, values listed in the SAR were considered valid if: (1) identified low concentrations were the result of low detection limits; (2) the concentration detected was within 50 percent of historical minimum or maximum values; or (3) if there were less than 5 historical results for comparison. If results do not meet these criteria, then they are listed on the Anomalous Data Checksheet along with the appropriate follow-up action. If a SAR report will not run, a historical minimum and maximum report will be produced by the UGW database manager. The criteria listed above will be applied to the data listed in the minimum and maximum report to determine potentially anomalous data.

2.5 UGW Database Printouts

Database printouts in tabular form are to be included for ground water, surface water, equipment blank, and ground water level measurement data. A disk containing an electronic copy of the ground water (USEE200 report), surface water (USEE800 report) and equipment blank data also must be included for sites outside the state of Colorado. These reports are generated from the DOE-GJO database call "SEPro".

2.6 Comparison to Standards Table

Ground water results that exceed UMTRA standards should be displayed in a table format. When comparing nitrate results to the standard (nitrate as N), the standard must be converted to nitrate using the following formula: $\text{nitrate as N} \times 4.427 = \text{nitrate}$, which makes the standard 44.27 milligrams per liter (mg/L) as nitrate. The gross alpha standard excludes uranium and radon. Radon is removed during the analytical process, but uranium must be subtracted from the gross alpha result for comparison to the standard. To accomplish this, total uranium values are converted to activity using the following formula: $\text{uranium in picocuries per liter (pCi/L)} = \text{uranium in mg/L} \times 687 \text{ picocuries per milligram (pCi/mg)}$. Then the converted uranium activity is subtracted from the gross alpha for comparison to the standard, and the corrected net alpha is displayed in the table.

2.7 Sampling Work Order

The Sampling Work Order letter detailing the sampling locations and the analyte list is to be included in the data validation package.

2.8 Trip Report

The trip report prepared by the Site Sampling Lead is also to be included in the data validation package.

3.0 Data Assessment Procedures

This section details procedures used to complete specific items in the data package assessment, including validation of laboratory data and field data.

3.1 Laboratory Data Validation

In order to complete the Data Package Assessment form, validation of laboratory data must be conducted. The following sections provide procedures to evaluate each item listed on the Data Package Assessment form. Sample results that do not meet data validation criteria will be qualified with either a "J" flag (estimated), "U" flag (not detected), or an "R" flag (data unusable). Additional detail regarding laboratory data validation, including formulas to calculate percent recovery, can be found in EPA's *Functional Guidelines for Evaluating Inorganic Analyses* (EPA 1988).

3.1.1 Chain of Custody

Chain-of-custody records must be verified to ensure (1) all samples are listed, (2) all fields are completed with the appropriate information, (3) signatures were obtained for sample transfers, and (4) that there is no time gap between relinquishing and receiving samples (a time gap implies the samples were "out of custody"). Time gaps do not apply to samples shipped by commercial carrier because there will always be a time gap. For samples shipped by commercial carrier, verify that the custody seals were present and intact; this information can be checked in the "Receiving Documentation" section of the analytical reports. If the preceding information is acceptable, then write an "OK" in the Chain Of Custody section on the Data Package Assessment form for the appropriate analytical methods. If portions of the chain of custody record are deficient, then make a notation in the Chain Of Custody section and describe the deficiencies in the Data Assessment Summary section.

3.1.2 Holding Time

Sample holding times must be checked to verify that maximum holding times allowed for the UGW project were not exceeded. The case narrative of the analytical report from the laboratory will usually note samples that exceeded maximum holding times. Holding time refers to the time between sample collection and sample analysis. Holding times can be evaluated by checking the sample collection date and time on the chain-of-custody form, or the sample ticket, with the sample analysis date and time on the analysis run logs (metals and anions), or with the summary worksheets in the Radiochemical Supporting Documentation section in the analytical reports. The holding time for all samples should be checked against the maximum holding times allowed for the UGW project, which are found in Section 2.4 of the sampling and analysis plan.

If the maximum holding times were not exceeded, then write an "OK" in the Holding Time section on the Data Package Assessment form for the appropriate analytical methods. If samples exceeded the maximum holding times, then qualify the results with a "J" flag and make a notation in the Holding Time section and list the samples/analytes that exceeded maximum holding times in the Data Assessment Summary section.

3.1.3 Calibration Verification

Initial Calibration Verification (ICV) and Continuing Calibration Verification (CCV) must be checked to ensure they were within the control limits of 90 - 110 percent recovery (% R) (except for cyanide 80-115 % R). This information is found in Form 2A in the analytical report.

If the ICV and CCV % R were within the control limits, then write an "OK" in the Calibration Verification section on the Data Package Assessment form for the appropriate analytical methods. If the % R were outside the control limits, then make a notation in the Calibration Verification section and qualify the affected samples using the following criteria.

$75 < \% R < 89$ or $111 < \%R < 125$ and sample results $> IDL$ – J flag

$111 < \%R < 125$ and sample results $< IDL$ – sample results acceptable

$75 < \% R < 89$ and sample results $< IDL$ – U and J flags

$\% R < 75$ – R flag

$\%R > 125$ and sample results $< IDL$ – sample results acceptable

Note: GJO laboratory procedures require the laboratory to rerun samples that fall outside the ICV and CCV % R control limits; therefore, flagged data as a result of this aspect of data validation will be rare.

For alpha spectrometry analyses, verify that the chemical recovery is greater than 30 % R. If the % R is outside the control limits, make a notation in the Calibration Verification section on the Data Package Assessment form and qualify the affected samples using the following criteria.

$\%R < 10$ – R flag

$10 < \%R < 30$ – J flag

List the qualified data along with the associated flag in the Data Assessment Summary section.

3.1.4 Blanks

Blank results are found on Form 3 of the analytical reports (metals and anions) or on the summary tables in the Radiochemical Supporting Documentation section (radiological analyses).

To determine which samples are associated with Initial Calibration Blanks (ICB) and Continuing Calibrations Blanks (CCB) a rule of five is used, i.e. the five samples before and the five samples after the ICB or CCB as listed on the analysis run log are the samples associated with that blank. To evaluate if a sample is affected by the associated blank, the sample concentration must meet the following criteria:

IDL (or MDA) $<$ sample result $< 5 \times$ blank concentration.

If the associated sample concentration falls within this range, the sample should be qualified with a "U" flag at the IDL (or MDA).

Prep Blanks are required for all samples that require preparation (e.g., extraction or digestion). Prep Blanks (PB) have the same qualification criteria as ICBs and CCBs; however, prep blanks apply to all samples in the same preparation batch. This information can be found in the preparation log (Form 13) or in the Radiochemical Supporting Documentation section of the

analytical report. Note: When checking soils data (or other solid matrices), the units may be reported differently between the blank ($\mu\text{g/L}$) and the sample result (mg/kg); therefore, the validator may have to check the raw data to compare like units. When checking radiological results, the prep blank may be in units of pCi/sample . In order to compare like units, multiply the sample concentration by the sample volume to obtain units of pCi/sample .

If samples are not affected by blank contamination, then write an "OK" in the appropriate Blanks section on the Data Package Assessment form for the associated analytical methods. If samples are affected by blank contamination, then make a notation in the appropriate Blanks section and list the flagged data in the Data Assessment Summary section.

3.1.5 ICP Serial Dilution

Verify that a serial dilution was run for all ICP analyses and that the diluted sample is within 10 percent difference of the original sample. If the original sample concentration is less than 50 times the IDL, then the 10 percent difference criteria does not apply. This information is found on Form 9 of the analytical reports.

If the percent difference was within the control limits, then write an "OK" in the Serial Dilution section on the Data Package Assessment form for the appropriate analytical methods. If the results differed more than 10 percent and the original result was greater than 50 times the IDL, then make a notation in the Serial Dilution section and J flag the affected samples. Samples affected include all samples on the analysis run log between the serial dilution that did not meet criteria and the next serial dilution that met the criteria.

3.1.6 ICP Interference Check Sample

Verify that an Interference Check Sample (ICS) was run for all Inductively Coupled Plasma - Atomic Emission Spectrometry (ICP-AES) analyses at the beginning and end of each analytical run, and at the beginning of the run for Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) analyses. This information is found in the analysis run logs in the analytical reports. Verify that the results of the ICS solution AB analysis fall within the control limits of 80 – 120 % R. This information is found on Form 4 of the analytical reports.

If the ICS solution AB was within the control limits, then write an "OK" in the ICS section on the Data Package Assessment form for the appropriate analytical methods. If the ICS solution AB was outside the control limits, then make a notation in the ICS section and flag the affected samples using the following criteria.

$\% R > 120$ and sample results $< \text{IDL}$ – sample results acceptable

$\% R > 120$ and sample results $> \text{IDL}$ – J flag

$50 < \%R < 79$ and sample results $> \text{IDL}$ – J flag

$50 < \%R < 79$ and sample results $< \text{IDL}$ – U and J flags

$\% R < 50$ – R flag

List the qualified data with the associated flags in the Data Assessment Summary section.

7.1.1 Laboratory Control Sample

Verify that Laboratory Control Samples (LCS) were run and that the % R is within the control limits of 80 – 120. This can be checked on Form 7 (metals and anions) or in the QC Summary (radiological) of the analytical reports.

If the LCS was within the control limits, then write an “OK” in the LCS section on the Data Package Assessment form for the appropriate analytical methods. If the LCS was outside the control limits, then make a notation in the LCS section and flag the affected samples using the following criteria.

$50 < \%R < 79$ and sample results $> IDL$ – J flag

$50 < \%R < 79$ and sample results $< IDL$ – U and J flags

$\% R > 120$ and sample results $> IDL$ – sample results acceptable

$\% R < 50$ – R flag

List the qualified data with the associated flags in the Data Assessment Summary section.

3.1.8 Duplicates

For inorganic analyses, verify that duplicate analyses were within the control limits of ± 20 RPD for sample concentrations that are greater than 5 times the CRDL. For sample concentrations that are less than 5 times the CRDL, a control limit of \pm the CRDL is used; this includes the case where one of the duplicate sample concentrations is less than 5 times the CRDL. This information can be found on Form 6 of the analytical reports.

For radiological analyses, verify that there is 3σ agreement between results when both results are above the MDA. The 3σ can be calculated by multiplying the uncertainty (2σ) by 1.5. If one result is above the MDA, then the results must agree within \pm MDA. If both results are below the MDA, then no flag is required. Duplicate radiological results are found on the summary worksheets in the Radiochemical Supporting Documentation section of the analytical reports.

If the duplicate samples were within the control limits, then write an “OK” in the Duplicate section on the Data Package Assessment form for the appropriate analytical methods. If the duplicate was outside the control limits, then make a notation in the Duplicate section and qualify all results in the analytical run for that analyte with a “J” flag; list the flagged data in the Data Assessment Summary section.

3.1.9 Matrix Spikes

Verify that matrix spike % R was within the control limits of 75 – 125. Matrix spike recovery limits do not apply when the sample concentration exceeds the spike concentration by a factor of 4 or more. This information is found on Form 5A (inorganics) or in the QC Summary section (radiological) of the analytical reports.

If the matrix spike was within the control limits, then write an "OK" in the Matrix Spike section on the Data Package Assessment form for the appropriate analytical methods. If the matrix spike was outside the control limits, then make a notation in the Matrix Spike section and flag the affected samples using the following criteria.

% R > 125 and sample results < IDL – sample results acceptable

% R > 125 or % R < 75 and sample results > IDL – J flag

30 < % R < 74 and sample results < IDL – U and J flags

% R < 30 and sample results < IDL – R flag

List the qualified data in the Data Assessment Summary section. In addition, if the matrix spike did not meet criteria, verify that a post-digestion spike was analyzed (inorganics only, not including Graphite Furnace); there is no acceptance criteria for the post-digestion spike.

3.1.10 Radiological

The following statement should be included in "Radiochemical Analysis" section of the Data Assessment Summary: Radiological results that were less than the MDA and/or the 3-sigma counting statistic range were qualified with a "U" flag (non-detect) in the database, as reflected on the data base printouts. With this statement, the UGW Database Manager will initiate a program that will "U" flag the appropriate radiological results.

3.2 Field Data Validation

The Water Sampling Field Data forms should be reviewed to determine the method of purging, the pH of ground water samples, and the volume of water purged from the well. Samples collected using a low-flow purging strategy should be qualified with an "F" flag. Sample results that have a pH greater than 9 should be qualified with a "G" flag. Samples collected using Category II and Category III protocol should be qualified with a "Q" flag.

All field data validation flags should be documented in the Data Assessment Summary section. All field measurements displayed on the data base printouts should be checked for transcription errors against the entries on the Water Sampling Field Data forms.

4.0 Logistics

Data validation packages are due to DOE 21 days after the electronic data transfer is received from the GJO Laboratory. When the person responsible for data validation for a particular site is identified, that person should contact the Ground Water Monitoring Coordinator so that their name can be entered on the Data Validation Requisition Tracking Form. When the sampling data have been entered into the UGW database, the UGW Database Manager will notify the person responsible for the data validation for that site via E-mail. The field data, analytical reports, trip report, and sampling work order may be obtained from the Ground Water Monitoring Coordinator at that time to start the validation process. A flowchart detailing the data validation process is shown in Figure 1.

The data assessment portion of data validation should be the first item completed during the data validation process. Once this is completed, the data validation flags should be forwarded to the UGW Database Manager for incorporation. This allows presentation of qualified data in the final data printout that is included in the data validation package.

5.0 Reporting

The completed draft data validation package is forwarded to DOE for review. When comments from DOE are addressed, the final data validation package is delivered to DOE for distribution. Copies of each package are delivered to the stakeholders as specified in Table 1.

If samples have been collected from domestic-supply wells a letter and table for each sampling round are sent to the owners of the property where the wells are located. A sample letter and table are presented in Figure 2.

6.0 References

Jacobs Engineering Group Inc., 1994. *Albuquerque Operations Manual* "Validation of Chemical Analysis Data and Data Management," Albuquerque, New Mexico.

Lockheed Martin Energy Systems, Inc., 1995. *ERWM Programs Intersite Procedures Manual* Number ERWM/ER-P2209, Rev. 0, "Radiochemical Data Verification and Validation Procedure," Oak Ridge, Tennessee.

U. S. Environmental Protection Agency, 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis*.

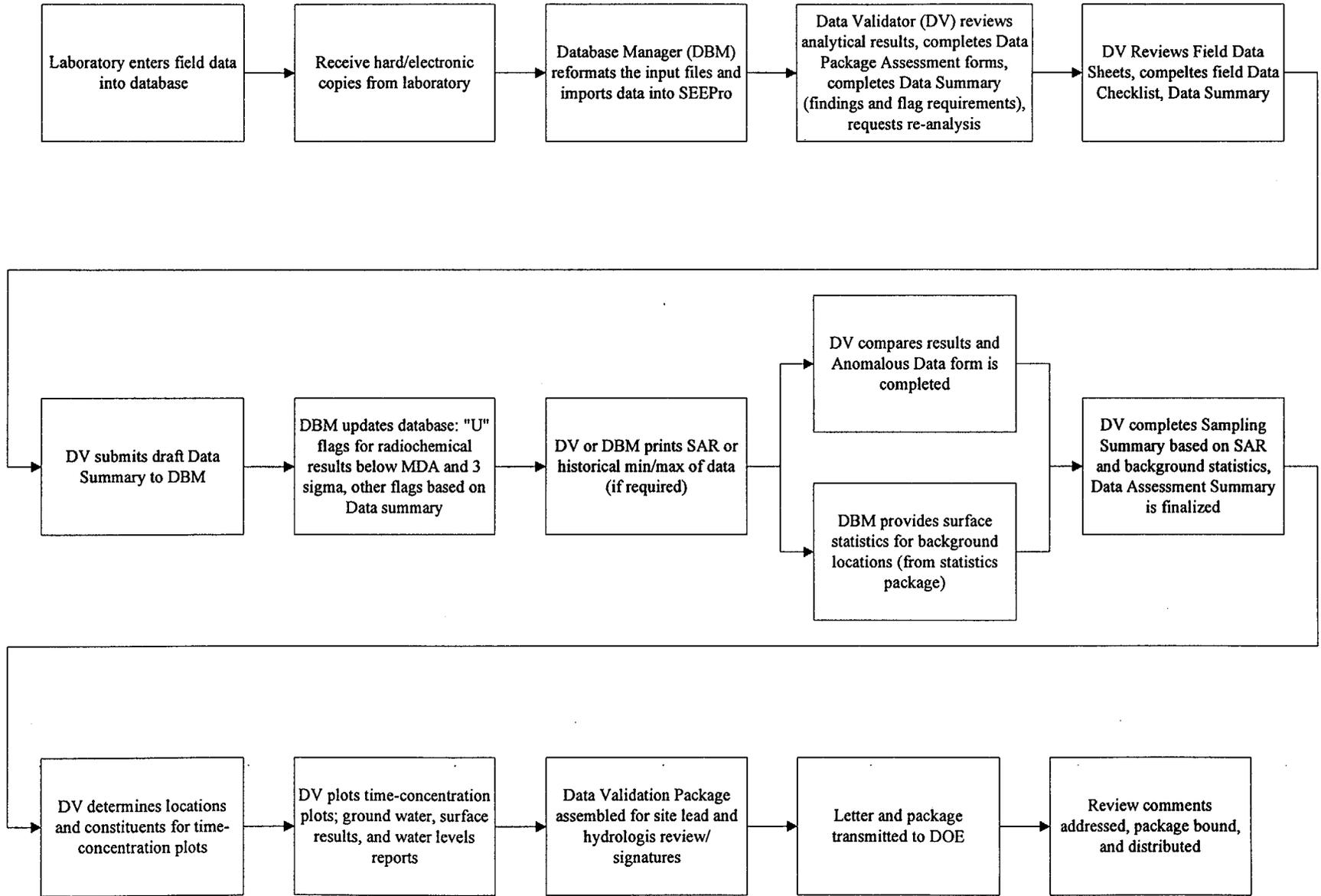


Figure 1. UMTRA Ground Water Data Validation Flowchart

Table 1. Data Validation Report Distribution List

Site	Project	Stakeholder	Total Number of Copies/Disks
Ambrosia Lake	LTSM	Scott McKittrick, New Mexico Environment Department (VDP + disk) cc w/enclosure: Kenneth Hooks, NRC/Rockville, MD	3/1
Canonsburg	LTSM	James Yusko, Pennsylvania Dept. of Environmental Protection cc w/enclosure: S. Harper, Pennsylvania Dept. of Environmental Protection cc w/enclosure: Mike Layton, NRC	4/0
Durango	UGW/LTSM	Wendy Naugle, CDPHE cc w/enclosure: W. Urbonas, San Juan Basin Health Dept. cc w/enclosure: Durango Public Library	4/0
Falls City	LTSM	Bruce Calder, Texas Dept. of Health, Bureau of Radiation Control (VDP + disk) cc w/enclosure: Falls City Public Library cc w/o enclosure: Gary Smith, Texas Dept. of Health, Bureau of Radiation Control	3/1
Grand Junction	UGW/LTSM	Wendy Naugle, CDPHE/Denver cc w/enclosure: Mesa County Public Library	3/0
Green River	UGW/LTSM	Rob Herbert, Utah Department of Environmental Quality (VDP + disk) cc w/enclosure: Green River Public Library cc w/o enclosure: Loren Morten, UDEQ	3/1
Gunnison	UGW/LTSM	Wendy Naugle, CDPHE/Denver Gunnison Public Library	3/0
Lakeview	UGW	David Stewart-Smith, State of Oregon, Office of Radiation Control (VDP + disk) cc w/enclosure: Lake County Library	3/1
Lowman	LTSM	No VDPs being sent on this site (per M. Plessinger, OK'd by D. Metzler)	3/0
Maybell	LTSM	Wendy Naugle, CDPHE/Denver	2/0
Mexican Hat	UGW/LTSM	Madeline Roanhorse, Navajo UMTRA Program (always gets 3 VDPs + disk) cc w/enclosure: J. Larry Breckenridge, Knight Piesold cc w/enclosure: Eric Rich, Navajo EPA cc w/enclosure: Monument Valley High School Library cc w/o enclosure: Ray Russell, Navajo UMTRA	6/1
Monument Valley	UGW	Madeline Roanhorse, Navajo UMTRA Program (always gets 3 VDPs + disk) cc w/enclosure: J. Larry Breckenridge, Knight Piesold cc w/enclosure: Eric Rich, Navajo EPA cc w/o enclosure: Ray Russell, Navajo UMTRA	5/1
Naturita	UGW	Wendy Naugle, CDPHE/Denver cc w/enclosure: J. Davis, USGS cc w/enclosure: D. Naftz, USGS cc w/enclosure: Naturita Public Library	5/0

Table 1 (continued). Data Validation Report Distribution List

Rifle	UGW	Wendy Naugle, CDPHE/Denver cc w/enclosure: Rifle Public Library cc w/enclosure on special request only: Bill Sappington, City of Rifle	3/0 (or 4/0)
Riverton	UGW	Don Aragon, Shoshone-Arapaho Tribes (VDP only) cc w/enclosure: John Erickson, Dept. of Environmental Quality/Wyoming cc w/enclosure: B. Weed, Wind River Environmental Quality Council (VDP + disk) cc w/enclosure: Riverton Branch Library	5/1
Salt Lake City	LTSM	Rob Herbert, UDEQ (VDP + disk) cc w/enclosure: South Salt Lake Public Library cc w/enclosure: Mike Layton, NRC	4/1
Shiprock	UGW	Madeline Roanhorse, Navajo UMTRA Program (always gets 3 VDPs + disk) cc w/enclosure: S. Austin, NPDES Program cc w/enclosure: J. Larry Breckenridge, Knight Piesold cc w/enclosure: Shiprock Public Library cc w/o enclosure: Ray Russell, Navajo UMTRA	6/1
Slick Rock	UGW	Wendy Naugle, CDPHE/Denver cc w/enclosure: Naturita Public Library	3/0
Spook	LTSM	John Erickson, Dept. of Environmental Quality/Wyoming (VDP + disk) cc w/enclosure: Roberta Hoy, Dept. of Environmental Quality/Wyoming	3/1
Tuba City	UGW	Madeline Roanhorse, Navajo UMTRA Program (always gets 3 VDPs + disk) cc w/enclosure: J. Larry Breckenridge, Knight Piesold cc w/enclosure: Steve Semken, Dine College cc w/enclosure: Eric Rich, Navajo EPA cc w/enclosure: Tuba City Library cc w/o enclosure: Ray Russell, Navajo UMTRA Norman Honie, Hopi Tribe (two VDPs + disk) cc w/o enclosure: D. Ahownewa, Office of Mining and Mineral Resources	10/2

Mr. George Smith
c/o Smith Construction, Co.
2720 Jones Avenue
Washington, Colorado 83838

SUBJECT: Water Quality Tests

Dear Mr. Smith:

In June 2000, MACTEC-ERS, a subcontractor for the U.S. Department of Energy, collected a water sample from your property at well location 442, in Washington, Colorado, as part of the on-going assessment of ground water conditions near the UMTRA disposal site. Enclosed with this letter is a data table that shows the results for the June 2000 sampling. The samples were not filtered during the sampling process, thus representing what would be used for domestic purposes.

Drinking Water Standards

For most common chemicals, the U.S. Environmental Protection Agency (EPA) established standards for drinking water under the Safe Drinking Water Act that are called "Maximum Contaminant Levels" (MCLs). These values are based on available health effect data for each chemical and are designed to protect municipal drinking water supplies. Although MCLs are not used to regulate privately owned wells, the available MCLs are commonly used to evaluate the quality of water in private wells. Therefore, if the concentration in your well is below the MCL, there is no cause for concern.

For some chemicals, the EPA has set "Secondary Maximum Contaminant Levels" (SMCLs) for drinking water. An SMCL is simply a suggested level, based on aesthetic qualities of the water such as taste and odor. However, please note that an SMCL is not based on health effects and a recommended health-based limit would be at a higher value. For example, a recommended health-based limit for manganese would be 2.00 mg/L, compared to the SMCL of 0.05 mg/L.

UMTRA Ground Water Standard

EPA has promulgated standards for the cleanup of ground water at former uranium mill sites. These standards were finalized in January 1995 and are included in Column 4 of the attached table.

Figure 2. Example of Domestic Well Reporting

Results of the Sampling Program

A summary table of the June 2000 sampling is enclosed with this letter. On the data table, Column 1 lists the chemical name. Column 2 lists the amount detected in the well. Column 3 shows the units of measurement. The common units of measurement are: milligrams per liter (mg/L), one mg/L is approximately equivalent to one part per million; or picoCuries per liter (pCi/L), a picoCurie is a measure of the amount of radiation resulting from a chemical. Column 4 shows the MCL, SMCL, or UMTRA standard for the chemical. Column 5 indicates if the well exceeds the MCL, SMCL, or UMTRA standard associated with that chemical. If nothing appears in Column 5, the amount in the water does not exceed the MCL, SMCL, or UMTRA standards.

If you have any questions regarding this information, please feel free to contact me at (970) 248-7612.

Sincerely,

Donald R. Metzler
Project Manager

Enclosure

cc w/enclosure:
W. Naugle, CDPHE

cc w/o enclosure:
R. Plienness, DOE-GJO
GWRFL 3.2.4 (record thru P. Taylor)

Figure 2 (continued). Example of Domestic Well Reporting

Table 1.

Water Quality Analytical Results
Well Number: 442

Unfiltered Well Water
Sample Date: 6/6/00

(1) Chemical	(2) Result	(3) Units	(4) EPA MCL SMCL UMTRA			(5) Exceeds?
Alkalinity as CaCO ₃	377	mg/L				
Ammonia as NH ₄	0.306	mg/L				
Arsenic	nd	mg/L	0.05		0.05	
Fluoride	0.19B	mg/L	4.0	2.0		
Manganese	0.113	mg/L		0.05		SMCL
Molybdenum	0.0044B	mg/L			0.1	
Nitrate	71.8	mg/L	44		44	MCL/UMTRA
Oxidation Reduction	125	mV				
Selenium	0.00054B	mg/L	0.05		0.01	
Specific Conductance	5150	µmhos/cm				
Temperature	21.6	C				
Total Dissolved Solids	4720	mg/L		500		SMCL
Turbidity	3.47	NTU				
Uranium	0.0585	mg/L	0.030		0.044	MCL/UMTRA
Vanadium	nd	mg/L				
pH	7.11	s.u.		6.5 - 8.5		

NOTE: nd = not detected; mg/L = milligrams per liter; NTU = nephelometric turbidity units; s.u. = standard units; mV = millivolts; µmhos/cm = micromhos per centimeter; C = degrees Centigrade; MCL = Maximum Contaminant Level; SMCL = Secondary Maximum Contaminant Level

Figure 2 (continued). Example of Domestic Well Reporting