ENTERED

DEPARTMENT OF THE AIR FORCE
27TH SPECIAL OPERATIONS CIVIL ENGINEER SQUADRON (AFSOC)
CANNON AIR FORCE BASE NEW MEXICO

AUG 03 2011

RECEIVED
AUG, 2011
NMED Hazardous Waste Bureau

Ronald A. Lancaster
Chief, Asset Management
506 N DL Ingram Blvd
Cannon AFB NM 88103-5003

Mr David Cobrain
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East Bldg 1
Santa Fe NM 87505-6063

Dear Mr Cobrain

Attached is the Work Plan for Monitoring Well Installation at Landfill No. 25 (LF-25/SWMU 97) at Cannon Air Force Base, New Mexico, Final, July 2011 for your review and approval.

If you have any questions regarding this submittal please contact our office at (575)784-1146 or 1092.

Sincerely

RONALD A. LANCASTER, REM, CHMM

Attachment:
Work Plan for Monitoring Well Installation at Landfill No. 25 (LF-25/SWMU 97), Cannon Air Force Base, New Mexico, Final, July 2011

cc:
Environmental Protection Agency, Region VI, Ms Wendy Jacques (w/o Attachment)

Work Plan for Monitoring Well Installation at Landfill No. 25 (LF-25/Solid Waste Management Unit [SWMU] 97)

Contract No. FA4890-04-D-0006, Task Order DK02
Project No. CZQZ20087600M

Final
July 2011

Prepared for:

27 SOCES/CEAN
Cannon Air Force Base, New Mexico

United States Army Corps of Engineers
Omaha District

Prepared by:

TETRA TECH

Tetra Tech, Inc.
143 Union Boulevard
Lakewood, Colorado 80228

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington Virginia 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, D.C. 20503.

1. AGENCY USE ONLY	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	July 2011	Work Plan for Monitoring Well Installation at Landfill No. 25 (LF-25/Solid Waste Management Unit [SWMU] 97), Cannon Air Force Base, New Mexico

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
Work Plan for Monitoring Well Installation at Landfill No. 25 (LF-25/Solid Waste Management Unit [SWMU] 97), Cannon Air Force Base, New Mexico	Contract No. FA4890-04-D-0006 Task Order DK02
6. AUTHOR Ms. Carol Rieger, Ms. Deborah Wilson	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Tetra Tech EC, Inc. 143 Union Blvd., Suite 1010 Lakewood, Colorado 80228	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers, Omaha District 1616 Capitol Avenue Omaha, Nebraska 68102	10. SPONSORING/ MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES:

This is a final report.

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

This Work Plan outlines the site-specific requirements to install one downgradient monitoring well at Landfill No. 25 (LF-25/Solid Waste Management Unit [SWMU] 97), Cannon Air Force Base (AFB), under the Environmental Restoration Program. The monitoring well will replace a well that can no longer be sampled as part of the biennial Long-Term Groundwater Monitoring (LTM) program at Cannon AFB because groundwater in the regional aquifer at that location is at an elevation lower than the bottom of the well screen (310 ft bgs). The total drilling depth will be approximately 350 feet. The new well will be monitored under the base's biennial LTM program in compliance with state requirements and included in the 2012 sampling event at the site.

14. SUBJECT TERMS	15. NUMBER OF PAGES
• Monitoring well installation • Landfill No. 25 (LF-25/SWMU 97) • Cannon Air Force Base, New Mexico	162 pages 16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	ABSTRACT

CONTENTS

Section **Page**

1. INTRODUCTION 1-1
   1.1 Background 1-1
   1.2 Cannon AFB Description and History 1-2
   1.3 Overview of Work Plan 1-2

2. SITE DESCRIPTIONS AND FIELD ACTIVITIES PLAN 2-1
   2.1 Project Rationale 2-1
   2.2 Site Description and History 2-1
   2.3 Monitoring Well Installation Scope of Work 2-2
      2.3.1 Mobilization and Demobilization 2-5
      2.3.2 Site Survey 2-5
      2.3.3 Monitoring During Field Investigation 2-6
      2.3.4 Equipment Decontamination 2-6
      2.3.5 Well Installation Methodology 2-7
      2.3.6 Drill Cuttings 2-9

3. QUALITY ASSURANCE/QUALITY CONTROL 3-1

4. DATA MANAGEMENT AND REPORTING 4-1
   4.1 Data Management Plan 4-1
      4.1.1 Overview 4-1
      4.1.2 Data Review 4-1
      4.1.3 Data Integrity and Rejected Data 4-2
      4.1.4 Database Management 4-2
   4.2 Reporting 4-2

5. INVESTIGATION-DERIVED WASTE MANAGEMENT 5-1
   5.1 Management and Characterization of Soils 5-1
   5.2 Management and Characterization of Decontamination Fluids and Well Development Water 5-2
   5.3 Management of Personal Protective Equipment and Plastic Sheeting 5-2

6. HEALTH AND SAFETY 6-1

7. PROJECT MANAGEMENT 7-1
   7.1 Project Team 7-1
   7.2 Schedule 7-1

REFERENCES R-1

APPENDICES

Appendix A Site-Specific Quality Assurance Project Plan
Appendix B Site Safety and Health Plan
Appendix C Standard Operating Procedures for Field Investigations
Appendix D Application for Permit to Drill an Exploratory Well

FIGURES

Figure **Page**

Figure 1. Site Location Map 1-3
Figure 2. Proposed Well Location Map at Landfill No. 25 (LF-25/SWMU 97) 2-3
Figure 3. Project Team Organization 7-3

TABLES

Table **Page**

Table 1. Summary of Investigation-Derived Waste Streams 5-1
Table 2. Responsibilities of Key Project Personnel 7-4
Table 3. Field Project Schedule 7-6

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFSOC	Air Force Special Operations Command
ARCH	air rotary casing hammer
bgs	below ground surface
DQO	data quality objective
DQCR	Daily Quality Control Report
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
ft	feet/foot
IDW	investigation-derived waste
LTM	Long-Term (Groundwater) Monitoring
LF-25	Landfill No. 25
MCL	Maximum Contaminant Level
M&M	Monitoring and Maintenance
NCR	Nonconformance Report
NFA	No Further Action
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SVOC	Semivolatile Organic Compound
SSHP	Site Safety and Health Plan
SWMU	Solid Waste Management Unit

ACRONYMS AND ABBREVIATIONS (CONCLUDED)

USACE	U.S. Army Corps of Engineers
USSOCOM	United States Special Operations Command
WQCC	Water Quality Control Commission

1. INTRODUCTION

This Work Plan presents the site-specific rationale, strategies, and procedures for drilling and installing one downgradient monitoring well at a location administered under the Environmental Restoration Program at Cannon Air Force Base (AFB), New Mexico. The monitoring well, MW-Rb, will be installed at Landfill No. 25 (LF-25)/Solid Waste Management Unit (SWMU) 97, an inactive landfill located in east-central portion of Cannon AFB (Figure 1). The monitoring well installation will achieve the following objectives:

- Replace downgradient well MW-Ra at LF-25. This well can no longer be monitored as part of the Cannon AFB biennial Long-Term Groundwater Monitoring (LTM) program because groundwater in the regional aquifer at this location is at an elevation lower than the bottom of the well screen, 310 feet (ft) below ground surface (bgs).
- Allow for future monitoring of LF-25 in compliance with New Mexico Environment Department (NMED) requirements.

To support the biennial LTM program at LF-25, downgradient monitoring well MW-Rb will be installed to a maximum depth of approximately 350 ft bgs. Evaluation of the length of saturated screen in MW-Ra as determined from water level measurements and observed rate of water level decline in the regional aquifer suggests that the groundwater level at this location is on a continuing downward trend that will not recover. The new well will be monitored in compliance with NMED requirements and included in the 2012 biennial sampling event at the site. This work will be performed under the authority of the U.S. Army Corps of Engineers (USACE), Contract No. FA4890-04-D-0006, Task Order DK02.

1.1 Background

In 2006 a petition for No Further Action (NFA) under NMED criterion 5 and a Class III permit modification was requested for LF-25 in the *Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) Report for Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), and Landfill No. 25 (LF-25/SWMU 97)* (HGL, 2006). NMED approved the report but directed Cannon AFB to perform additional monitoring and inspection activities at these sites. In response Cannon AFB developed a Monitoring and Maintenance (M&M) Plan (Tetra Tech and Brown, Burdine, & Associates, LLC, 2009) to address biennial groundwater monitoring requirements at LF-25. Groundwater monitoring was conducted at downgradient wells MW-Pa and MW-Ra in 2008 and 2010 in accordance with the M&M Plan. However, during the 2010 monitoring event insufficient water was present in well MW-Ra to collect a groundwater sample (Tetra Tech and Trinity, 2010).

Hydrographs for wells MW-P/Pa and MW-Ra show that groundwater levels have steadily decreased at LF-25 since gauging was initiated in 1995 and 2001, respectively. Over the 6-year period from 2004 to 2010 regional water levels declined at a rate of 1.8 ft per year in MW-Ra and 2.2 ft per year in MW-Pa (Tetra Tech and Trinity, 2010). This scenario is corroborated by hydrologic studies conducted by the U.S. Geological Survey (USGS, 2006) that indicate water levels in the Southern High Plains aquifer (Ogallala Formation) are declining beneath the base. Evaluation of the length of

saturated screen in MW-Ra as determined from water level measurements and observed rate of water level decline in the regional aquifer suggests that the groundwater level at this location is lower than the bottom of the well screen (310 ft bgs). These data explain why MW-Ra was dry in 2010 and support the need to install a replacement well to continue monitoring downgradient of LF-25 in compliance with NMED requirements.

1.2 Cannon AFB Description and History

Cannon AFB is located approximately 6 miles west of the community of Clovis, New Mexico, on approximately 3,782 acres of land (Figure 1). The majority of the base is bound to the north by U.S. Highway 60/84 with the exception of a housing area that is located north of the highway. The remaining areas bordering the base are utilized as farmland and the occasional residential home.

Prior to the existence of the base, the primary land usage of the area was as farmland. In 1929 Portair Field was established on the land as a transcontinental air terminal. In 1942, the Department of Defense took control of Portair Field and re-named it as Clovis Army Air Base. Clovis Army Air Base was subsequently closed in 1947.

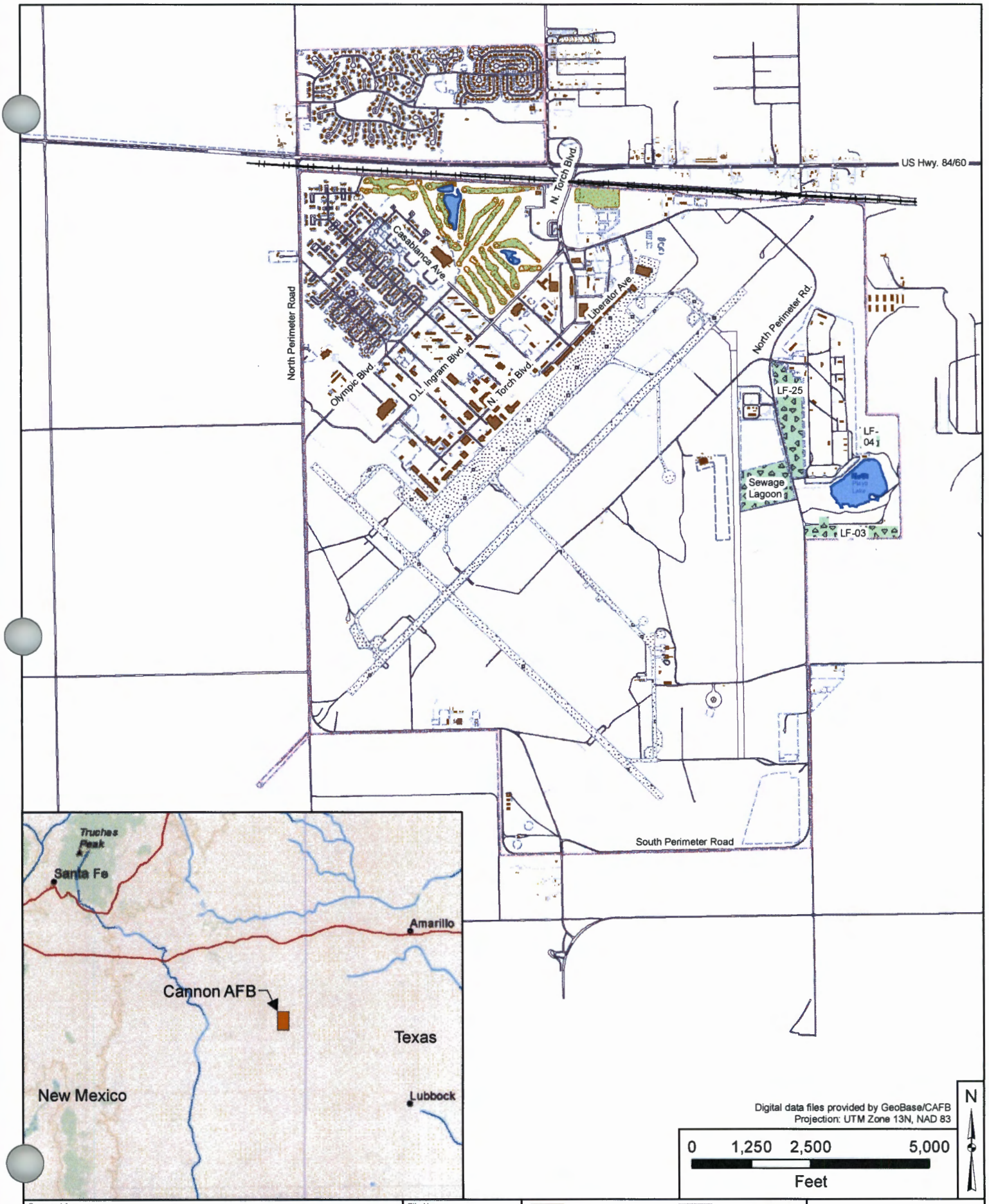
In 1951, the Air Base was reopened and assigned to the Tactical Air Command as Clovis Air Force Base. In 1957, the base was renamed Cannon AFB. From the 1960s until 2007, Cannon AFB was part of the Tactical Air Command or Air Combat Command and home of the 27th Fighter Wing. In May 2005, the Base Realignment and Closure Commission recommended to the Secretary of Defense to close Cannon AFB. Subsequently, a final report (September 2005) from the Commission to the President recommended Cannon AFB remain open as an enclave until at least December 2009 and that the 27th Fighter Wing be disestablished. In the interim, the Secretary of Defense was to seek other missions for assignment to Cannon AFB.

As a result of this search, the Air Force Special Operations Command (AFSOC) was designated as the new mission for Cannon AFB in 2007. AFSOC is headquartered at Hurlburt Field, Florida. AFSOC is a Major Command and the Air Force component of United States Special Operations Command (USSOCOM), a unified command located at MacDill AFB, Florida. AFSOC is responsible to USSOCOM for the readiness of Air Force Special Operations Forces for worldwide deployment. AFSOC is composed of highly trained, rapidly deployable airmen who are equipped with highly specialized aircraft. These forces provide global ability to conduct special operations missions ranging from precision application of firepower, to infiltration, exfiltration, resupply, and refueling of operational elements. Cannon AFB will provide AFSOC dedicated installation, range facilities, and training airspace for special operations forces to achieve and maintain skills.

1.3 Overview of Work Plan

This Work Plan is structured to address the major issues that relate to installing the proposed monitoring well at LF-25. Cross-references are used throughout this document to direct the reader to the appropriate section that addresses related requirements to a particular activity or aspect of work. The Work Plan is organized as follows:

- Section 1 presents an introduction to the project and an overview of the Work Plan and summarizes pertinent background information for the site.



Prepared for: ***Cannon Air Force Base, New Mexico***	File Name: Figure1.mxd	Existing Building / Airfield Surface / ERP Sites/SWMUs	Figure 1 Site Location Map
Project: LF-25 Well Installation	Date of Issue: 06/13/2011		

This page intentionally left blank.

- Section 2 presents site descriptions, project rationale, and an overview of the site-specific monitoring well installation activities. The general approach to implementing field investigation activities is discussed. The respective proposed activities are described in detail.
- Section 3 addresses the quality assurance/quality control (QA/QC) program that will be implemented for the project.
- Section 4 describes data management and reporting requirements for the project.
- Section 5 represents the project-specific Investigation-Derived Waste (IDW) Management Plan.
- Section 6 references health and safety issues that are specific to the site, activities, and contaminants associated with the monitoring well installation.
- Section 7 discusses project management issues related to planned work activities. An organization chart and project schedule are presented.

Four appendices accompany this Work Plan. Appendix A, the site-specific Quality Assurance Project Plan (QAPP), provides detailed information relative to the project-specific data quality objectives (DQOs), data assessment, reporting, control of nonconforming conditions, and corrective action. Appendix B, the Site Safety and Health Plan (SSHP), addresses site-specific as well as activity-specific hazards based upon available chemical data, site background information, and proposed field activities. Appendix C contains the Standard Operating Procedures (SOPs) and forms that will be used to implement and document monitoring well installation and development activities. Appendix D presents the Application for Permit to Drill an Exploratory Well that will be submitted to the Office of the State Engineer for approval.

This page intentionally left blank.

2. SITE DESCRIPTIONS AND FIELD ACTIVITIES PLAN

2.1 Project Rationale

Proposed monitoring well MW-Rb will be installed at LF-25 to replace well MW-Ra, which requires monitoring under the biennial LTM program. MW-Ra can no longer be sampled or gauged because groundwater associated with the regional aquifer is at an elevation below the bottom of the well screen (310 ft bgs). The total depth of drilling for the replacement well will be approximately 350 ft and is based on the estimated depth required to replace well MW-Ra. The replacement well will be installed within 100 ft of MW-Ra and within the perimeter fence of LF-25 in a location that does not compromise the existing vegetative cover. Figure 2 shows the boundary of LF-25/SWMU 97 and the proposed location of monitoring well MW-Rb.

2.2 Site Description and History

This section provides a brief background and history of LF-25. LF-25 is an inactive construction debris landfill located in the east-central portion of Cannon AFB. The former landfill covers a 32-acre area roughly trapezoidal in shape, located east of Perimeter Road and approximately 500 ft northwest of Playa Lake. A detailed summary of the site's background and history, results of previous investigations, corrective measures, and current status is presented in the 2006 RFI Report (HGL, 2006).

From about 1945 through the 1980s, LF-25 was used as a waste disposal site although it is unknown when disposal activities ceased. After World War II, construction demolition debris was disposed of in the landfill. The debris consists of concrete, wood, asbestos tiles, metal, transite/cement pipe, and asphalt mixed with soil. Concrete pieces are of various sizes and shapes from demolition of buildings and pavement (runways) at Cannon AFB. Debris extended approximately 3 to 4 ft above natural grade over most of the site, reaching a maximum of approximately 15 ft above natural grade at the northern end of the site.

In December 1990, the USACE performed a site environmental assessment. Trenches were excavated at nine locations and waste and native soil samples were collected for laboratory analysis. Excavation revealed the majority of the material in the debris pile was airfield paving and sub-grade material, followed by building demolition debris. In addition, glass, metal cinders, ash, and other burned material were encountered in what appeared to be burn trenches. Minor concentrations of metals (barium, mercury, and cadmium) and one semivolatile organic compound (SVOC) (benzedine) were detected in the trench samples (USACE, 1991). In 1992, 139 field samples were analyzed during additional site characterization. One surface sample exceeded the soil action level for lead, and one sample exceeded regulatory carcinogenic action levels for SVOCs benzo(a)pyrene and benzo(b)fluoranthene (Woodward-Clyde 1992). Concentrations of all organic compounds were below regulatory noncarcinogenic soil action levels. In 1992, metals concentrations below maximum contaminant levels (MCLs) were detected in a monitoring well sample (Woodward Clyde, 1992).

Only minor impacts to soil were identified at LF-25 during the Appendix I, Phase I RFI (Radian, 1994), and the site was recommended for NFA status and Class III permit modification. U.S. Environmental Protection Agency (EPA) Region 6 accepted the RFI but directed Cannon AFB to

monitor well MW-K, which was installed downgradient of the debris pile. Monitoring began in June 1997, but the well was abandoned and replaced by MW-R in 1998 after it could no longer be sampled due to declining water levels in the regional aquifer. Well MW-R was sampled semiannually until December 2000. However, elevated metals concentrations detected in MW-R groundwater samples were attributed to corrosion of the well's stainless-steel well screen, and the well was replaced with a polyvinyl chloride (PVC)-constructed well, MW-Ra, in June 2001 (Bhate, 2002). Well MW-Ra is located approximately 30 ft north and sidegradient from the abandoned well MW-R. Groundwater monitoring was also conducted at well MW-P, which was abandoned and replaced by well MW-Pa in February 2004. No constituents have been detected at concentrations exceeding EPA or state groundwater standards in any of the downgradient compliance wells.

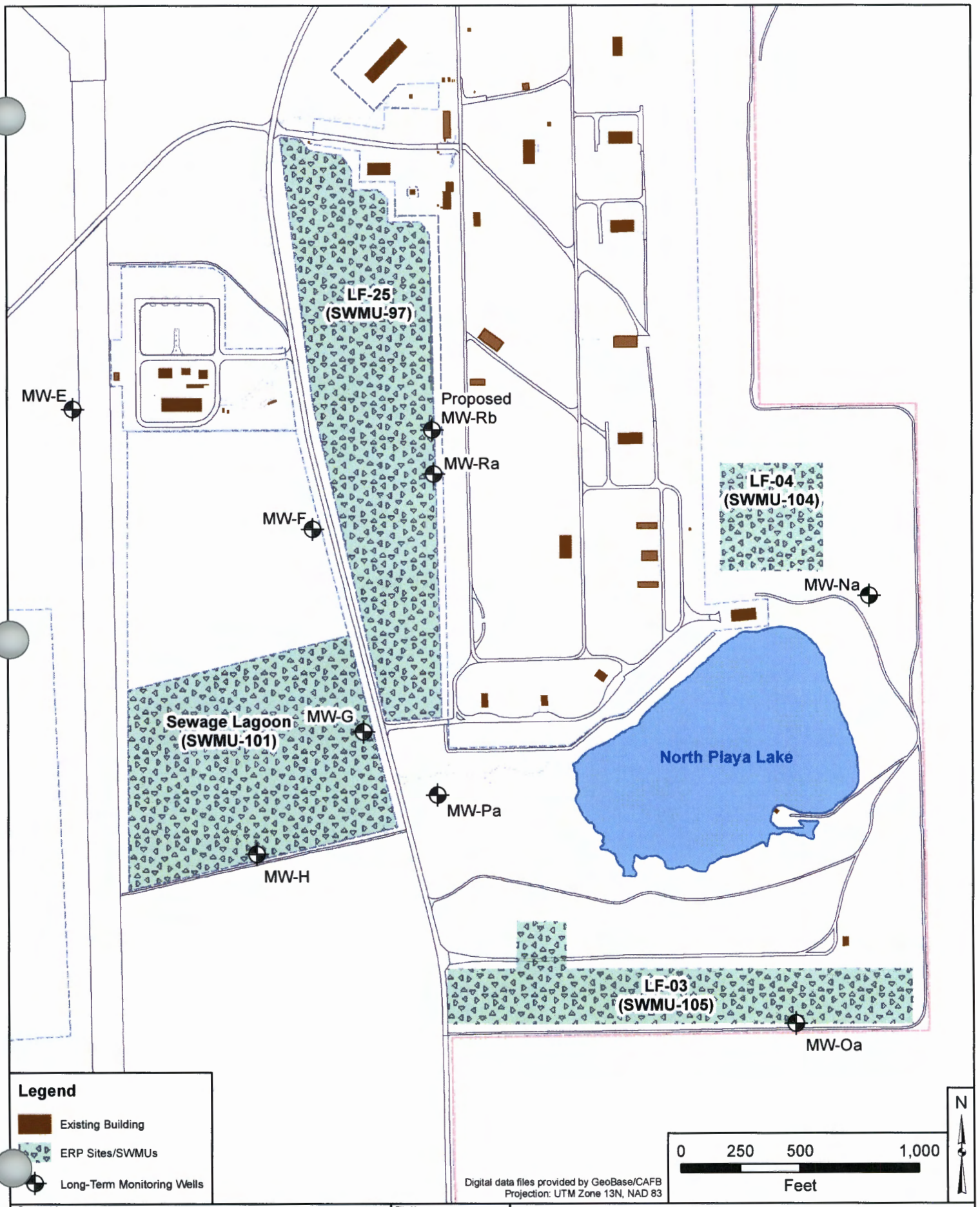
In 2001 exposed non-friable asbestos-containing material was observed at the site. Remediation activities associated with removal of asbestos and concrete debris were conducted in 2000 (Foster Wheeler, 2001). The site was graded and a 2-ft-high permanent earthen berm was constructed along the landfill's southern and eastern edges to prevent stormwater runoff from leaving the site. A 6-inch-thick topsoil cover was installed and the site was revegetated. A three-strand barbed-wire fence with gates and signage was installed around the perimeter of the site to control access.

Cannon AFB submitted a NFA petition for LF-25 under NMED criterion 5 and a Class III permit modification in 2006 (HGL, 2006). NMED approved the report but specified additional monitoring and inspection requirements for the site, which are being implemented under the Cannon AFB M&M Plan. Biennial sampling events were conducted at two downgradient wells, MW-Ra and MW-Pa, in 2008 (Tetra Tech and Brown, Burdine, & Associates, LLC, 2008) and 2010 (Tetra Tech and Trinity, 2010). However, during the 2010 monitoring event insufficient water was present in well MW-Ra to collect a groundwater sample.

The 2010 Biennial LTM Report provides a map of the potentiometric surface and hydrographs for LF-25. Based on the potentiometric surface, the groundwater flow direction generally follows surface topography, moving in a southeasterly trend across the base. Hydrographs for wells MW-P/Pa and MW-Ra indicate that groundwater levels have been steadily decreasing since well gauging began in 1995 and 2001, respectively. This steady decrease in groundwater elevations across the site accounts for the lack of water in MW-Ra, and substantiates the need to replace this well to support the biennial LTM program for LF-25.

2.3 Monitoring Well Installation Scope of Work

This section represents the Field Activities Plan for monitoring well installation at LF-25. It provides, in conjunction with the site-specific QAPP (Section 3 and Appendix A), SOPs (Appendix C), and application for permit (Appendix D), the information necessary to satisfy the well installation requirements for this project.



Prepared for: ***Cannon Air Force Base, New Mexico***	File Name: Figure2.mxd	Figure 2 Proposed Well Location Map at Landfill No. 25 (LF-25/SWMU 97)
Project: Cannon Air Force Base	Date of Issue: 06/13/2011	

This page intentionally left blank.

2.3.1 Mobilization and Demobilization

This task consists of field personnel orientation, equipment mobilization, identification of the installation location, and demobilization. Each field team member will attend an onsite orientation detailing the site-specific health and safety requirements as outlined in the attached SSHP (Appendix B). This orientation will also include a review of all applicable field activity procedures.

Mobilization activities include procuring field equipment and subcontractors, obtaining underground utility clearance, securing required passes and permits for the field crew, and performing site restoration, waste management, and waste disposition activities.

Prior to beginning field work, two permits will be obtained and approved:

- ***Dig Permit***—This permit is issued by Cannon AFB and will be obtained for the area where field activities will take place. The Dig Permit will be approved by Cannon AFB points of contact regarding the locations of underground utilities including water, natural gas, communications, and electrical lines. The locations of the underground lines will be marked at the surface to prevent encountering these utilities during drilling operations. The Dig Permit will be kept on site each day during drilling operations.

- ***Exploratory Well Drilling Permit***—This permit is obtained from the New Mexico Office of the State Engineer for the drilling of exploratory wells such as monitoring wells. An application for this permit will be submitted by Cannon AFB, and approval will be received from the state prior to the commencement of drilling. Information in this permit includes the proposed well location and well construction information. A copy of the Application For Permit To Drill An Exploratory Well is presented in Appendix D.

Equipment will be demobilized at the completion of each phase of field activities as necessary. Decontamination of equipment for demobilization purposes is outlined in Section 2.3.4.

2.3.2 Site Survey

Topographic mapping has been completed at LF-25. Survey data will be recorded upon completion of the well installation as specified in SOP C4, *Land Surveys* (Appendix C).

- ***Monitoring Well***—Coordinates and elevations will be established for the monitoring well. The monitoring well location will be surveyed to the closest 0.10 ft and referenced to the New Mexico State Plane Coordinate System using the North America Datum for 1983. The ground elevation of the monitoring well will be determined to the nearest 0.10 ft and an elevation for the top of the well riser to the closest 0.01 ft. The elevations will be referenced to the North American Vertical Datum of 1988. Positions and coordinates of permanent points within the control traverse will be identified on a site map and tied to the nearest site benchmark.

- ***Documentation***—The location, identification, coordinates, and elevations of the well and associated monuments will be plotted on a map at a scale large enough to show the location of the well in relation to other structures at the site. A tabulated list of the monitoring well and monuments coordinates, copies of field books, and computation sheets will be prepared.

The tabulation will consist of the designated number of the well or monument, the State Plane easting and northing coordinates, and elevation.

2.3.3 Monitoring During Field Investigation

No monitoring is anticipated during the installation of the well. Field headspace screening will be conducted if staining or other indicator of contamination is encountered during operations. If required, the screening will be conducted upwind of the well using a photoionization detector.

2.3.4 Equipment Decontamination

Equipment involved in field activities will be decontaminated prior to, and at the completion of, well installation activities. Decontamination procedures are outlined in SOP C5, *Equipment Decontamination (*Appendix C); project-specific guidelines are presented below.

2.3.4.1 Specifications for Cleaning Materials

1. Use a standard brand of phosphate-free laboratory detergent, either liquid or powder, such as Liquinox® or Alconox®.

2. Use tap water from any municipal water treatment system or use bottled drinking water.

3. Perform a final rinse with deionized water.

2.3.4.2 Handling and Containers for Cleaning Solutions

Containers shall be constructed of the proper materials to ensure their integrity. The following containers shall be used for storing the specified cleaning materials:

- Soap—Keep in clean containers until use. Detergents shall be poured directly from the container into the wash bucket or tub.

- Tap water—Keep in clean tanks, hand-pressure sprayers, or squeeze bottles or apply directly from a hose.

- Deionized water—Store in clean containers that can be closed when not in use. Deionized water may be applied from squeeze bottles.

2.3.4.3 Decontamination of Large Equipment

The following steps shall be followed to decontaminate large pieces of equipment such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location and that may come into contact with casing, auger flights, pipe, or rods:

1. Wash the external surfaces of equipment with high-pressure hot water and Alconox® or equivalent non-phosphate, laboratory-grade detergent if necessary. Also, if necessary, scrub the equipment until visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The inside surfaces of the casing and drill rod flights shall also be washed as described above.

2. Rinse with tap water.

3. Implement this decontamination procedure prior to and at the conclusion of well installation activities.

Whenever possible, decontamination pads provided by Cannon AFB shall be used to clean large equipment. In other instances, a decontamination pad may need to be constructed at the investigation site. Use of a Cannon AFB decontamination pad will be coordinated to avoid delays and mixing of decontamination IDW from other projects.

2.3.4.4 Personal Protective Equipment

Personnel directly involved in equipment decontamination shall wear appropriate personal protective equipment (PPE) as specified in the SSHP (Appendix B).

2.3.5 Well Installation Methodology

Monitoring well installation will be completed as an overburden well with surface completion under the general guidance outlined in SOP C2, *Monitoring Well Installation* (Appendix C). See Figure C2-1 for details. Any deviations from SOP C2 are presented in the procedure described below. Appendix C includes the well construction diagrams and required field logs to be completed by the Field Geologist during installation (soil boring and well development logs). Continuous soil logging will be completed for the installation in accordance with SOP C1, *Borehole and Sample Logging* (Appendix C). However, no soil samples will be collected for laboratory analysis. Drilling and installation of the well will be achieved using an air rotary casing hammer (ARCH) drilling rig with a 950 cubic feet per second, 350 pounds per square inch, on-board air compressor, or equivalent.

The following procedure will be implemented during monitoring well installation and development:

1. Drill the borehole to the total appropriate depth for the regional aquifer using the ARCH drilling rig. The appropriate depth will be determined in the field and is dependent on the occurrence of significant water. If significant groundwater is encountered during drilling, drilling will cease, and the hole will be allowed to equilibrate for approximately 1 hour. If a determination is made that the target aquifer (regional) has been reached, well installation will be completed within this zone. Approximate depth to be drilled is 350 ft bgs.

2. Well construction will require 4-inch, flush-threaded Schedule 80 PVC casing and 30 ft of 0.01-inch Schedule 80 slotted screen with a 6-inch PVC screw-on end cap.

3. The borehole will be drilled with 11 ¾-inch outer-diameter drive casing to 200 ft bgs. Collect and log soil cuttings at 5- to 10-ft intervals or at changes in lithology. Cutting samples for lithologic logging will be collected from the cyclone. Install 9 5/8-inch casing inside the 11 ¾-inch casing and advance the 9 5/8-inch casing to the desired depth of the completed well. Soil cuttings will be collected and logged at 5- to 10-ft intervals or at changes in lithology.

4. Use 30 ft of 0.01-inch PVC slotted screen and blank casing to the top of the well stick-up. The top of the screened interval will be set at the existing water table. No sump will be used at the bottom of the well. Centralizers will be installed at 40-ft intervals and at the top and bottom of the screened interval.

5. Once the drill casing has been slowly removed from the borehole, seat the capped screen and casing at the bottom of the borehole. Using a tremie pipe, fill the annular space from the bottom of the borehole to a minimum of 2 ft above the well screen with a filter pack (10/20 silica sand). The filter pack will be placed using a tremie pipe to avoid bridging and ensure a continuous filter pack throughout the screened interval of the well. Next, a bentonite chip or pellet seal will be installed for a thickness of 10–20 ft and hydrated every 1 ft per manufacturer instructions to ensure a competent seal. Installation of a thicker bentonite seal is currently used for monitoring wells at the base to ensure that there will be no intrusion of grout from above the seal with the filter pack material below the seal.

6. In the event of overdrilling the borehole to a depth greater than necessary, backfilling of the borehole will be required prior to setting the well screen and casing. Once the drill casing has been slowly removed from the borehole, backfill the borehole to the desired depth at which the capped screen and casing will be seated. Proceed with the installation of the filter pack and the bentonite seal as illustrated previously in Step 5.

7. After allowing a minimum of 4 hours for the bentonite seal to set, install a 20 percent high solids bentonite grout slurry over the bentonite seal using a tremie pipe. The slurry will consist of 20 percent by weight of sodium bentonite powder. Install the slurry to within 30 ft of the surface. The high-solids bentonite grout slurry is currently and successfully used for well installation at the base to inhibit intrusion of grout into the well's filter pack and screen.

8. To the surface, install a cement/bentonite grout mixture over the high-solids bentonite grout using a tremie pipe. The mixture will consist of 94 pounds of Portland cement to 7 gallons of approved water and 3 percent by weight of sodium bentonite powder.

9. Install an 8-inch by 5-ft protective steel casing and a 4-ft by 4-ft by 4-inch concrete pad mounded in such a way as to direct surface runoff from the casing. Install four 4-inch-diameter by 5-ft long steel bollards around each well on the outside of the concrete pad. Drill a drain hole in the protective casing above the concrete surface. If appropriate, the finished pad must be designed to resist damage caused by frost heaving.

10. Leave an approximate stick-up height of 3 ft for the protective steel casing with the inside well PVC casing a minimum of 6 inches below this to allow for storage of tubing to be used with a non-dedicated pump or to accommodate a dedicated pump system.

11. The well will be equipped with a security lock. The well will be tagged with a corrosion-resistant identification stamped on the protective casing which identifies the well number, depth, date of installation, and the adjusted top of casing elevation. The well will also be clearly designated as a monitoring well. The casing will be coated with protective paint the same color as the other wells on the site.

12. After completion of the well a well alignment test to verify plumbness and integrity of well is recommended. The recommended method to test well plumbness and alignment is as follows:

- A 10-ft-long section of pipe, ½ inch less in diameter than the inner diameter of the well riser pipe, shall be run through the entire length of the well to check the alignment. The result of such test shall be recorded on the Daily Quality Control Reports (DQCRs) and the well installation diagram. The pipe section shall be decontaminated with steam prior to the test. Adequate precautions shall be taken to prevent cross-contamination of wells with cable or rope used to conduct the test.

- The pipe must pass freely for the entire depth of the well.

13. After well installation and a minimum of 48 hours after grout installation, develop the well by swabbing, bailing, and pumping for a minimum of 4 hours or greater until parameters have stabilized and turbidity is less than 100 Nephelometric Turbidity Units as per procedures in SOP C3, *Monitoring Well Development* (Appendix C) in order to remove the suspended solids and optimize the well efficiency. Following waste characterization as described in Section 5.2, the nonhazardous development and purge water will be disposed of by discharging directly to the ground surface at the well head.

The remaining details on well logging, completion, and development will be in accordance with procedures presented in SOPs C1, *Borehole and Sample Logging*; C2, *Monitoring Well Installation*; and C3, *Monitoring Well Development* (Appendix C).

2.3.6 Drill Cuttings

The saturated and unsaturated soil cuttings from the borehole will be placed on 8-mil plastic sheeting and stockpiled adjacent to the drilling location. The cuttings will be allowed to dry and then spread on the ground in the vicinity of the well following waste characterization as described in Section 5.1.

Plastic sheeting used for stockpiling of drill cuttings will be disposed with other PPE as described in Section 5.3.

This page intentionally left blank.

3. QUALITY ASSURANCE/QUALITY CONTROL

Appendix A contains the site-specific QAPP for well installation at LF-25. Specific elements addressed within Appendix A include:

- Project-specific DQOs
- Equipment calibration
- Data review, assessment, and reporting
- Field QA/QC
- Reports to management
- Control of nonconformances and corrective action

This page intentionally left blank.

4. DATA MANAGEMENT AND REPORTING

4.1 Data Management Plan

4.1.1 Overview

This section describes the procedures that will be used to manage data generated during installation of monitoring well MW-Rb at LF-25. The objective of the plan is to ensure that project data are usable for their intended purpose and are consistent, accurate, accessible, traceable, and defensible. Effective implementation of this plan will ensure that:

- All field activities generating environmental data are performed in accordance with approved plans.
- Field parameter, boring log, geologic classification of soil cuttings, and well location and elevation data are of the appropriate type and are of known, acceptable, and defensible quality needed for their intended use.
- Data review and assessment activities are performed consistently.
- Data reporting and data presentation meet project requirements.
- Data transfers and data archives are performed in a systematic manner.
- Data are tracked from the time of acquisition through final disposition.

Established Environmental Restoration Program Information Management System (ERPIMS) formats and guidelines will be followed for the formatting and submittal of well installation data generated from this project. Data will be generated from several sources, including geological classification of cuttings, borehole logging, surveying, and well installation and development. The ERPIMS file structures for these data types are described in Section 4.1.4.

All data will be reviewed to ensure that approved procedures are followed; measuring and test instruments are calibrated; and appropriate documentation is maintained, including field records. Data will be organized and presented in a clear logical format, consisting of tabular and graphical displays, statistical analysis, etc., according to the needs of the end users. End uses of the data are described as DQOs. Data review and assessment, identification of project DQOs, recordkeeping procedures, and QA/QC processes are described in Section 3 and the site-specific QAPP (Appendix A).

4.1.2 Data Review

All data generated during the well installation will be reviewed to ensure that:

- Proper field procedures are implemented.
- Appropriate documentation is available for each activity.
- Field instruments are calibrated as required.
- Numerical value and units of each field measurement are documented.

- Field equipment is decontaminated as specified.
- Data completeness objectives are met.

4.1.3 Data Integrity and Rejected Data

Data integrity is essential and will be maintained at all times. Data will not be altered at any time for any reason other than to correct data entry errors. Procedures to be implemented to correct records are described in the site-specific QAPP (Appendix A). Any deficient condition that may potentially affect data quality or the quality of work products will be addressed by the Task Order Manager, discussed with the field personnel, and corrected immediately upon discovery. Assessment, control of nonconformances, corrective action, and reports to management are discussed in the site-specific QAPP.

4.1.4 Database Management

ERPIMS is the Air Force system for validation and management of data from environmental projects at all Air Force bases in a central repository. The database contains analytical chemistry data as well as hydrogeological information, site/location descriptions, and monitoring well information.

ERPTools X is the latest generation of the ERPIMS software developed for distribution to contractors, including prime contractors and laboratories, to assist them in preparing ERPIMS data submissions. The data are submitted via electronic files with a transmittal letter to the ERPIMS web site as identified in the current version of the ERPIMS Data Handbook, and processed against validation rules developed by the Air Force Center for Engineering and the Environment to ensure the integrity of the data. Once these data have passed the required integrity checks and balances, they are loaded into the central data repository (i.e., database) for use by environmental remediation contractors and base personnel. Since this event includes well installation and borehole logging, the following files will be submitted:

- Location Definition (LDI)
- Well Completion Information (WCI)
- Well Interval (WINT)
- Lithologic Description (LTD)
- Groundwater Level Data (GWD)

No analytical samples will be collected during well installation.

4.2 Reporting

Reporting for this project will consist of a narrative completion report providing the following information based on the execution of the field program:

- Drilling and installation details for the well including boring log and well construction forms
- Groundwater elevation measurement
- Survey information
- Explanations on any deviations from the Work Plan including field change requests
- Waste characterization and management information for waste streams generated

The well installation completion report will be submitted in two versions, including a draft version that will be reviewed by Cannon AFB and USACE. The final completion report will be revised based on comments received on the draft report.

This page intentionally left blank.

5. INVESTIGATION-DERIVED WASTE MANAGEMENT

The IDW Management Plan describes the procedures to store, handle, characterize, and dispose of IDW generated during installation of monitoring well MW-Rb at LF-25. Table 1 presents a summary of IDW waste streams for all planned installation activities. The nature and type of waste streams associated with this project are anticipated to be the same as those generated while installing well MW-Ra at this location. Waste characterization will therefore be based on existing analytical data and knowledge of site conditions in accordance with 40 Code of Federal Regulations 262.11 and New Mexico Administrative Code (NMAC) regulations, which require the generator to determine whether a waste is a listed, characteristic, or special waste. Waste minimization techniques will be employed where possible to reduce the quantity of IDW generated.

Table 1. Summary of Investigation-Derived Waste Streams

Activity	Waste Stream
Drilling	PPE Soil cuttings Decontamination water Decontamination sediment/sludge
Well Development	PPE Development and purge water Decontamination water

5.1 Management and Characterization of Soils

The following are general procedures to be followed when managing soil generated from well installation activities:

- ***Soil Cuttings***—Soil cuttings will be placed on 8-mil plastic and allowed to dry. Characterization of the cuttings will be through generator knowledge based on known site conditions reported during installation of well MW-Ra. Site history and chemical analytical results from previous investigations indicate that soil characterized as special waste or hazardous waste will not be encountered or generated during drilling operations at this location. The boring log and geological classification of cuttings produced during drilling of MW-Rb will be compared to the boring log and cuttings description reported during installation of well MW-Ra to confirm that the same lithology/stratigraphic column is present at the proposed location and geological and hydrological conditions have not changed since 2001. Based on characterization of the waste stream as nonhazardous the dried cuttings will be spread on the ground in the vicinity of the well head.

- ***Gross Decontamination Residues***—Gross decontamination soil residues generated from the decontamination of the drill rig and vehicles are not anticipated during the well installation activities. However, in the event soil residues are generated, they will be removed from vehicles during gross decontamination. Whenever possible, decontamination pads provided by Cannon AFB shall be used to clean large equipment. In other instances, a decontamination pad may need to be constructed at the investigation site. Use of a Cannon AFB decontamination pad will be coordinated to avoid delays and mixing of decontamination IDW from other projects. Gross decontamination residues, if generated,

will be managed and characterized as a separate waste stream, but are anticipated to be nonhazardous based on generator knowledge. If residues attributable to downhole activities are generated, they will be segregated from gross residues and combined with soil cuttings for disposal.

5.2 Management and Characterization of Decontamination Fluids and Well Development Water

Well MW-Rb will be installed to replace existing well MW-Ra that is dry as a result of declining groundwater levels in the regional aquifer at that location. Characterization of wastewater generated through well development and decontamination procedures will be through generator knowledge gained from construction, development, and sampling of the original well MW-Ra.

Evaluation of groundwater analytical results from well MW-Ra show that detected constituent concentrations were less than corresponding EPA MCLs or New Mexico Water Quality Control Commission (WQCC) standards (20.6.2.3103, NMAC) during all sampling events. Groundwater analytical results for samples collected under the biennial LTM program at well MW-Ra are presented in the 2008 and 2010 Biennial LTM Reports (Tetra Tech and Brown, Burdine, & Associates, LLC, 2008; Tetra Tech and Trinity, 2010).

Based on generator knowledge of site conditions at the proposed location gathered from installation and groundwater sampling of well MW-Ra, wastewater generated during well development and decontamination is anticipated to be nonhazardous. Wastewater characterized as nonhazardous will be discharged directly to the ground surface in the vicinity of the drilling location upon generation.

To minimize waste, decontamination fluids will be allowed to evaporate within the decontamination pad immediately after generation. The decontamination pad sheeting will be disposed of in the same manner as PPE.

5.3 Management of Personal Protective Equipment and Plastic Sheeting

Based on site conditions known from investigation of soil and installation and sampling of well MW-Ra, PPE and plastic sheeting used to stockpile soil cuttings are not anticipated to be hazardous waste. All PPE and plastic sheeting characterized as nonhazardous will be placed in double plastic trash bags and sealed. These items will be disposed of in dumpsters located on base.

6. HEALTH AND SAFETY

An addendum to the *Final Basewide Health and Safety Plan* (Foster Wheeler, 2000) is presented in Appendix B. The SSHP addresses site-specific information for monitoring well installation at LF-25, including activity hazard analysis, job safety analysis, monitoring, and PPE. The *Basewide Health and Safety Plan* shall be referenced for all other safety and health issues.

This page intentionally left blank

7. PROJECT MANAGEMENT

This section describes the project team and schedule for the LF-25 monitoring well installation.

7.1 Project Team

Figure 3 depicts an organization chart for the project. Descriptions of key personnel roles and responsibilities are presented in Table 2.

7.2 Schedule

Table 3 presents the project schedule for the LF-25 monitoring well installation. Activities have been scheduled assuming the shortest possible duration. Equipment will be moved in a logical sequence as the needs of the project dictate. If site or project conditions warrant change, the schedule will be reevaluated to address the changes with the objective of completing the project within the overall project duration currently envisioned. The USACE and Cannon AFB will approve the revised schedule prior to implementation.

This page intentionally left blank

Figure 3. Project Team Organization

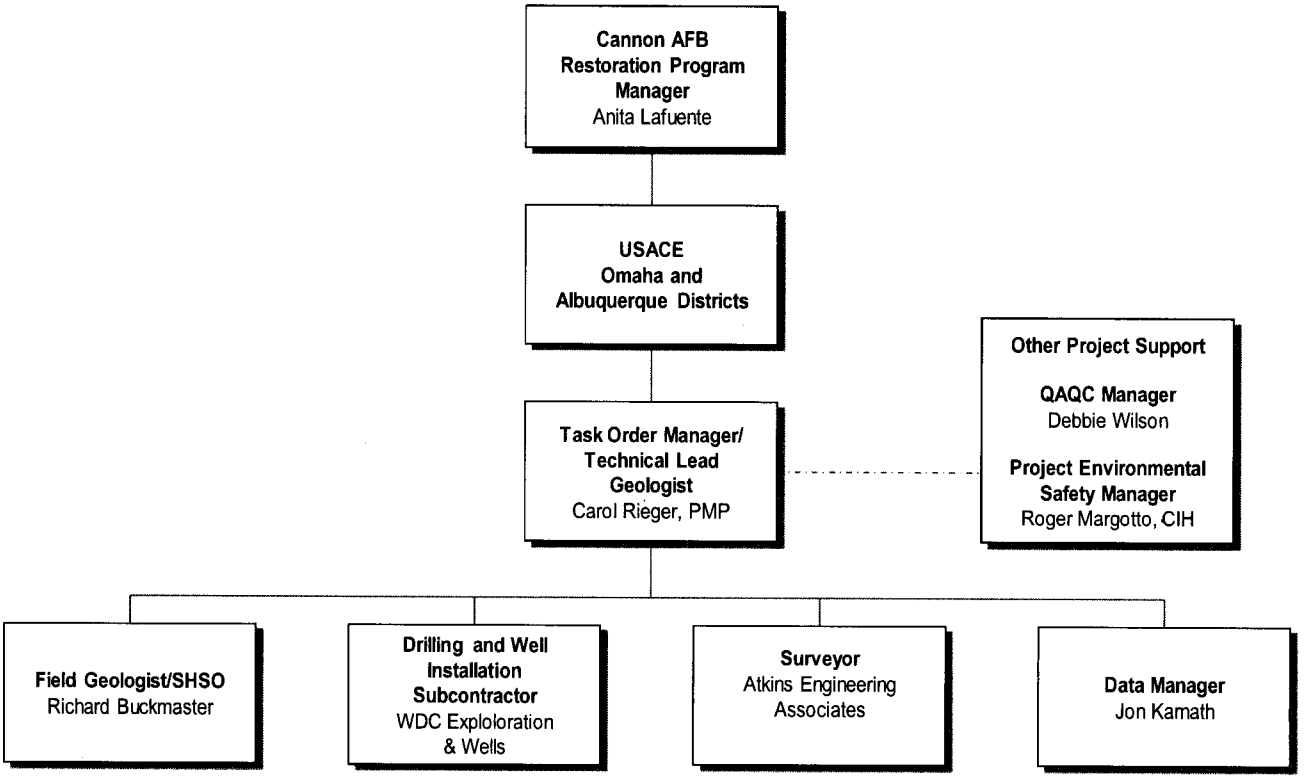


Table 2. Responsibilities of Key Project Personnel

Position	Responsibilities
Task Order Manager	• Maintain regular contact with the appropriate Contract Officer and Cannon AFB representative and provide status reports. • Direct all technical and administrative aspects associated with individual corrective actions and project task(s). • Evaluate project-specific procedures and plans, and ensure that all procedures, project plan elements, and specifications can be implemented on schedule and within budget, and are in compliance with applicable regulations. • Evaluate project schedule and budget to recommend and justify change orders. • Develop and/or modify a critical path method or similar method to track project materials and resources and to identify key project milestones. • Prepare specifications for subcontractors and equipment procurement. • Direct subcontractor and equipment procurement. • Recommend change orders to the appropriate Contract Officer and Cannon AFB representative. • Interface with project scientists and engineers on relevant issues and methods of resolution. • Interface with the Project Health and Safety Manager and QA/QC Manager to ensure compliance of approved plans. • Recommend a team of professionals to accomplish each corrective action or task activity. • Manage the activities of the professionals assigned to the project. • Monitor task costs and schedules. • Interface with Cannon AFB on logistics, site access, or other issues pertaining to the execution of a specific task. • Prepare progress and financial reports as required. • Implement required field activities and ensure compliance with all regulatory requirements.
Well Installation Field Geologist/Site Health and Safety Officer	• Report to Task Order Manager. • Manage daily field installation activity activities. • Schedule work activities and personnel. • Coordinate work with Cannon AFB technical personnel and base operations as needed. • Ensure project plans are implemented correctly. • Implement recommendations of QA/QC Manager. • Answer, evaluate, and solve geological work concerns. • Act as point of contact for well installation subcontractors and field personnel. • Supervise field drilling and sampling activities. • Conduct well development activities. • Provide oversight of well development subcontractor. • Review and sign shift reports from subcontractor personnel. • Ensure proper field procedures are implemented. • Record data and observations on log forms and in the field log book. • Complete appropriate field documentation. • Maintain and calibrate field instruments. • Minimize the amount of IDW generated at the well installation location. • Supervise correct implementation of the SSHP. • Monitor the work zone for potentially hazardous conditions as presented in the SSHP. • Ensure proper PPE is used.

Table 2. Responsibilities of Key Project Personnel

Position	Responsibilities
Data Manager	• Coordinate and control all data flow activities from various sources. • Organize the received data in the electronic data management system. • Upload and download data files to and from the electronic data management system. • Receive data from field measurements or historical data. • Upload, download, back-up all data files as required. • Track data from various sources and identify any missing data. • Organize the data in accordance with the requirements specified in the current version of the ERPIMS Data Loading Handbook. • Submit ERPIMS data files to the USACE and Cannon AFB as specified in the Handbook and project requirements. • Maintain the electronic data management system (both hardware and software) in working condition. • Maintain the electronic data management system(both hardware and software) in working condition.
Project QA/QC Manager	• Provide and maintain an effective control QA/QC system for all project activities. • Assign a QA Officer for a specific task, if required. • Develop project-specific quality plans and procedures. • Monitor QA/QC activities to ensure conformance with authorized policies, procedures, and sound practices; recommend improvements as necessary. • Inform the Task Order Manager of nonconformances to the QAPP. • Ensure that all records, logs, standard procedures, and project plans are maintained in a retrievable fashion, and that controlled copies of standard procedures and project plans are distributed to all appropriate personnel. • Ensure that a document control system is established and maintained for the project. • Perform audits and surveillance of project activities to ensure that project procedures are followed. The QA/QC Manager has the authority to require re-performance of any activity determined to have been adversely affected by improper application of prescribed procedures with the concurrence and approval of the Task Order Manager. • Maintain awareness of the entire project to detect any conditions that may affect quality. • Monitor corrective action documentation for conditions adverse to quality, verify implementation of corrective action, track and analyze corrective action, and close corrective action documentation upon completion of corrective action. • Concur with nonconformance report (NCR) dispositions, and maintain a system for tracking and analyzing NCRs. • Direct stop-work order until poor quality conditions have been corrected.
Subcontractor Driller and Well Developer	• Conduct borehole drilling and well installation tasks. • Follow all applicable SOPs and SSHP. • Take direction from Field Geologist as appropriate to task. • Support Field Geologist in developing the well.
Surveyor	• Be licensed surveyor registered in the state of New Mexico. • Perform topographic and site surveys as directed. • Produce computer-generated maps that are based upon the New Mexico State Plane Coordinate System.

Table 3. Field Project Schedule

Task	Field Start Date	Duration (work days)
Field Mobilization Drilling equipment mobilization Waste staging areas set up Decontamination pad set up Dig Permit obtained for LF-025 Well Installation	October 3, 2011	2–3 days
Start Well Development Well development and Surface Completion	October 5, 2011	1–2 day
Soil Cuttings Collect soil cuttings Stockpile cuttings for temporary storage	October 7, 2011	1 day
Field Demobilization Equipment demobilization	October 7, 2011	1 day
Completion Report—Draft	October 17, 2011	30 days
Completion Report—Final	December 5, 2011	15 days

REFERENCES

Bhate (Bhate Environmental Associates, Inc.)

2002. Final Semi-Annual Monitoring Report, July 2001 Sampling Event, Long-Term Monitoring Landfill No. 25 (MW-Ra). Cannon Air Force Base, New Mexico. May.

Foster Wheeler (Foster Wheler Environmental Corporation)

2001. Construction Completion Report for the Remedial Action at SWMU 97—Landfill No. 25. Cannon Air Force Base, New Mexico.

2000. Final Basewide Health and Safety Plan, Cannon Air Force Base, New Mexico. October.

HGL (HydroGeoLogic, Inc.)

2006. RCRA Facility Investigation Report for Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), and Landfill No. 25 (LF-25/SWMU 97). Cannon Air Force Base, New Mexico.

Radian (Radian Corporation)

1994. RCRA Facility Investigation (RFI) Final Report, SWMU No. 97, Landfill No. 25, IRP Site LF-25. Cannon Air Force Base, New Mexico.

Tetra Tech and Trinity (Tetra Tech, Inc. and Trinity Analysis and Development Corporation)

2010 Final 2010 Biennial Groundwater Monitoring and Annual Landfill Inspection Report, Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), and Landfill No. 25 (LF-25/SWMU 97). Cannon Air Force Base, New Mexico. December.

Tetra Tech (Tetra Tech, Inc.) and Brown, Burdine, & Associates, LLC

2009 Final Long-Term Monitoring and Maintenance Work Plan for Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), Landfill No. 25 (LF-25/SWMU 97), and Sewage Lagoons (SWMU 101). Cannon Air Force Base, New Mexico. July.

2008 Final 2008 Biennial Groundwater Monitoring and Annual Landfill Inspection Report, Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), and Landfill No. 25 (LF-25/SWMU 97). Cannon Air Force Base, New Mexico. December.

USACE (United States Army Corps of Engineers), Tulsa District

1991 LF-25 Environmental Assessment. February.

USGS (U.S. Geological Service)

2006. Groundwater Hydrology and Water Quality of the Southern High Plains Aquifer, Cannon Air Force Base, Curry County, New Mexico, 1994-2005: Scientific Investigations Report 2006-5280.

Woodward-Clyde (Woodward-Clyde Consultants)

1992. Remedial Investigation Report for 18 Solid Waste Management Units. Cannon Air Force Base, New Mexico.

This page intentionally left blank.

Appendix A
Site-Specific Quality Assurance Project Plan

CONTENTS

Section **Page**

1. INTRODUCTION A-5

2. PROJECT DESCRIPTION A-5

3. PROJECT ORGANIZATION AND RESPONSIBILITIES A-5

4. QUALITY ASSURANCE OBJECTIVES A-5

5. FIELD INVESTIGATION PROCEDURES A-6

6. RECORDKEEPING A-7
   6.1 Field Records A-7

7. CALIBRATION PROCEDURES AND FREQUENCY A-8
   7.1 Responsibilities A-8
   7.2 Out-of-Calibration Equipment A-8
   7.3 Calibration Procedures for Field Equipment A-9

8. ANALYTICAL PROCEDURES A-9

9. INTERNAL QUALITY CONTROL CHECKS A-9
   9.1 Field Quality Control Checks A-9

10. DATA VALIDATION, REDUCTION, AND REPORTING A-9
    10.1 Data Validation/Assessment A-9
    10.2 Field Records A-9
    10.3 Data Reduction A-10

11. FIELD QUALITY ASSURANCE/QUALITY CONTROL PROGRAM A-10

12. CORRECTIVE ACTION A-11
    12.1 Deviations and Corrective Action A-11
    12.2 Nonconformance Report A-12
    12.3 Stop-Work Order A-12
    12.4 Cause and Action to Prevent Recurrence A-12
    12.5 Field Changes A-12

13. QUALITY ASSURANCE REPORTS TO MANAGEMENT A-16
    13.1 Project-Specific Daily Quality Control Report (DQCR) A-16
    13.2 Quality Control Summary Report (QCSR) A-17

FIGURES

Figure **Page**

Figure 1. Nonconformance Report A-14
Figure 2. Typical Field Change Request Form A-15

ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
DQCR	Daily Quality Control Report
DQO	Data Quality Objective
ERPIMS	Environmental Restoration Program Information Management System
FCR	Field Change Request
NCR	Nonconformance Report
NIST	National Institute of Standards and Technology
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCSR	Quality Control Summary Report
SOP	standard operating procedure
SWMU	Solid Waste Management Unit
USACE	U.S. Army Corps of Engineers

This page intentionally left blank.

1. INTRODUCTION

This Site-Specific Quality Assurance Project Plan (QAPP) describes the objectives and procedures to support drilling and installation of a monitoring well at Landfill No. 25 (LF-25/Solid Waste Management Unit [SWMU] 97), Cannon Air Force Base (AFB). The procedures apply to the well installation program, field quality assurance/quality control (QA/QC), and associated data management and evaluation activities.

Installation of one downgradient well, designated MW-Rb, is proposed as a replacement well for MW-Ra, which can no longer be monitored under the biennial Long-Term Groundwater Monitoring program because the groundwater level of the regional aquifer at this location is lower than the bottom of the well screen.

2. PROJECT DESCRIPTION

Section 2 of the Work Plan provides a site description of LF-25; summaries of previous investigations and results; and an overview of planned field activities, including the scope of work and project objectives.

3. PROJECT ORGANIZATION AND RESPONSIBILITIES

A project organizational chart is included as Figure 3 in the Work Plan. Section 7 also summarizes the responsibilities and authorities of the QA/QC organization and other key project personnel.

4. QUALITY ASSURANCE OBJECTIVES

Data related to the installation of monitoring well MW-Rb may be used for the following purposes:

1. Identification of potential contamination in soil and groundwater
2. Evaluation of local hydrological conditions
3. Confirmation of contamination
4. Characterization of contamination
5. Determination of environmental and human health risks
6. Monitoring of response/removal actions (corrective actions)
7. Evaluation of remedial alternatives
8. Monitoring compliance with regulations

The data quality objectives (DQOs) for this project are to accomplish the following:

- Install one downgradient replacement monitoring well in the regional aquifer at LF-25 in compliance with New Mexico Solid Waste regulations to evaluate water levels and groundwater quality in the regional aquifer beneath the former landfill.
- Conduct borehole logging and geological classification of soil cuttings to clarify local geological conditions at the site.
- Perform well location survey.
- Collect well construction, location, and lithological information that will meet all Environmental Restoration Program Information Management System (ERPIMS) requirements

Based on the end use of the monitoring well installation data, the following analytical levels are needed:

Data Type	Level	Criteria
Field Screening Data	Screening Level	Well installation Borehole log Cuttings classification Field parameter measurements
Survey Data	Definitive Level	Surveyor must be licensed and registered in the state of New Mexico. Results require confirmed identification and quantitation. Methods include standardized QC and documentation.

5. FIELD INVESTIGATION PROCEDURES

The Standard Operating Procedures (SOPs) that will be used for this project are presented in Appendix C of the Work Plan. The following procedures are included:

SOP C1	Borehole and Sample Logging
SOP C2	Monitoring Well Installation
SOP C3	Monitoring Well Development
SOP C4	Land Surveys
SOP C5	Equipment Decontamination
SOP C6	pH
SOP C7	Specific Conductance
SOP C8	Water Temperature
SOP C9	Dissolved Oxygen
SOP C10	Oxidation-Reduction Potential
SOP C11	Water Levels

6. RECORDKEEPING

6.1 Field Records

Field records include the project log book(s), photographs, standards for field analyses, well development forms, soil boring logs, and well construction logs.

A permanently bound field log book with sequentially numbered pages will be maintained by the Field Geologist to provide daily records of significant events, observations, and measurements during field investigations. All entries will be signed and dated and will be kept as permanent records in the project file. These records will be archived in an easily accessible form and made available to Cannon AFB or the U.S. Army Corps of Engineers (USACE) upon request.

Field log books are intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during field projects. A summary of all site activities and level of personnel protection will be recorded in the log book. At a minimum the following information will be recorded in the log book for all activities:

- Location
- Date and time
- Identity of personnel performing activities
- Identity of visitors
- Weather conditions
- Numerical value and units of each measurement
- Description/identification of equipment used
- Identification of field instruments used and calibration results

The field log book entries will be factual, detailed, and objective and will meet all ERPIMS data loading requirements. At the completion of all entries for a given task or at the end of the day, the log book will be signed and dated. A numbering system will be assigned to field log books for ease of reference and reconstruction of field events. A record of the numbering system and the individuals assigned field log books will also be maintained.

Unless restricted by weather conditions, all original data recorded in field log books are written in waterproof black ink. Field log books will not be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document.

If an error is made on a field record or in the field log book assigned to one person, that individual may make corrections by crossing out the error and entering the correct information. The erroneous information will not be obliterated and no erasures will be permitted. Any error discovered on a field record or in a logbook entry will be corrected by the person who made the entry. All corrections will be initialed by the person who made the entry and dated. No erasures will be permitted. If an incorrect entry is made, the data will be crossed out with a single strike mark, and initialed and dated.

All photorgraphs will be taken digitally, and a photographic log will be maintained in the field logbook to record the date, time, subject, file name, and name of the photographer.

7. CALIBRATION PROCEDURES AND FREQUENCY

Measuring and test equipment used in the field will be controlled by formally prescribed calibration requirements. Equipment will be of the type, range, accuracy, and precision necessary to provide data compatible with the DQOs. When available, accepted procedures published by the American Society for Testing and Materials, the U.S. Environmental Protection Agency, the National Institute of Standards and Technology (NIST), or manufacturer equipment manuals will be used. Variances from these procedures will be justified and documented in the project-specific plans. Each calibration procedure will also include the acceptance criteria and the conditions that will require recalibration or repair.

The frequency of calibration will be determined based on the following:

- Type of equipment
- Inherent stability
- Manufacturer recommendations
- Values given in published sources
- Intended use
- Instrument response to spot checks with standards
- Instrument performance and response time
- Experience

7.1 Responsibilities

The Field Geologist will be responsible to assure the following procedure is implemented:

- Establish a protocol that will include the field measuring and testing devices requiring calibration and the frequency of calibration for each device based on manufacturer's suggestions and procedures

- Assure that the field measuring and testing devices used are of the proper range, type, and accuracy for the tests being performed

- Implement a system for issuing, collecting, and returning all field measuring and testing devices and assure that methods are employed to for proper handling, storage, and care of the test equipment in order to maintain its required accuracy

7.2 Out-of-Calibration Equipment

The following procedures will be implemented for out-of-calibration equipment:

- Any test equipment determined to be out of calibration will be recalibrated as often as necessary to maintain accuracy. When test equipment is found to be out of calibration, damaged, lost, or stolen, an evaluation will be made to ascertain the validity of previous test results since the last calibration check. If it is necessary to assure the acceptability of suspect items, the originally required tests will be repeated using properly calibrated equipment.

- Any test equipment consistently found to be out of calibration will be repaired or replaced.

7.3 Calibration Procedures for Field Equipment

Several types of test equipment may be used during the course of a field program and may include, but not be limited, to the following:

- pH meter
- Temperature meter
- Specific conductivity meter
- Turbidity meter

All field equipment should be calibrated and maintained based on the manufacturer's procedures. Calibration records should be entered in a designated log book and maintained throughout the course of the field program for ultimate storage in the project files.

A full description of the calibration procedures and required frequency are provided in the SOPs contained in the Appendix C of the Work Plan.

8. ANALYTICAL PROCEDURES

Collection of field parameters during well development should be implemented in accordance with the manufacturer's instructions and associated SOPs.

9. INTERNAL QUALITY CONTROL CHECKS

This section describes all specific QC checks to be addressed for field analysis in order to comply with the requirements of the project investigation.

9.1 Field Quality Control Checks

QC procedures for field measurements will include:

- Calibrating the instruments as described in Section 7.0 of this QAPP
- Measuring duplicate samples
- Checking the reproducibility of measurements by taking multiple readings on a single sample or reference standard
- Comparing field measurements with NIST or other approved and traceable standards

10. DATA VALIDATION, REDUCTION, AND REPORTING

10.1 Data Validation/Assessment

The following section describes the procedures pertaining to data validation/assessment of the field data.

10.2 Field Records

Field documentation will ensure work product integrity and provide sufficient technical information to recreate each field event. All field data will be reviewed to ensure that:

- Proper field procedures are implemented
- Appropriate documentation is available for each activity
- Field instruments are calibrated as required
- Required number and type of field QC samples are collected
- Numerical value and units of each field measurement are documented
- Field equipment is decontaminated as specified

Any deficient condition that may potentially affect the work product integrity and/or data quality will be discussed with the field personnel immediately and corrected upon discovery.

10.3 Data Reduction

Data reduction frequently includes computation of analytical results from raw instrument data and summary statistics, including standard errors, confidence intervals, test of hypothesis relative to the parameters, and model validation. Procedures address the reliability of computations and the overall correctness of the data reduction. The numerical transformation algorithms used for data reduction will be verified against a known problem set to ensure that the reduction methods are correct. Standard analytical procedures will be used for analytical and data reduction.

The data generated will be used to satisfy individual project requirements. The equations and the typical calculation sequence that should be followed to reduce the data to the acceptable format are instrument-and method-specific.

Auxiliary data produced for internal records and not reported as part of the measurement data include the following: worksheets, log books, data forms, instrument logs, standard records, maintenance records, calibration records, and associated QC. These sources will document data reduction and will be available for inspection during audits and to determine the validity of data.

A multidisciplinary team (e.g., Task Order Manager, hydrologists, QA officers) will review field records and laboratory data to determine if any environmental data are not representative of environmental conditions due to deviations from acceptable field practices. Such data will not be used.

11. FIELD QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The objective of the field QA/QC program is to ensure that all field operations produce results that:

- Are of known quality and in compliance with specified DQOs
- Are traceable, technically accurate, legally defensible, and have definable characteristics

Fundamental mechanisms for achieving established quality goals can be categorized as prevention, quality assessment, and correction, and include the following:

- Prevention of errors by planning and careful selection of methods, processes, and resources
- Quality assessment through a program of audits and surveillance activities
- Correction of processes to prevent recurrence of conditions adverse to quality
- Incorporation of new processes as they develop to increase quality

The following items are controlled activities to ensure effective implementation of the field QA/QC program:

- Written and approved SOPs for all field activities; these procedures are detailed in Appendix C
- Equipment calibration in accordance with the approved procedures and manufacturer's recommendation
- Documentation and recordkeeping activities.
- Audits, surveillance activities, and a corrective action program.

Project-specific plans have been developed based on the above guidelines and in accordance with individual project requirements. The project-specific plans include the following items in the QA/QC program section:

- Identify and describe the parameters that will be controlled during field operations
- Identify the frequency of control checks and sources of any control materials
- Provide the acceptance criteria for each parameter that is controlled
- Describe the actions required in the event that controlled parameters exceed acceptance criteria

12. CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-control performance, which can affect quality. All corrective action proposed and implemented will be documented in the regular QA reports to management. Corrective actions for field operations will be implemented after approval by the Task Order Manager, or his/her designee.

12.1 Deviations and Corrective Action

A deviation is a deficiency in characteristics, documentation, procedures, or a departure from a requirement that renders the quality of an item, datum, or activity unacceptable or indeterminate. A deviation can be a condition in which characteristics of an item or service do not conform to prescribed limits as follows:

- Unavailability or inadequacy of a required document
- Failure to fulfill a regulatory requirement
- Failure of a procedure to yield the intended results
- An unapproved variation from the Work Plan

In general, the Field Geologist, Task Order Manager, QA/QC Manager, or field team may identify the need for corrective action. The field staff, in consultation with the Field Geologist, will

recommend a corrective action. The Task Order Manager will approve the corrective action, which will be implemented by the field team.

Corrective action resulting from internal field audits will be implemented immediately if the quality of work products may be adversely affected due to unapproved or improper use of approved methods. The QA/QC Manager will identify deficiencies and recommend corrective action to the Task Order Manager. Implementation of corrective actions will be performed by the Field Geologist and field team.

12.2 Nonconformance Report

A nonconformance report (NCR) will be issued for each deficient/nonconforming condition identified (i.e., when unacceptable procedural practices or conditions are identified). The person identifying the deficient/nonconforming condition will prepare the NCR.

The NCR will fully describe the conditions requiring corrective action, will indicate the nature of the corrections required, and will specify a schedule for compliance. The final authority for issuance of an NCR rests with the QA/QC Manager through the Task Order Manager.

A typical NCR is shown in Figure 1.

12.3 Stop-Work Order

If corrective actions are insufficient, resolution cannot be reached, or results of prior work are indeterminate, work may be stopped by a Stop-Work Order. The Stop-Work Order can only be authorized by the Task Order Manager or QA/QC Manager in writing. If there is a disagreement between these personnel, the differences will be brought to the attention of succeeding levels of management until resolution is achieved.

The conditions for which the Stop-Work Order was issued will be described in sufficient detail to allow proper evaluation of the problems and to affect proper corrective action. Documentation of discussions, telephone conference notes, or correspondence which describe the actions taken to evaluate the problems, provide solutions, and verify implementation of solutions will be attached to the Stop-Work Order and fully referenced in the appropriate spaces. Work will not continue until the Stop-Work Order has been rescinded by the individual that authorized the order.

12.4 Cause and Action to Prevent Recurrence

The QA/QC Manager will track the NCRs, analyze the corrective actions required, and take the necessary steps to resolve the causes of the nonconforming conditions in order to prevent recurrence.

12.5 Field Changes

The Task Order Manager or his/her designee is responsible for all site activities. In this role, the Task Order Manager at times is required to adjust the site programs to accommodate project-specific needs. The Contracting Officer must be notified prior to the implementation of any changes in the Work Plan.

When it becomes necessary to modify a field program, the Field Geologist will notify the Task Order Manager of the anticipated changes and implement the necessary changes. When a change is determined to be necessary, the initiator of the change will submit a written notification and a copy will be filed in the project records. If unacceptable, the action taken during the period of deviation will be evaluated in order to determine the significance of any departure from established program practices and action taken.

The changes in the program are documented on a field change request (FCR) form that is signed by the initiator and Task Order Manager. A typical FCR form utilized to document field changes is shown in Figure 2. The FCRs will be numbered serially starting with the number "1".

The Task Order Manager is responsible for the controlling, tracking, and implementing identified changes. Completed FCRs are distributed to affected parties and those parties to whom copies of affected plans were assigned. Completed FCRs are maintained in the project files.

Figure 1. Nonconformance Report

TYPICAL NONCONFORMANCE REPORT

REPORT NO(1) _____

CLIENT OR PROJECT (2)		DRAWING NO/SPEC NO. (3)
SUPPLIER, CONSTRUCTION QC OR CONTRACTOR (4)	P. O. NO. (5)	
DESCRIPTION OF COMPONENT, PART OR SYSTEM (6)		

I. DESCRIPTION OF NONCONFORMANCE (7) *(Items involved, Specifications, Code or Standard to Which Items Do Not Comply, Submit Sketch (If Applicable)*

NAME AND SIGNATURE OF PERSON REPORTING NONCONFORMANCE (8)	TITLE/COMPANY	DATE (9)

II. RECOMMENDED DISPOSITION (10) *(Submit Sketch If Applicable)*

NAME AND SIGNATURE OF PERSON RECOMMENDING DISPOSITION (11)	TITLE/COMPANY	DATE (12)

III. EVALUATION OF DISPOSITION BY FOSTER WHEELER ENVIRONMENTAL. REASON OF DISPOSITION (13)

IV. CORRECTIVE ACTION (14) ☐ Required ☐ Not Required

V.(15) ☐ ENGINEERING	☐ QUALITY ASSURANCE	☐ CONSTRUCTION	☐ OTHER
NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)	NAME (SIGNATURE)
DATE	DATE	DATE	DATE
☐ ACCEPTED ☐ REJECTED	☐ ACCEPTED ☐ REJECTED	☐ ACCEPTED ☐ REJECTED	☐ ACCEPTED ☐ REJECTED
☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED WITH COMMENTS	☐ ACCEPTED WITH COMMENTS

VI. VERIFICATION OF DISPOSITION ☐ REQUIRED ☐ NOT REQUIRED (16)
(17) BY _____ SIGNATURE _____ TITLE _____ DATE _____

Figure 2. Typical Field Change Request Form

FIELD CHANGE REQUEST

PROJECT	PROJ. NO.	FIELD CHANGE NO.

TO _____ DEPT. _____ LOCATION _____ DATE _____

RE: ☐ DRAWING NO. _____ TITLE _____

☐ SPEC NO. _____ TITLE _____

☐ OTHER. _____

1. DESCRIPTION (Items involved, submit sketch if applicable)_____

2. REASONS FOR CHANGE (If from disposition of nonconformance report, list report number)_____

3. RECOMMENDED DISPOSITION ☐ MINOR CHANGE ☐ MAJOR CHANGE

4. RESIDENT ENGINEER (Signature)	DATE	PROJECT SUPT. CONCURRENCE (Signature)	DATE

5. DISPOSITION

☐ NOT APPROVED (Give Reason)

☐ CONSIDERED MINOR CHANGE - Approval per Recommended Disposition - Design Documents will not be normally revised; field to maintain as-built records

☐ CONSIDERED MAJOR CHANGE - Action will be taken as prescribed on DCN -

LEAD DISCIPLINE ENGINEER OR DESIGNEE (Signature)	DATE	PROJECT ENGR OR DESIGNEE (Signature)	DATE

Project Engineer signs and returns to LDE for transmittal to Resident Engineer with copies to:

Project Manager _____ *Others as Required* _____

Project Supt. _____

Project Files _____

13. QUALITY ASSURANCE REPORTS TO MANAGEMENT

13.1 Project-Specific Daily Quality Control Report (DQCR)

During field activities, DQCRs will be compiled and sent out to the client designee on a daily basis. However, should problems arise during project-related activities, the client will be notified immediately. DQCRs will include, but not be limited to, the following list of topics:

- Date (and corresponding sequential report number)
- Location of the work (including installation, site, boring, etc.)
- Weather information (including temperature, wind speed and direction, humidity, precipitation, etc.)
- Work performed and personnel performing the work
- Sampling or tests performed (including specifics such as location, type of samples, log number, etc.)
- Field analysis performed (including results, instrument checks and calibration, problems, etc.)
- Problems encountered and corrective actions taken (including specifics regarding sampling problems and alternate sampling methods utilized.)
- QC activities
- Verbal or written instructions from government personnel
- Calibration procedures and recording
- Names of all personnel on site (including their corporate, government, or other affiliations, their job titles, and their job functions and/or reasons for being on-site)
- Equipment used
- Health and safety considerations (including site control measures, levels of personal protection required, on-site monitoring activities and results, accidents, etc.)
- Deviations from approved work plan
- General and specific remarks
- Expected activities for the next working day
- Distribution list for the DQCRs
- Signature and job title of the DQCRs preparer

- Boring logs completed as outlined in SOP C1.

13.2 Quality Control Summary Report (QCSR)

The QCSR may be used to document QC practices and results implemented on a project-specific basis. Issues covered in this report will include a discussion of all data points that may have been influenced or compromised and their effect on achieving the DQOs for the project. An example of the elements required for this level of effort include:

1. Project description
2. Sampling and analysis scope
3. Laboratory quality control activities
4. Field quality control activities
5. Data evaluation
6. Analytical data results
7. Discussion of qualified data
8. Internal quality control reporting.
9. Lessons learned
10. Conclusions and recommendations

This page intentionally left blank.

Appendix B
Site Safety and Health Plan

CONTENTS

Section **Page**

1. GENERAL B-5

2. SITE HISTORY AND DESCRIPTION B-5

3. HEALTH AND SAFETY PERSONNEL B-5
   - 3.1 Project Environmental Safety Manager B-5
   - 3.2 Site Health and Safety Officer B-6
   - 3.3 Project Field Personnel B-6
   - 3.4 Site Visitors B-6

4. HAZARD ASSESSMENT B-6
   - 4.1 Chemical Hazards B-6
   - 4.2 Biological Hazards B-7
   - 4.3 Physical Hazards B-7
   - 4.4 Activity Hazard Analysis B-7

5. DRILL RIG SAFETY PROCEDURES B-8

6. PERSONAL PROTECTIVE EQUIPMENT B-8

7. SAFETY CONSIDERATIONS FOR SITE OPERATIONS B-8
   - 7.1 Slips, Trips, and Falls B-8
   - 7.2 Electrically Powered Equipment B-9
   - 7.3 Noise B-9
   - 7.4 Bloodborne Pathogen Exposure B-9
   - 7.5 Heat Stress B-9
   - 7.6 Buried Utility Lines B-10
   - 7.7 Inclement Weather B-10
   - 7.8 Manual Lifting B-10
   - 7.9 Heavy Equipment B-11
   - 7.10 Driver Safety B-11
   - 7.11 Hand Protection B-11
   - 7.12 Lockout/Tagout B-11
   - 7.13 Traffic Control B-11
   - 7.14 Hot Work B-12
   - 7.15 Spills B-12

8. MONITORING B-13
   - 8.1 Monitoring During Site Operations B-13

9. TRAINING B-13

10. EMERGENCY RESPONSE PLAN B-13
    - 10.1 Emergency Contacts B-13

10.2 Emergency Route to Hospital B-14

APPROVALS B-17

REFERENCES B-19

ATTACHMENTS

Attachment 1 Activity Hazard Analysis

FIGURES

Figure **Page**

Figure A-1. Hospital Route Map from LF-25 ..... B-15

ACRONYMS

AFB	Air Force Base
AHA	Activity Hazard Analysis
CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
CRL	Corporate Reference Library
EHS	Environmental Health and Safety
EM	Engineers Manual
ERP	Emergency Response Plan
ESQ	Environmental Safety and Quality
°F	degrees Fahrenheit
ft	feet/foot
HASP	Health and Safety Plan
LF-25	Landfill No. 25
OSHA	Occupational Safety and Health Act
PESM	Project Environmental Safety Manager
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
RPM	Restoration Project Manager
SHSO	Site Health and Safety Officer
SSHP	Site Safety and Health Plan
SWMU	Solid Waste Management Unit
Tetra Tech	Tetra Tech, Inc.
USACE	U.S. Army Corps of Engineers
Work Plan	Work Plan for Monitoring Well Installation at Landfill 25 (LF-25)

This page intentionally left blank.

1. GENERAL

This Site Safety and Health Plan (SSHP) provides the site-specific health and safety requirements for drilling and installing a monitoring well at Cannon Air Force Base (AFB), Solid Waste Management Unit (SWMU) 97, Landfill No. 25 (LF-25).

This SSHP will serve as an addendum to the Basewide Health and Safety Plan (HASP) (Foster Wheeler, 2000) and provides the Hazard Assessment and Activity Hazard Analysis (AHA), a description of personal protective equipment (PPE), and the monitoring requirements for the anticipated field activities. An addendum to the Emergency Response Plan (ERP) presented in the Basewide HASP is also provided; the Basewide HASP will be referenced for all other safety and health issues.

This SSHP, the Basewide HASP, and the Tetra Tech, Inc. (Tetra Tech) Environmental Health and Safety (EHS) Program constitute the health and safety procedures for the project. Additional guidelines for safe work practices and health and safety work rules are presented in the U.S. Army Corps of Engineers (USACE) Engineers Manual (EM) 385-1-1 and the Tetra Tech Project Orientation, Rules, and Safety Guidelines Handbook (Tetra Tech, 2009). The *Work Plan for Monitoring Well Installation at Landfill 25 (LF-25)* (Work Plan) will be on site at all times during field activities.

2. SITE HISTORY AND DESCRIPTION

Section 2 of the Work Plan provides the scope of work and descriptions of the sites where monitoring well installations will occur.

3. HEALTH AND SAFETY PERSONNEL

Mr. Roger Margotto is the Project Environmental Safety Manager (PESM); the Site Health and Safety Officer (SHSO) will be identified before field activities begin. Health and safety personnel and their responsibilities are detailed in the Basewide HASP. Additional responsibilities applicable to this project are presented below.

3.1 Project Environmental Safety Manager

The PESM is responsible for:

- Overseeing the overall EHS Program and for developing, implementing, and approving all project-specific addenda
- Coordinating all aspects of each project-specific addendum with the Program Manager, Task Order Manager, and the PESM
- Conducting health and safety inspections for tasks at Cannon AFB
- Approving and overseeing implementation of the ERP
- Supervising and overseeing the activities of the SHSO assigned to specific tasks

3.2 Site Health and Safety Officer

The Field Lead will be qualified to serve as the SHSO and is responsible for:

- Ensuring that site-specific orientations and health and safety training are conducted
- Ensuring that daily health and safety meetings are conducted
- Modifying and/or developing procedures or revisions to this plan, after consultation with the PESM, when the scope of work is changed through natural causes, contract modifications, or contact with hazardous materials
- Investigating all accidents and incidents
- Ensuring that work areas are appropriately posted
- Monitoring compliance with this plan and all work practices
- Conducting site inspections
- Directing onsite health and safety activities

The SHSO has "stop-work authorization" if an imminent danger or potentially dangerous work practice exists. The field lead and the PESM will verify authorization to proceed with work. The SHSO will coordinate with the Cannon AFB Restoration Project Manager (RPM), Ms. Anita Lafuente, to ensure compliance with all site requirements.

3.3 Project Field Personnel

All project field personnel will be responsible for understanding and complying with all site health and safety requirements.

3.4 Site Visitors

All visitors will sign in and report to the SHSO. The SHSO will provide training on the SSHP and the requirements for entering the project site. Only the SHSO or the Project Manager can authorize unescorted entry of visitors.

4. HAZARD ASSESSMENT

The following sections provide detailed descriptions of the chemical, biological, and physical hazards associated with drilling and monitoring well installation activities. An AHA summarizing the project activities and associated potential hazards and the means used to control the hazards is provided in Attachment 1.

4.1 Chemical Hazards

Previous sampling events and well installation activities conducted along the perimeter of LF-25 indicate that the surface and subsurface of the site is free of chemical contamination (Tetra Tech and Trinity, 2010). Therefore, there is no anticipated chemical exposure threat to site workers. Based on the contaminant concentrations in soil and groundwater, the proposed monitoring well location, and

the anticipated work activities, the likelihood of exposure to hazardous chemicals is considered very low.

Chemical health and safety monitoring will be conducted by monitoring the breathing space of site personnel with a photoionization detector (PID). PID readings higher than 10 parts per million (ppm) will require the SHSO monitor the situation, possibly stop work, and contact the PESM.

4.2 Biological Hazards

Several varieties of snakes are known to inhabit the site, and some, such as the rattlesnake, are venomous. Mice may also be present at this site. The SHSO shall inform all personnel onsite of this hazard during the site orientation lecture. All personnel shall avoid areas of thick ground cover when possible and proceed with caution while working in these areas. To avoid being exposed to hantavirus, all personnel shall avoid areas with presence of excrement from any rodents or other animals. Under no circumstances will any personnel attempt to kill or capture or otherwise come into contact with a potentially hazardous animal or insect.

4.3 Physical Hazards

The potential hazards associated with the site activities at LF-25 are primarily physical in nature. The likelihood of encountering physical hazards depends on the type of work to be performed and the location of the work activity. Potential physical hazards include the following:

- Trips, slips, and falls
- Electrically powered equipment
- Noise
- Bloodborne pathogen exposure
- Heat stress
- Buried utility lines
- Inclement weather
- Manual lifting
- Heavy equipment
- Hand injuries
- Flash flooding
- Hot work
- Spills
- Lead exposure

Requirements for minimizing potential exposures to these physical hazards, including safety considerations for driver safety, lockout/tagout, and traffic control, are detailed in Section 7 of this SSHP.

4.4 Activity Hazard Analysis

The activities anticipated during the field investigation include monitoring well location surveying, drilling, well installation, drum handling, and pressure washing.

The AHA for these activities is provided in Attachment 1 of this SSHP.

5. DRILL RIG SAFETY PROCEDURES

Drill rig safety procedures as presented in Tetra Tech Corporate Reference Library (CRL) Procedure EHS 6-2, Drill Rigs, will be followed at all times. Additional guidelines to be implemented when clearing discharge from air rotary drills are provided in the AHA, Attachment 1 to this SSHP.

6. PERSONAL PROTECTIVE EQUIPMENT

Personnel will wear appropriate PPE as outlined by the Occupational Safety and Health Act (OSHA) requirements in 29 Code of Federal Regulations (CFR) 1910 and the requirements of 29 CFR 1926. Level D protection consisting of a shirt, long pants, steel-toed boots, hard hat, safety glasses, and hearing protection (when personnel work in close proximity to equipment that produces high noise levels) is the primary work uniform and will be worn only in areas where there is no potential for exposure to toxic substances. Equipment and PPE will be cleaned at the end of each day.

The level of protection for the activities to be conducted conforms to a level of protection for "clean construction" projects. If site conditions change or a hazardous situation is encountered, all work will be stopped, the work crew will evacuate the site, and the SHSO, Project Manager, and the PESM will assess the situation. The SHSO will make decisions concerning changes in the level of protection and will then provide appropriate documentation to the PESM.

The level of protection needed to minimize potential exposures for the anticipated activities are outlined below:

Task	Level of Protection
Mobilization/Site Setup	D
Drilling	D
Equipment Decontamination	D*
Monitoring Well Installation	D
Surveying	D

*Coated tyvek or equivalent

7. SAFETY CONSIDERATIONS FOR SITE OPERATIONS

Because of the nature of work to be conducted, physical hazards potentially pose the greatest health and safety concern during this project. The following sections supplement the Basewide HASP.

7.1 Slips, Trips, and Falls

Field personnel will become familiar with the specific hazards associated with each structure and work area. Hazards causing slips, trips, and falls may be a result of debris, uneven terrain, sampling at elevated locations, and poor lighting. Field personnel will remain alert to the surrounding conditions. Upon arrival at a site, personnel will inspect the area for hazards, which will either be removed from the immediate area or marked to prevent injury.

7.2 Electrically Powered Equipment

All electrical equipment, including portable tools, lighting, and power cords, will conform to 29 CFR 1926.400. All power tools will be inspected before use. A weekly inspection of power tools will also be performed and recorded. Power and hand tools used will be in accordance with the following practices:

- Tools will be maintained in good condition and be inspected prior to use.
- Electrical tools will be double insulated or have a ground plug.
- Tools will be used for their intended purpose.
- Unsafe tools will be removed from service.
- All outdoor power sources will have a Ground Fault Circuit Interrupter attached.

7.3 Noise

The main source of noise for this project is the drill rig. Hearing protection must be worn within 100 feet (ft) of drilling operations while equipment is in operation. Personnel exposed to noise hazards will be included in their company's Hearing Conservation Program.

7.4 Bloodborne Pathogen Exposure

Bloodborne pathogen exposure risks are associated with medical emergencies requiring performing cardiopulmonary resuscitation (CPR), stabilizing a bleeding victim or a victim with an open wound, or cleaning up blood, body fluids or tissues, or broken or sharp objects that might be contaminated with blood. At least two onsite personnel will be trained in CPR and first aid. Personnel trained in CPR and first aid will also be trained in their company's Bloodborne Pathogens Program.

7.5 Heat Stress

Project employees must learn to recognize and treat various forms of heat stress through preventive heat stress management. However, the following procedures should be observed, as applicable:

- Workers should drink 16 ounces of water before beginning work. Provide disposable, 4-ounce cups and water that is maintained at 50 to 60 degrees Fahrenheit (°F). Urge workers to drink one or two of these cups of water every 20 minutes, for a total of 1 to 2 gallons per day. Provide a cool, preferably air-conditioned, area for rest breaks.

- Discourage the use of alcohol during nonworking hours and discourage the intake of coffee during working hours. Monitor for signs of heat stress.

- Acclimate workers to site work conditions by slowly increasing workloads (i.e., do not begin site work activities with extremely demanding activities).

- Provide cooling devices to aid natural body ventilation. Because these devices add weight, however, their use should be balanced against worker efficiency. An example of a cooling aid is long cotton underwear, which acts as a wick to help absorb moisture and protects the skin from direct contact with heat-absorbing protective clothing.

- Ensure that adequate shelter is available to protect personnel against heat, which can decrease physical efficiency and increase the probability of heat stress. If possible, set up a rest area in the shade.

Monitoring for heat stress will be in accordance with Tetra Tech CRL Procedure EHS 4-6, Temperature Extremes.

7.6 Buried Utility Lines

A review will be made of any available property maps, redlines, or as-built drawings to identify potential buried utilities before work activities are begun. Cannon AFB uses utilities locating personnel to identify, mark, and de-energize buried utilities prior to starting work. If additional concerns remain regarding the location of buried utilities, the SHSO will be contacted for guidance.

7.7 Inclement Weather

Natural phenomena, including excessive heat or cold, rain, snow, ice, and lightning, can affect work activities and increase risk. At the daily morning health and safety meetings, the SHSO will discuss potential weather issues that could affect workers. Additionally, extremes in temperature and moisture could affect the function of monitoring instrumentation as a standard bulb thermometer will be used to determine current air temperature. It is the SHSO's responsibility to recognize weather conditions and adjust site activities accordingly.

7.8 Manual Lifting

Personnel performing material handling will abide by the following guidelines:

- **DO** design manual lifting and lowering out of the task and workplace. If you must perform manual lifting, try to carry the load at the approximate center of your body, i.e., between your knees and shoulder.
- **DO** be in good physical shape. If you are not used to lifting and vigorous exercise, do not attempt to do difficult lifting or lowering tasks.
- **DO** think before acting. Place material conveniently within reach. Have handling aids available. Make sure sufficient space is cleared.
- **DO** get the load close to the body. Test the weight before trying to move it. If it is too bulky or heavy, get a mechanical lifting aid or somebody else to help or both. Place the feet close to the load. Stand in a stable position with the feet pointing in the direction of movement. Lift mostly by straightening the legs.
- **DO NOT** twist the back or bend sideways.
- **DO NOT** lift or lower awkwardly.
- **DO NOT** hesitate to get mechanical help or help from another person.
- **DO NOT** continue heaving when the load is too heavy.

7.9 Heavy Equipment

Because heavy equipment may present a diverse number of hazards, the following practices will be observed:

- Subcontractors will be required to provide equipment that meets the requirements of all relevant OSHA standards.
- The SHSO will inspect equipment before use. At a minimum, guarding, hydraulics, hoisting, rigging, backup alarms, and the overall condition will be reviewed. Deficiencies found will be corrected before use.
- Operator qualifications will be verified before work is initiated.
- Noise monitoring will be conducted, as needed, to ensuring adequate protection is afforded to employees.
- All equipment will have operational backup alarms and a fire extinguisher.
- Copies of any pertinent inspections will be provided to the SHSO before the start of work.
- Prior to use, vehicles will be inspected daily and documented with the daily quality control summary report.

7.10 Driver Safety

During the performance of this work, all personnel using project vehicles will posses a valid driver's license and obey all posted speed limits, signs, and traffic signals. Personnel riding in vehicles will wear seat belts at all times. The SHSO under the direction of the Task Order Manager will coordinate with Cannon AFB police to procure any necessary permits.

7.11 Hand Protection

Heavy leather gloves will be worn when handling materials or performing other work that could result in hand injuries.

7.12 Lockout/Tagout

As necessary, lockout/tagout procedures will be used to control employee exposure to hazardous energy sources in accordance with 29 CFR 1910.147 and Tetra Tech CRL Procedure EHS 6-4, Lockout/Tagout, throughout this project and, in particular, to control access to below and aboveground utilities and services. Subcontractors will present their lockout/tagout procedures to the SHSO for approval.

7.13 Traffic Control

Although no traffic is anticipated along the road adjacent to the well installation location, unauthorized vehicles will be controlled through the use of caution tape, cones, or other warning devices. The Field Lead will coordinate all activities that affect base traffic with Cannon AFB Security.

7.14 Hot Work

Work involving the use of cutting or welding equipment will be conducted using a hot work procedure. The SHSO will coordinate with Cannon AFB Fire Department the initiation of permits. In addition, the following site-specific practices will be observed:

- Tetra Tech CRL Procedure EHS 6-5, Welding/Hot Work, will be followed when hot work is performed.
- Performance of hot work will be contingent upon acceptable entry conditions to confined spaces and excavations.
- All lines will be cleaned of contaminants prior to hot work being performed as applicable.
- Coatings of piping and vessels containing lead will be chemically stripped a minimum of 6 inches on either side of the work as applicable.
- Monitoring will be completed on the inside of the piping or vessel to ensure a hazardous or flammable atmosphere does not exist.
- If a flammable or hazardous atmosphere does exist, it will be inerted or vented prior to working.

7.15 Spills

Precautions will be taken to prevent oil and hazardous material spills, including daily inspection by the site personnel of equipment, structures, and containers. Personnel using hazardous materials will inspect containers before and after use. In the event of a spill/release, the SHSO will notify the Cannon AFB Fire Department, the Cannon AFB RPM, and the USACE. Spill response will be conducted in accordance with federal, state, local, and Cannon AFB regulations.

The following chain of communications should be used in case of a spill:

- The SHSO, will be designated as the Tetra Tech Spill and Release Reporting Site Representative. This individual will receive training in the Tetra Tech CRL Procedure EHS 1-7, Incident Reporting and Investigation. If a spill or release occurs, the SHSO will immediately notify the Task Order Manager. The Task Order Manager will then immediately notify the Cannon AFB Onsite Representative, Ms. Anita Lafuente at (575) 784-1092; and the Cannon AFB Emergency Spill Response Coordinator, at (575) 784-*TBD*; the Cannon AFB Fire Department at (575) 784-*TBD* (nonemergency) or *TBD*-911 (from a Cannon AFB phone).
- The Task Order Project Manager must immediately notify the Tetra Tech PESM of any spills or releases. A written incident report must be submitted within 24 hours. Emergency contacts and telephone numbers include:
  - Tetra Tech Project Manager: Carol Rieger, PMP
    Phone: 303-980-3574 (office); 303-887-6113 (mobile)
    Fax: 303- 980-3539

— Tetra Tech PESM: Roger Margotto, CIH
Phone: 619- 471-3503 (office); 619-988-0529 (mobile)

— Tetra Tech Regulatory Specialist: Jennifer Fadden
Phone: 360-808-2145 (mobile)

Any project activity that releases significant amounts of vapor must be reported immediately as described in the spill release procedure. Every attempt to mitigate the release must be taken if it can be safely performed.

8. MONITORING

Monitoring will be performed in accordance with the Basewide HASP to ensure that field personnel are adequately protected. The following sections provide the practices to be implemented for direct reading instrumentation and the calibration and maintenance of instruments.

All instruments will be calibrated according to the manufacturer's recommendations. All equipment will be calibrated at the beginning of each workday. A calibration record will be maintained as part of the SHSO's field book.

8.1 Monitoring During Site Operations

Field screening using a PID is planned for the monitoring well installation. An action level of 10 ppm sustained over a 5 minute period within the breathing zone will be used for upgrading the level of protection. Upgrade or downgrade of levels of protection will be coordinated with the PESM, and a detailed justification will be noted in the field book. Based on the results of soil and groundwater sampling at and the lack of contamination associated with the disposal of construction and demolition debris at LF-25 (Tetra Tech and Trinity, 2010), it is not anticipated that air monitoring will detect the presence of volatile vapors in soil, at the top of the borehole location or in the breathing zone.

9. TRAINING

Training requirements for personnel onsite will be in accordance with requirements specified in Section 5 of the Basewide HASP (Foster Wheeler, 2000).

10. EMERGENCY RESPONSE PLAN

The ERP presented in Section 10 of the Basewide HASP will be implemented, and the SHSO will act as the Emergency Coordinator. Additional information is provided below.

10.1 Emergency Contacts

Emergency contact numbers will be conspicuously posted onsite to allow for easy access to all personnel. Additional emergency telephone numbers include the following:

Personnel/Organization	Number
Roger Margotto, PESM	619-471-3503 619-988-0520
Carol Rieger, Task Order Manager	303-980-3574 (office) 303-887-6113 (mobile)
Anita Lafuente, Cannon AFB Onsite Representative	575-784-1092
Cannon AFB Security	575-784- *TBD*
Cannon AFB Command Post	575-784-*TBD* (24-hour emergency contact)

10.2 Emergency Route to Hospital

The route to the Plains Regional Medical Center from LF-25 at Cannon AFB is shown in Figure A-1.

LF-25 to Base Main Gate

Follow Perimeter Rd north around the north end of the flight line.
Continue to the stoplight at D.L. Ingram Blvd.
Turn right to exit the Base at the Main Gate at US-60/US-84.

Google maps

Directions to Plains Regional Medical Center
2100 North Doctor M L King Junior Boulevard,
Clovis, NM 88101-9412 - (575) 769-2141
6.1 mi – about **11 mins**
Directions from Cannon AFB Main Gate to Plains Regional Medical Center

A US-60 E/US-84 E

1.	Head **east** on **US-60 E/US-84 E** toward **Marco Rd** About 4 mins	go 3.9 mi total 3.9 mi
2.	Turn left onto **Curry Rd M/N Wheaton St** About 3 mins	go 1.0 mi total 4.9 mi
3.	Turn right onto **W 21st St/County Rd 11** About 2 mins	go 1.0 mi total 5.9 mi
4.	Turn left onto **N Dr Martin Luther King Blvd/N Dr Martin Luther King Jr Blvd/N Thomas St**	go 0.1 mi total 6.0 mi
5.	Take the 1st left Destination will be on the right	go 446 ft total 6.1 mi

B **Plains Regional Medical Center**
2100 North Doctor M L King Junior Boulevard, Clovis, NM 88101-9412 - (575) 769-2141

These directions are for planning purposes only. You may find that construction projects, traffic, weather, or other events may cause conditions to differ from the map results, and you should plan your route accordingly. You must obey all signs or notices regarding your route.

Map data ©2011 Google

Figure A-1

LF-25 Hospital Route Map

This page intentionally left blank.

APPROVALS

By their signature, the undersigned certify that this SSHP is approved and will be used for monitoring well installation at LF-25 (SWMU 97).

Carol L Rieger

6/13/2011

Carol L. Rieger, PMP
Project Manager

Date

7/27/2011

Richard A. Buckmaster
Site Health and Safety Officer

Date

Roger N Margotto, CIH

6/10/2011

Roger Margotto, CIH
Project Environmental Safety Manager

Date

This page intentionally left blank.

REFERENCES

Foster Wheeler (Foster Wheeler Environmental Corporation), 2000. *Final Basewide Health and Safety Plan, Cannon Air Force Base, New Mexico.* October.

Tetra Tech and Trinity (Tetra Tech, Inc. and Trinity Analysis and Development Corporation), 2010. *Final 2010 Biennial Groundwater Monitoring and Annual Landfill Inspection Report Landfill No. 3 (LF-03/SWMU 105), Landfill No. 4 (LF-04/SWMU 104), Landfill No. 25 (LF-5/SWMU 97), and Sewage Lagoons (SWMU 101). Cannon Air Force Base, New Mexico.* December.

Tetra Tech, 2009. *Project Orientation, Rules, and Safety Guidelines Handbook.* August 2009 update.

USACE, 2008. U.S. Army Corps of Engineers Manual 385-1-1, Safety and Health Requirements Manual. September.

This page intentionally left blank.

Attachment 1
Activity Hazard Analysis

This page intentionally left blank.

Activity Hazard Analysis A-1

Job/Task: Well Drilling	Overall Risk Assessment Code (RAC) (Use highest code)	H
Project Location: LF-25 Cannon AFB, NM		
Contract Number: W9128F-10-D0019, Task Order 001		
Date Prepared: June 10, 2011		
Prepared by (Name/Title): Carol Rieger, Project Manager		
Reviewed by (Name/Title): Roger Margotto, CIH, CSP, Program CIH		

Risk Assessment Code (RAC) Matrix

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
In addition to the information listed in this AHA, all field personnel must review and be familiar with all provisions of the approved APP/SSHP. TtEC Corporate Safety Programs and the EM 385-1-1 will also be available on-site for review of specific materials and mitigation measures.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (see above).

"Probability" is the likelihood to cause an incident, near miss, or accident and is identified as Frequent, Likely, Occasional, Seldom, or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and is identified as Catastrophic, Critical, Marginal, or Negligible.

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on the AHA. Annotate the overall highest RAC at the top of the AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

AHA A-1 – Well Drilling

Job Steps	Hazards	Controls	RAC
1. Pre-survey the area over which the rig will be driven.	The vehicle could run over unstable ground surface or other hazards.	Mark all physical hazards. The weight of the rig can be significant, so verify the stability of all routes of travel.	L
2. Pre-survey the area to ensure that underground locator services have marked all utilities and that as-built drawings have been reviewed.	Accidental contact with underground utilities could cause the release of gas or water, electrocution if an underground power line is struck, and damage to communication lines.	Verify that there are no utilities present, especially PVC water lines that are often placed in some concrete pads, and lead-shielded electrical service lines. Review drawings and nearby utility connections, and scan, locate, and mark. Call National One Call (811) for the connection to the closest utility location services before you dig. They should have already been contacted and the area marked.	L

AHA A-1 – Well Drilling			
Job Steps	**Hazards**	**Controls**	**RAC**
3. Drilling operations; inspect drill rig.	Improper inspection of the rig could cause workers to be exposed to hazards associated with operating mechanical devices.	Ensure that the rig and all associated equipment are inspected by a competent person, and that the rig is in a safe operating condition. Inspect equipment, including brakes, tire pressure, cables, and hydraulic and pneumatic hoses, before use and at the start of each shift. Verify that there is a guard cage that can surround the rotating auger when the rig is in use. Tag and remove from service any faulty or unsafe equipment. Verify that emergency shutdown systems (at least two) are clearly marked, and that all site workers know the locations. Verify that shutdown systems work properly when trip wires are pulled or pushed. The operator's manual must be available and reviewed prior to operation.	L
4. Drilling operations; set up work area and move rig into position.	Failure to review the site layout plan could cause exposure to potential hazards such as electrocution, damage to underground utilities, or tipping the rig over in unstable soil conditions.	Do not move the drill rig into any work area until the site layout plan has been completed and the route of travel to any work site has been assessed for hazards (overhead lines and stability of roads and ground). At the pre-activity safety briefing, discuss the site layout plan and analysis of the route of travel, along with AHAs. Use a spotter for positioning as necessary. Set brake and place wheel chocks under front wheels of mobile rig. Extend stabilizer jacks and ensure that footing is sound. The vehicle must be level to vertical and horizontal planes. Do not position wheels (loads) or rig over manholes, vaults, valve boxes, etc. Do not place rig within 15 feet of any overhead electrical lines (lines must be less than 200 kV).	M
	The rig could come into contact with overhead lines (including power lines), if it is transported with the mast raised, potentially causing electric shock.	Never move the rig when the mast is extended.	
	The vehicle may move if not properly set up.	Use a spotter to properly position the vehicle. Set brakes and place wheel chocks under front wheels of the mobile rig. Extend stabilizer jacks, and ensure that footing is sound. Ensure that the ground can support the weight of the unit and any outriggers. Use cribbing of specified size and strength, as required by the manufacturer, if necessary. The vehicle must be level to the vertical and horizontal planes.	

AHA A-1 – Well Drilling			
Job Steps	**Hazards**	**Controls**	**RAC**
4. Drilling operations; set up work area and move rig into position. (Continued)	When raising the rig, it may not install properly due to the condition of the rig and its connecting cables.	Inspect all components of the rig to determine its condition. Make all repairs before raising the rig.	
	When raising the rig, the mast could come into contact with (or be in close proximity to), overhead power lines, causing electrocution of the workers.	The mast and other equipment must be at least 15 feet from any overhead utility lines. Verify the voltage of any overhead power lines. If any lines are above 50 kV, the clearance distance must be greater. Refer to the National Electrical Code for voltages above 50kV.	
	A worker may become pinned between the rig and other truck components, or the worker could be pinned under the truck rig if the rig must be serviced from under the truck.	When any part of the rig or equipment is in motion, the worker will stand far enough away from the moving parts so that he/she is not pinned between the moving parts. Workers will not manually guide any moving part of the rig when it is being raised. Workers will not work under the rig or under the truck. If work must be done under the rig or truck, the drill crew supervisor will contact the SSHO to ascertain a safe method for lock-out of the equipment to ensure that adequate blocking is installed.	
	High winds could destabilize the rig. Also, the mast could act as a conductor during a thunderstorm.	Check weather conditions and forecasts to determine if conditions are acceptable for use of the rig. Do not operate the rig if winds exceed the manufacturer's recommended tolerances. TtEC policy requires an evaluation any time the wind exceeds 25 miles per hour.	
	Excessive noise exposure to workers could cause hearing loss.	When necessary, earplugs will be worn.	
	Pinch points can cause injury to workers' hands.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate.	
	Vehicular traffic in the area of drilling could injure workers.	Wear high-visibility safety vests. Barricade and mark drilling sites for visibility. Use a flagger, if necessary, to direct traffic away from drilling areas.	

AHA A-1 – Well Drilling			
Job Steps	**Hazards**	**Controls**	**RAC**
5. Hand-auger the first 5 feet of the intended borehole.	Workers could experience back and muscle strain from improper use of tools.	Surveys shall be performed by persons qualified to identify and evaluate tasks that might result in injuries due to ergonomic hazards. The focus of the surveys will be operations that involve manually lifting and moving excessively heavy or asymmetric, objects. Hand tools shall be selected to minimize the following stressors: chronic muscle contraction or steady force, extreme or awkward finger/hand/arm positions, repetitive forceful motions, and excessive gripping, pinching, and/or pressing with hand and fingers. Avoid prolonged repetitive motion. Rotate job task with other workers. Perform flex/stretch exercises prior to task.	M
6. Drilling operations: start up the drill and perform drilling.	Unqualified operators or personnel working on site who are not trained in drilling safety procedures.	Ensure that personnel are trained in the proper use of drilling equipment. Ensure that the operator has current certifications to operate the equipment. Ensure that a 20-pound dry chemical ABC fire extinguisher is readily available. Ensure that a spill control kit is available at the drilling location. Ensure that there is a first aid kit, eyewash, and an emergency air horn nearby.	H
	Start-up of the unit without a guard "cage" around the auger could cause a worker to come into contact with the auger, resulting in injury or death.	In no case will the auger be engaged without a guard "cage" placed around the auger.	
	Pressurized hydraulic lines could rupture, causing the release of hot hydraulic fluid. Hot fluid could ignite if contact is made with an engine. Hot fluid could also burn workers, and the fluid could cause environmental contamination.	Inspect all hydraulic lines before placing the rig in service. Any damaged hoses or connections must be replaced before the unit is used. Immediately shut down equipment if any lines rupture. Ensure that a 20-pound dry chemical ABC fire extinguisher is readily available. Ensure that a spill control kit is available at the drilling location. If a rupture occurs, as quickly as possible berm the liquid to minimize the area over which the liquid spreads. Ensure that all pressurized lines have whip checks.	
	Air hoses, or hydraulic hoses under pressure, could suddenly release, whip, and hit workers, causing severe injury.	Do not disconnect air hoses and compressors until the hose line has been bled. Visually inspect all connections of any lines under pressure. Use safety clamps to connect each side of the connection to the other if the connection breaks. (The safety clamps will keep the hoses from whipping under the sudden release of pressure.) Tie back, or attach hoses wherever possible, to minimize the length of hose that could whip around if there is a sudden release of pressure.	

AHA A-1 – Well Drilling			
Job Steps	**Hazards**	**Controls**	**RAC**
6. Drilling operations: start up the drill and perform drilling. (Continued)	Strains to workers could result from manually moving materials, equipment, and drums.	Personnel will be directed to use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help in moving bulky/heavy materials and equipment. Mechanical equipment will be used as much as possible. Use care when handling augers or drill rods. Avoid standing under any load. Do not lift more than 50 pounds without assistance. Perform flex/stretch exercises prior to task.	
	Atmospheric and contact hazards from chemical agents could occur.	Ambient air/visual monitoring will be used to verify selection of PPE, SSHP, Table 6-1. Use a PID to determine if the recently drilled hole is off-gassing vapors. An MSDS for any drilling fluids will be obtained/reviewed with workers. Decontaminate drilling implements after use (or cover contaminated parts when moving to the next drilling site). Avoid exposure to dust. Use dust control as necessary and possible. PPE will be used. Drum and label all soil cuttings. Determine if PPE is contaminated (based on exposure to contaminants). Place contaminated PPE in a separate, properly labeled container. Discard other PPE, as approved by the project manager and PESM. Do not place face or head over hole.	
	Sometimes workers use plastic sheeting in the area where they are drilling to protect the surrounding ground. This sheeting becomes very slippery when drilling muds are placed on it.	Avoid using plastic sheeting, if possible. Many drillers today build a small bermed area where they place the drilling muds. It is easier to clean up the surface of the soil than to have workers slip on plastic sheeting. If plastic sheeting must be used, dig out a small depression, place the plastic on the ground, and cover it with the removed soil. This way the plastic sheeting should not become too slippery, as it will be covered by the removed soil. (This creates a larger volume of soil to be disposed of, but it is a safer method than working on slippery plastic.) Do not cover or mark any holes covered with plastic sheeting.	
	The drill mast could be used to lift other objects as it is being raised, causing potential failure of the mast.	Masts shall be used in a manner specified by the manufacturer and should never be loaded beyond their capacity.	
	Workers could climb the drill mast and expose themselves to a fall hazard.	Climbing on the drill mast is not allowed.	

AHA A-1 – Well Drilling			
Job Steps	**Hazards**	**Controls**	**RAC**
6. Drilling operations: start up the drill and perform drilling. (Continued)	Workers could place hands into moving parts of the rig, or loose clothing could become entangled in moving machine parts, either of which could injure a worker.	Chains, sprockets, and moving parts will be guarded. Workers will not wear loose clothing or any jewelry. Workers will not place their hands or any part of their bodies between the drill rod, and the drill plate. Workers should never place themselves in positions where they could come into contact with the moving drill rods. DPT and CPT rigs do not have a rotating auger but workers will still keep clear of rig components.. The operator will verbally alert all workers and visually ensure that all workers are clear of dangerous parts of equipment before starting or engaging equipment.	
	Workers could trip or fall by stepping on a borehole.	Cap and flag open boreholes. All open boreholes will be protected as any open excavation if they are left unattended. (Place a steel trench plate, for example.)	
	Pinch points could injure the hands of workers.	Avoid placing hands close to moving machinery. Wear gloves, as appropriate. Keep constantly alert.	

AHA A-1 – Well Installation		
Equipment to be Used	**Training Requirements/Competent or Qualified Personnel Name(s)**	**Inspection Requirements**
1. Vehicles – pickup trucks	Department of Motor Vehicles-licensed personnel will operate vehicles.	Inspect daily and before use. Use the equipment safety checklist found in the SSHP.
2, Heavy equipment, dump trucks, excavator, loader	Only trained equipment operators may operate heavy equipment; only Department of Motor Vehicles-licensed personnel will operate trucks. Operators' manuals must be available on site and personnel must have reviewed them.	Inspect daily or before use. All equipment must be inspected and certified by a competent mechanic.
3. Drill rig	Only trained equipment operators may operate a drill rig. The operator's manual is to be reviewed by all operators, and the manual maintained on site.	Inspect upon arrival at the site as specified in this AHA. Inspect daily or before use. Use the inspection form for drilling rigs
4. Hand tools – drills, mixing elements, screwdrivers, hammers, pliers, etc.	Personnel must have reviewed operator's manual and have been trained on power tools. Only qualified person will operate equipment	Inspect hand tools before each use following manufacturers' requirements. Discard or tag "out of service" any tools that are damaged. Do not use power tools that have frayed cords or exposed wiring. All power tools must have a grounding plug or be double insulated.

Abbreviations and Acronyms:

AHA – Activity Hazard Analysis
APP – Accident Prevention Plan
CIH – Certified Industrial Hygienist
CSP – Certified Safety Professional
CTO – Contract Task Order
EM – Engineer Manual
kV – kilovolt
MSDS – Material Safety Data Sheet
PESM – Project Environmental Safety Manager
PID – photoionization detector
PPE – personal protective equipment
PVC – polyvinyl chloride
RAC – Risk Assessment Code
SSHO – Site Safety and Health Officer
SSHP – Site Safety and Health Plan
TtEC – Tetra Tech EC, Inc.

Activity Hazard Analysis A-2

Job/Task: Groundwater Monitoring Well Installation and Development	**Overall Risk Assessment Code (RAC) (Use highest code)** **M**
Project Location Cannon AFB, Clovis, NM	**Risk Assessment Code (RAC) Matrix**
Contract Number: W9128F-10-D0019, Task Order 001	
Date Prepared: June 10, 2011	
Prepared by (Name/Title): Carol Rieger, Project Manager	
Reviewed by (Name/Title): Roger Margotto, CIH, CSP	

Severity	Probability				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	E	E	H	H	M
Critical	E	H	H	M	L
Marginal	H	M	M	L	L
Negligible	M	L	L	L	L

Notes: (Field Notes, Review Comments, etc.)
In addition to the information listed in this AHA, all field personnel must review and be familiar with all provisions of the approved APP/SSHP. TtEC Corporate Safety Programs and the EM 385-1-1 will also be available on site for review of specific materials and mitigation measures.

Step 1: Review each **"Hazard"** with identified safety **"Controls"** and determine RAC (See above)

"Probability" is the likelihood to cause an incident, near miss, or accident and identified as: Frequent, Likely, Occasional, Seldom or Unlikely.

"Severity" is the outcome/degree if an incident, near miss, or accident did occur and identified as: Catastrophic, Critical, Marginal, or Negligible

Step 2: Identify the RAC (Probability/Severity) as E, H, M, or L for each "Hazard" on AHA. Annotate the overall highest RAC at the top of AHA.

RAC Chart

- **E = Extremely High Risk**
- **H = High Risk**
- **M = Moderate Risk**
- **L = Low Risk**

AHA A-2 – Groundwater Monitoring Well Installation and Development

Job Steps	Hazards	Controls	RAC
1. Visually survey the site prior to installation activities.	Failure to properly survey the site could cause exposure and/or damage to underground and overhead utilities, and cause slips, trips, and falls to workers from various agents.	Ensure that the ground has no hazards such as unstable soil, underground utilities (marked per utility survey), overhead utilities, or pre-existing slip, trip, and fall hazards. Mark, or eliminate, all hazards as feasible.	L
2. Unload the monitoring well casing and annulus materials, and place near the boring.	Well materials could have shifted during transport, or are poorly tied down, causing loads to fall when tie-downs are removed.	Remove each tie-down carefully. No other personnel will be on the ground near the truck when the tie-downs are removed.	L

AHA A-2 – Groundwater Monitoring Well Installation and Development			
Job Steps	**Hazards**	**Controls**	**RAC**
	Workers injury from lifting heavy loads.	Workers will not lift more than 50 pounds without assistance. Workers must avoid any twisting motion at the torso and neck, and use legs to do most of the lifting.	L
	Traffic in/ adjacent the work area may result in injuries to workers. Also, work activity could damage nearby vehicles.	Establish a safe work zone and a Traffic Plan. Non-site traffic should be at least 50 feet away from operations. Demarcate or barricade the work area. Wear high-visibility safety vests.	
3. Install the monitoring well casing and backfill materials.	An overhead winch or cable failure, causing injury or property damage.	Inspect the winch prior to operating. Never lift loads greater than the capacity of the winch. Never work under any raised materials or loads.	M
	Load could swing when raised and strike a worker or other objects.	Use a tag line to guide and secure the load as it is being raised.	
4. Pour bentonite into mixing drum.	Inhalation of bentonite dust.	Wear designated PPE, dust masks while handling dry bentonite powder. Wear N95 dusk mask when handling bentonite powder. Remove PPE properly and wash hands. Work upwind while pouring to avoid inhalation of dust. Employ dust suppression as necessary. Review the MSDS for bentonite.	L
	Improper lifting of materials could cause strain to the workers.	Use proper lifting techniques such as keeping the back straight, lifting with legs, limiting twisting, and getting help when moving bulky/heavy materials and equipment. Use a hand-truck, if needed. For loads greater than 50 pounds, use two people to lift.	
5. Well development.	Electrocution during decontamination of submersible pump.	While powering the submersible pump with a generator during decontamination of the pump, never handle the (powered) pump in one hand while contacting the generator with the other hand. Worn power-cable (4 wire) insulation contacting the stainless steel body of the pump (where the flat-wire enters the pump body) energizes the pump body. Grabbing the (wet) energized pump body with one hand, and touching the generator (or ground) completes the circuit, allowing the electrical energy travel from the pump body, through the chest (heart), back to the generator set/ ground. Inspect the insulation on power cable wires!	M
	Entanglement with surge block cable/ strike by surge block.	Never handle/ approach the surge block/ cable while oscillating within the well screen. Should the development rig operator miscalculate the depth of the surge block, he may project it out the top of casing, a potential missile/ entanglement hazard. Do not wear loose hair, clothing or jewelry while working with a development rig.	

AHA A-2 – Groundwater Monitoring Well Installation and Development		
Equipment to be Used	**Training Requirements/Competent or Qualified Personnel name(s)**	**Inspection Requirements**
Drill	Only trained equipment operators may operate a drill rig. The operator's manual is to be reviewed by all operators, and the manual maintained on site.	Inspect daily, or before use. Use the inspection form for drilling rigs.
Vehicles	All drivers must have a valid driver's license.	Inspect daily, and before use.
Hand tools – basic screwdrivers, hammers, pliers, etc.	Personnel must have reviewed the operator's manual and have been trained on power tools. Only a qualified person will operate a generator or compressor, if used.	Inspect hand tools before each use, following the manufacturers' requirements. Discard, or tag as "out-of-service" any tools that are damaged. Do not use power tools that have frayed cords or exposed wiring. All power tools must have a grounding plug or be double-insulated.
Fire Extinguishers	Fire Extinguisher Training including use/limitations.	At least monthly by SSHO or designee.
First aid kits and other emergency equipment	Use of emergency equipment/first aid kits must be done by personnel familiar with this plan; use and inspection criteria of the equipment, and what the equipment is used for, by or under direction of the SSHO.	Initially and at least weekly thereafter or after use for restocking. (29 CFR 1926.50(d)(2)) First aid kits must be filled per EM 385-1-1, Table 3-1.
Submersible Pump	Development rig operator.	Inspect for worn insulation on flat 4-wire cable, especially where it enters the pump body.

Abbreviations and Acronyms:

AHA – activity hazard analysis
APP – Accident Prevention Plan
CFR – Code of Federal Regulations
CIH – Certified Industrial Hygienist
CSP – Certified Safety Professional
EM – Engineer Manual
MSDS – material safety data sheet
PPE – personal protective equipment
RAC – Risk Assessment Code
SSHO – Site Safety and Health Officer
TtEC – Tetra Tech EC Inc.

Appendix C
Standard Operating Procedures for Field Investigations

The Standard Operating Procedures for Cannon Air Force Base field investigation activities are included in this appendix. It is understood at all times that the site-specific requirements supersede these generic requirements.

CONTENTS

Section		Page
SOP C1	BOREHOLE AND SAMPLE LOGGING	C-7
SOP C2	MONITORING WELL INSTALLATION	C-23
SOP C3	MONITORING WELL DEVELOPMENT	C-35
SOP C4	LAND SURVEYS	C-41
SOP C5	EQUIPMENT DECONTAMINATION	C-43
SOP C6	PH	C-47
SOP C7	SPECIFIC CONDUCTANCE	C-49
SOP C8	WATER TEMPERATURE	C-51
SOP C9	DISSOLVED OXYGEN	C-53
SOP C10	OXIDATION-REDUCTION POTENTIAL	C-55
SOP C11	WATER LEVELS	C-57

This page intentionally left blank.

FIGURES

Figure C1-1. Typical Bore Log Form Used to Describe Split Spoon Samples C-17

Figure C1-2. The Unified Soil Classification System (USCS) C-21

Figure C2-1. Overburden Monitoring Well Construction Diagram C-27

Figure C2-2. Overburden Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion C-29

Figure C2-3. Double Cased Monitoring Well Construction Diagram C-31

Figure C2-4. Double Cased Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion C-33

Figure C3-1. Well Development Record and Water Quality Field Data Sheet C-37

Figure C11-1. Groundwater Level Data Form C-59

This page intentionally left blank.

ACRONYMS

°C	degrees Celsius
AFB	Air Force Base
ARCH	Air rotary casing hammer
ASTM	American Society for Testing and Materials
bgs	below ground surface
cm	centimeter
EM	Engineers Manual
µmhos/cm	micromhos per centimeter
mg/L	milligrams per liter
mm	millimeter
mV	millivolt
NBS	National Bureau of Standards
NTU	Nephelometric Turbidity Unit
pH	potential of Hydrogen
PPE	personal protective equipment
PVC	polyvinyl chloride
RQD	rock quality designation
SOP	standard operating procedure
SPR	standard penetration resistance
SSHP	Site Safety and Health Plan
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System

This page intentionally left blank.

SOP C1 BOREHOLE AND SAMPLE LOGGING

Drilling Logs and Documentation

Each boring will be fully described on a boring log similar or equivalent to that shown in Figure C1-1 and in accordance with ASTM D5434. The rig geologist will log the boring as it is being drilled by recording relevant data, listed below, on either the appropriate boring log or in a bound field logbook. Boring log forms may be transcribed from a field logbook, but must be completed at a minimum on a weekly basis. Data that will be included in the logs, when applicable, are:

- Identifying number and location of each boring.
- All measurements shall be accurate to one-tenth of a foot.
- Drilling logs and other scaled drawings should be drawn at a scale of 1 inch = 1 foot. (Note: for wells deeper than 200 feet, the scale may be adjusted to a more practical ratio. In addition, if sampling intervals are greater than 10 feet apart the log can be represented with breaks in order to skip unlogged intervals)
- Soil classifications in accordance with the USCS. These classifications will be prepared in the field by the geologist and will be subject to revision based on laboratory tests or subsequent review.
- Rock classifications in accordance with the procedures and guidelines described in the below section on Rock Classification.
- A full description of soil samples. For split-spoon, thin wall, soil core, or otherwise intact samples, the description will include but not be limited to the USCS two-letter classification, plus a more complete verbal description of color, consistency, soil moisture, grain size and size distribution.
- Depth limits, type and number of each sample taken. All samples will be numbered consecutively.
- The number of blows required for each 6-inch penetration of split-spoon sampler and for each 12-inch penetration of casing; hammer weight and length of fall for split-spoon or driven samplers; hydraulic pressure used to push thin-wall tubes. If thin-wall tubes are pushed manually, that will be indicated.
- The start and finish times for all rock coring runs including a description and depth of any drilling anomalies such as voids, loss of fluids or air, odors, etc.
- Depth to water as first encountered during drilling, along with the method of determination. Any distinct water-bearing zones below the first zone also will be noted. Other observations during drilling will also be noted, such as bit chatter, rod binding, rod drops, flowing or heaving sands, bit pressure, rod rotations per minute, and water pressure.

- If drilling fluid is used, the fluid losses, interval over which they occur and the quantity losses, lost will be recorded.
- A general description of the drilling equipment used. This description, including such information as rod size, bit type, pump type, rig manufacturer, and model, may be provided in a general legend.
- Dates and times of start and completion of boring.
- Names of Contractor, driller and rig geologist.
- Size and length of casing or auger used in each borehole.
- Observations of visible contamination for each sample or from cuttings that appear contaminated.
- Field instrument readings.

As the boring is drilled, the rig geologist will evaluate adjacent samples recovered, together with observation of the drill cuttings, wash water (if any), drill performance, etc., to determine appropriate stratigraphic definitions or distinctions within the soil column. Such contacts or breaks between strata must be determined by the rig geologist and indicated on the boring log. If such information is not provided, the "log" is nothing more than a listing of individual sample descriptions. In general, a stratigraphic unit contains only similar soils which can be classified within the same two-letter USCS classification category symbol. In some cases, significant differences in soil color, grain size distribution, strength, etc., would be sufficient to classify soils having the same two-letter USCS classification category symbol into two or more distinct strata.

After the rig geologist has indicated the appropriate stratigraphic breaks on the log, he/she should develop and record an appropriate description for each defined stratigraphic unit. Each description should contain information about the color, grain size distribution, consistency, moisture, etc., and the appropriate two-letter USCS classification category symbol.

Classification of Soils

All classification data should be written directly on the boring log (if there is enough space) or in a field logbook. The method of deriving the classification should be described, or reference to this guideline or other manuals should be made. Handling of samples during soil classification should be coordinated with chemical sampling activities, if appropriate.

USCS Classification

Soils are to be classified according to the USCS (ASTM D2487). This method of classification is detailed in Figure C1-2. This method of classification identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols.

In the USCS system, fine-grained soils, or fines, are classified as those which will pass through a No. 200 U.S. standard sieve [0.074 millimeter (mm)] and are of two types: silt "M" and clay "C". Some classification systems define size ranges for these soil particles, but for field classification purposes,

they are identified by their respective behaviors only. Organic material "O" is common component of soil but has no size range, and is recognized by its composition.

Gravely soils are identified by a "G" as the first letter in the two-letter symbol, whereas sandy soils are identified with an "S". The term "rock fragments" should be used to indicate granular materials resulting from the breakup of rock. These materials are normally angular, indicating little or no transport from their source. When the term "rock fragments" is used it should be followed by a size designation, such as ¼ to ½ diameter or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

The second letter in the two-letter USCS symbol provides information about the grain size distribution of granular soils, or the plasticity characteristics of fine-grained soils. These second-letter modifiers are "P" well sorted, "W" well graded/poorly sorted, "C" clayey, "M" silty, "L" low plasticity, or "H" high plasticity. Note that the term "poorly graded" implies a uniform grain size distribution and is the same as "well sorted."

Color

Soil colors should be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Since color can be utilized in correlating units between sampling locations, it is important that color descriptions be kept consistent throughout field operations.

Colors must be described while the sample is still moist. Soil samples should be broken or split vertically to describe colors. Soil sampling devices tend to smear the sample surface creating color differences between the sample interior and exterior. In accordance with ASTM D1535, Munsell Color Charts or equivalent must be used based on project requirements.

Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist must first identify the soil type. Granular soils contain predominantly sands and gravels and are generally noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split-spoon sampling methods that are in accordance with ASTM D1586. Those designations are:

Standard Penetration Resistance (SPR)

Designation	Blows per foot
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140-pound hammer falling freely through 30 inches. The sampler is driven through an 18- or 24-inch sample interval and number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the second and third 6 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are logged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This should be noted on the log and referenced to the sample number.

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure B1-2. The consistency of cohesive soils is determined either by blow counts or most accurately by a pocket penetrometer or field Torvane device in accordance with ASTM D2573-72–*Method for Field Vane Sheer Text in Cohesive Soil.* The SPR can be applied to cohesive soils as follows:

Designation	SPR (blows per foot)
Very soft	<2
Soft	2-4
Medium soft	4-8
Stiff	8-15
Hard	>30

The pocket penetrometer method is conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-spoon sampler. The sample should be broken in half and the penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft, decomposed rock fragment rather than a hard soil. The pocket penetrometer or Torvane may be used in the conjunction with blow counts to determine cohesive soil consistency.

Soil Component

In nature, soils are comprised of particles of varying size and shape and are combinations of the various soil types. Figure B1-2 lists grain size classifications to be used in describing soils or rocks. The following terms are useful in the description of soil components:

The Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0-10 percent
little	11-20 percent
some	21-35 percent
"and"	36-50 percent

Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the

individual's judgment. A suggested parameter for judging this in a fine-grained soil would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests in accordance with ASTM D2216 or field tests for water content should be performed if the natural water content is important.

Stratification

Stratification can only be determined after the split-spoon sampler is opened. The stratification or bedding thickness for soil and rock is dependent on grain size and composition. The classification to be used for stratification description is described below:

Thickness (Metric)	Approximate English Equivalent	Classification
>1 meter	> 3.3 feet	Very thick
30 cm - 1 meter	1.0 feet - 3.3 feet	Thick Bedded
10 cm - 30 cm	4.0 inch - 1.0 feet	Medium Bedded
3 cm - 10 cm	1.0 inch - 4 inch	Thin Bedded
1 cm - 3 cm	2/5 inch - 1 inch	Very Thin Bedded
3 mm - 1 cm	1/8 inch - 2/5 inch	Laminated
1 mm - 3 mm	1/32 inch - 1/8 inch	Thinly Laminated
<1 mm	<1/32 inch	Micro Laminated

Classification of Rocks

Rocks are grouped into three main divisions: sedimentary, igneous and metamorphic. Sedimentary rocks are by far the most predominant type exposed at the earth's surface. The following basic names are applied to the type of rocks found in sedimentary sequences:

- ***Sandstone***—Made up predominantly of granular materials ranging between 1/16 and 2 inches diameter.
- ***Siltstone***—Made up of granular materials less than 1/16-inch diameter. Fractures irregularly.
- ***Claystone***—Very fine-grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.
- ***Shale***—A fissile, very fine-grained rock. Fractures along bedding planes.
- ***Limestone***—Rock made up predominantly of calcite. Effervesces upon the application of hydrochloric acid.
- ***Coal***—Rock consisting mainly of organic remains.

- ***Others***—Numerous other rock types are present in the geologic section. Their overall abundance is dependent upon the geographical locations.

In classifying a sedimentary rock the following characteristics should be noted:

- Rock Type
- Color
- Bedding Thickness
- Hardness
- Fracturing
- Weathering
- Mineralogy (if discernible)
- Other Characteristics

All classification data should be written directly on the boring log or in a field log book. The method of deriving the classification should be described or reference to this guideline or other manuals used should be included.

Rock Type

As described previously, there are numerous names for sedimentary rocks. In most cases a rock will be combination of several rock types, therefore a modifier such as sandy siltstone or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain diameters are used for the classification of classic sedimentary rock. The following is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks.

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125 - 02.5 mm
Very Fine Sand	0.0625 - 0.125 mm
Silt	0.0039 - 0.0625 mm
Clay	< 0.0625 mm

Color

The color of a rock can be determined in the same manner as for soil samples. Rock core samples should be classified while wet, when possible, and air-cored samples should be scraped clean of

cuttings prior to color classifications. Munsell Color Charts or equivalent may be used if required for the project.

Stratification

The bedding thickness designations applied to soil classification will also be used for rock classification.

Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- ***Soft***—Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- ***Medium soft***—Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- ***Medium hard***—No core erosion, easily scratched by screwdriver or breaks with sharp edges from single hammer blow.

Note the difference in usage here of the words "scratch" and "gouge." A scratch should be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

Fracturing

The degree of fracturing of a rock is described by measuring the fractures of joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken—Less than 2 inches
- Broke—2 inches to 1 foot
- Blocky—1 to 3 feet
- Massive—3 to 10 feet

Artificial breaks can be distinguished from natural partings by several criteria. Drilling breaks are generally relatively sharp edged and the newly exposed rock surfaces are invariably fresher in appearance (less weathered) than natural breaks. Core pieces on each side of a drilling break usually fit perfectly back together, whereas natural breaks may exhibit gaps and clay films or seams, oxidation stains, or mineralization. Do not confuse drill cuttings or drilling mud on a fractured surface with a natural clay film or seam.

The structural integrity of the rock can be approximated by calculating the RQD of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage:

$$RQD = \left(\frac{r}{l}\right) \times 100$$

where:

r = Total length of all pieces of the lithologic unit being measured, which are greater than four inches in length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc

l = Total length of the coring run

Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- ***Fresh***—Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.
- ***Slight***—Rock has some staining (i.e., discoloration along joints, cracks or exposed surfaces) which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.
- ***Moderate***—Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.
- ***Severe***—All rock, including quartz grains, is stained. Some of the rock is weathered to the extent of becoming a soil. The rock is very weak and crumbly.

Other Characteristics

The following items should be included in the rock description:

- Description of contacts between two rock units. These can be sharp or gradational.
- Description of any cavities or bugs, including fillings, if present.
- Description of any joints or fractures.
- Notation of joints or fractures with depth, any unusual staining (not weathering), approximate angle from horizontal, any mineral filling or coating, degree of weathering and interpretive, relative degree of groundwater movement through the fracture.

As an attachment to the log, additional information should be provided, including an estimation of the degree of cementation and type of cement for granular sedimentary rocks; a description of the texture and fabric of the rock (i.e., the shape and relationship of component particles or crystals); and the structure of macroscopic features of the rock mass. Generally, rock structure is best seen in the outcrop rather than the hand specimen, but some indication of structure (e.g., horizontal or dipping beds, open joints) can be obtained from core samples.

Numerous classification schemes for igneous and metamorphic rocks are available. Compton, 1962 *Manual of Field Geology*, John Wiley & Sons, Inc. New York and *Classification of Rocks*, Quarterly of the Colorado School of Mines, Volume 50, Number 1, January 1955 are preferred. Igneous and metamorphic rocks that may be encountered at Cannon AFB will be classified according to the procedures outlined in *Classification of Rocks*.

Igneous rock classification is based on texture and mineralogy. The distinction between intrusive and extrusive (volcanic) igneous rocks is not specifically addressed by rock classification schemes but is indicated by texture, which is a function of cooling history, and is determined by field relationships. Metamorphic rock classification is based primarily on structure and mineralogy. Directional or nondirectional structure is and important attribute in determining nomenclatures. Because metamorphic rocks derive from preexisting igneous or sedimentary rocks which have undergone a chemical or physical change after their original metamorphic rocks are divided into two groups:

- those formed by regional metamorphism, and
- those formed by contact metamorphism (Hurlbut, 1971, *Dana's Manual of Mineralogy*, 18th Edition, John Wiley & Sons, Inc.).

Igneous rock will be classified based on granularity or the absence of visible grains, the relationship between grains, the proportions of essential rock-forming minerals, color, and the presence and type of visible accessory minerals.

Metamorphic rocks will be classified on the basis of directional or nondirectional structure, the type of directional structure if any, mineralogy, and color.

In addition to standard classification of igneous and metamorphic rocks, other features will be described, Physical features of crystalline rocks that may contribute to groundwater or contaminant migration will be described and characterized. Joints or fractures will be mapped, widths measure, and their aspect and degree of interconnections described. Fracture-filling minerals will be described and sampled if necessary to determine potential interactions between these minerals and potential contaminants.

The predominant local bedrock encountered at Cannon AFB is the Tertiary Santa Fe Formation. The Santa Fe Formation consists of light brown to reddish-brown clays and mudstones, and sands and gravels which are indurated with caliche. The Santa Fe Formation should be noted and described on the boring log when encountered in core or cuttings.

References for Other Applicable ASTM Standards

ASTM D2488 – Description and Identification of Soils (Visual-Manual Procedure)
ASTM D 4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils

This page intentionally left blank.

Figure C1-1. Typical Bore Log Form Used to Describe Split Spoon Samples

HTRW DRILLING LOG	DISTRICT	HOLE NUMBER
1.COMPANY NAME	2.DRILL SUBCONTRACTOR	SHEET 1 OF SHEETS
3.SITE	4.LOCATION	
5.NAME OF DRILLER	6.MANUFACTURER'S DESIGNATION OF DRILL	
7.SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8.HOLE LOCATION	
	9.SURFACE ELEVATION	
	10.DATE STARTED	11.DATE COMPLETED
12.OVERBURDEN THICKNESS	15.DEPTH GROUNDWATER ENCOUNTERED	
13.DEPTH DRILLED INTO ROCK	16.DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14.TOTAL DEPTH OF HOLE	17.OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18.GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19.TOTAL NUMBER OF CORE BOXES

20.SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	SVOC	Pest/PCB	Cyanide/TRPH	21.TOTAL CORE RECOVERY %
	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23.SIGNATURE OF INSPECTOR		

22.DISPOSITION OF HOLE	SCALE 1 inch = 1 foot

LOCATION SKETCH/COMMENTS

PROJECT	HOLE NO.

This page intentionally left blank.

Figure C1-1. Typical Bore Log Form Used to Describe Split Spoon Samples (Concluded)

HTRW DRILLING LOG	SITE	LOCATION	HOLE NUMBER
PROJECT #	DISTRICT	INSPECTOR PATRICIA WESTON	SHEET 2 OF SHEETS

ELEV. (a)	DEPTH (ft.) (b)	DESCRIPTION OF MATERIALS (c)	USCS CLASS. (d)	FIELD SCREEN RESULTS (e)	REMARKS (f)
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

This page intentionally left blank.

Figure C1-2. The Unified Soil Classification System (USCS)

Revised 07-12-02

UNIFIED SOIL CLASSIFICATION SYSTEM

UNIFIED SOIL CLASSIFICATION AND SYMBOL CHART

COARSE-GRAINED SOILS (more than 50% of material is larger than No. 200 sieve size.)		
GRAVELS More than 50% of coarse fraction larger than No. 4 sieve size	Clean Gravels (Less than 5% fines)	
	GW	Well-graded gravels, gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
	Gravels with fines (More than 12% fines)	
	GM	Silty gravels, gravel-sand-silt mixtures
	GC	Clayey gravels, gravel-sand-clay mixtures
SANDS 50% or more of coarse fraction smaller than No. 4 sieve size	Clean Sands (Less than 5% fines)	
	SW	Well-graded sands, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines
	Sands with fines (More than 12% fines)	
	SM	Silty sands, sand-silt mixtures
	SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (50% or more of material is smaller than No. 200 sieve size.)		
SILTS AND CLAYS Liquid limit less than 50%	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silty clays of low plasticity
SILTS AND CLAYS Liquid limit 50% or greater	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	CH	Inorganic clays of high plasticity, fat clays
	OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

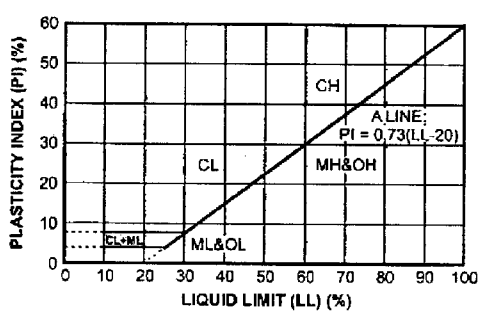
LABORATORY CLASSIFICATION CRITERIA

GW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
GP	Not meeting all gradation requirements for GW	
GM	Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols
GC	Atterberg limits above "A" line with P.I. greater than 7	
SW	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$ between 1 and 3	
SP	Not meeting all gradation requirements for GW	
SM	Atterberg limits below "A" line or P.I. less than 4	Limits plotting in shaded zone with P.I. between 4 and 7 are borderline cases requiring use of dual symbols.
SC	Atterberg limits above "A" line with P.I. greater than 7	

Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:

Less than 5 percent ..... GW, GP, SW, SP
More than 12 percent ..... GM, GC, SM, SC
5 to 12 percent ..... Borderline cases requiring dual symbols

PLASTICITY CHART



This page intentionally left blank.

SOP C2 MONITORING WELL INSTALLATION

Different methods exist for the installation of monitoring wells. This SOP outlines the suggested procedure currently implemented on Base that is proven reliable for successful installation of problem-free monitoring wells. Any deviations from this procedure must be addressed in the project-specific plan must include an approved site-specific SOP.

The monitoring well program is designed to provide groundwater sampling points on site as well as upgradient and downgradient of the site so that groundwater contamination may be characterized. Figures B2-1, B2-2, B2-3, and B2-4 illustrate typical construction details for monitoring wells.

Monitoring Well Installation Procedure

Proposed monitoring wells will be installed in accordance with the following procedure:

- Wear appropriate PPE as specified in the Basewide Health and Safety Plan (Foster Wheeler, 2000) and the Site Safety and Health Plan (SSHP) (Appendix B to the Work Plan).
- Drill borehole to the total depth using an air rotary casing hammer (ARCH) or drill rig (bit size of 8 or 10 inches). Temporary surface casing to the water table may be used to stabilize the upper portion of the drill hole, but casing must be removed as filter pack and bentonite-cement grout are installed.
- The appropriate depth will be determined in the field and is dependent on the occurrence of significant water. If significant groundwater is encountered during drilling, drilling will cease, and the hole will be allowed to equilibrate for approximately 1 hour. If a determination is made that the regional aquifer has been reached, well installation will be completed within this zone.
- Well construction will require 4-inch, flush-threaded Schedule 80 polyvinyl chloride (PVC) casing and 30 feet of 0.01-inch Schedule 80 slotted screen with 6-inch screw-on end cap. No sump will be installed.
- For a 4-inch diameter well the borehole will be drilled with 11 ¾-inch outer-diameter drive casing to 200 feet bgs. Collect and log soil cuttings at 5- to 10-foot intervals or at changes in lithology. Cutting samples will be collected from the cyclone. Install 9 5/8-inch casing inside the 11 ¾-inch casing and advance the 9 5/8-inch casing to the desired depth of the completed well. Collect and log soil cuttings at 5- to 10-foot intervals or at changes in lithology.
- Use 30 feet of 0.01-inch PVC slotted screen and blank casing to the top of the well stick-up. The top of the screened interval will be set at the existing water table. Centralizers will be installed at 40-foot intervals and at the top and bottom of the screened interval.
- Once the drill casing has been slowly removed from the borehole, seat the well end cap, screen, and casing at the bottom of the borehole. Using a tremie pipe, fill the annular space from the bottom of the borehole to a minimum of 2 feet above the well screen with a filter pack (10/20 silica sand). The filter pack will be placed using a tremie pipe to avoid bridging

and ensure a continuous filter pack throughout the screened interval of the well. Next, a bentonite chip or pellet seal will be installed for a thickness of 10–20 feet and hydrated every 1 foot per manufacturer instructions to ensure a competent seal. Installation of a thicker bentonite seal is currently used for monitoring wells at the base to ensure that there will be no intrusion of grout from above the seal with the filter pack material below the seal.

- In the event of overdrilling the borehole to a depth greater than necessary, backfilling of the borehole will be required prior to setting the end cap and well screen and casing. Once the drill casing has been slowly removed from the borehole, backfill the borehole to the desired depth at which the well end cap, screen, and casing will be seated. Proceed with the installation of the filter pack and the bentonite seal.

- After allowing a minimum of 4 hours for the bentonite seal to set, install a 20 percent high solids bentonite grout slurry over the bentonite seal using a tremie pipe. The slurry will consist of 20 percent by weight of sodium bentonite powder. Install the slurry to within 30 feet of the surface. The high-solids bentonite grout slurry is currently and successfully used for well installation at the base to inhibit intrusion of grout into the well's filter pack and screen.

- To the surface, install a cement/bentonite grout mixture over the high-solids bentonite grout using a tremie pipe. The mixture will consist of 94 pounds of Portland cement to 7 gallons of approved water and 3 percent by weight of sodium bentonite powder.

- Install an 8-inch by 5-foot protective round steel casing and a 4-foot by 4-foot by 4-inch concrete pad mounded in such a way as to direct surface runoff from the casing. Install four 4-inch by 5-foot steel bollards around each well on the outside of the concrete pad. Drill a drain hole in the protective casing above the concrete surface. In locations subject to freezing, the finished pad must be designed to resist damage caused by frost heaving.

- Leave an approximate stick-up height of 3 feet for the protective well casing with the inside well PVC casing a minimum of 6 inches below this to accommodate the dedicated pump system.

- The well will be equipped with a security lock. The lock will be a four digit combination lock and will be set to the well's four digit identification number. The well will be tagged with a corrosion-resistant identification stamped on the protective casing which identifies the well number, depth, date of installation, and the adjusted top of casing elevation. The well will also be clearly designated as a monitoring well. The casing will be coated with protective paint the same color as the other wells on the site.

- Some wells may have to be finished flush with the ground or pavement if they are in areas of heavy traffic. Flush finished wells shall also be equipped with a lock and shall be protected from the entry of surface fluids into the well. Protective posts shall not be required on flush-finished wells.

- Continuously log soil cuttings throughout the drilling operation in accordance with SOP B1, *Borehole and Sample Logging*. Document the findings on the soil boring log sheet.

- After completion of the well a well alignment test to verify plumbness and integrity of well is recommended. The recommended method to test well plumbness and alignment is as follows:
  - A 10-foot long section of pipe, ½ inch less in diameter than the inner diameter of the well riser pipe, shall be run through the entire length of the well to check the alignment. The result of such test shall be recorded on the Daily Quality Control Reports and the installation diagram. The pipe section shall be decontaminated with steam prior to the test. Adequate precautions shall be taken to prevent cross-contamination of wells with cable or rope used to conduct the test.
  - The pipe must pass freely for the entire depth of the well.

Well construction diagrams will be submitted to the client for approval. These forms will at a minimum include the following information:

- Project and site names, well number and the total depth of the well.
- Depth of any grouting or sealing, the amount of cement and/or bentonite used, and the total depth of the boring.
- Depth and type of well casing.
- Static water level upon completion of the well and after well development.
- Installation date or dates, and name of the driller and the geologist installing the well. Each installation diagram will be signed by the preparer.
- All pertinent construction details of the monitoring wells, such as depth to and description of all backfill materials installed (such as gravel pack, bentonite, and grout); gradation of gravel pack; length, location, diameter, slot size, material and manufacturer of well screen(s); position of centralizers; and location of any blank pipe installed in the well.
- Description of surface completion, including protective steel casing, protective pipes, and concrete surface seal.
- A description of any difficulties encountered during well installation.
- Survey coordinates and the elevation of top of ground and top of well riser.
- A brief stratigraphic log will be presented on the well installation diagram showing depths to and descriptions of major lithologic changes encountered in the boring.

References for Other Applicable ASTM Standards

ASTM D4750 – Determining Subsurface Liquid Levels in a Borehole or Monitoring Well

References

Foster Wheeler (Foster Wheeler Environmental Corporation)
2000. Final Basewide Health and Safety Plan. Cannon Air Force base, New Mexico.

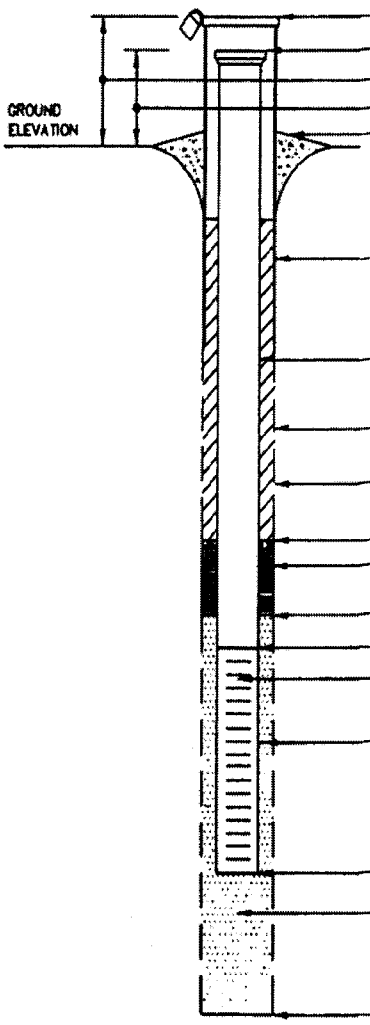
Figure C2-1. Overburden Monitoring Well Construction Diagram

OVERBURDEN
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. _____

PROJECT _____
PROJECT NO. _____
DATE _____ BORING NO.: _____
ELEVATION _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____
ELEVATION OF TOP OF RISER PIPE: _____
STICK-UP TOP OF SURFACE CASING: _____
STICK-UP RISER PIPE: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION/DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

DEPTH TOP OF SAND PACK: _____

ELEVATION/DEPTH TOP OF SCREEN: _____
TYPE OF SCREEN: _____
SLOT SIZE X LENGTH: _____
TYPE OF SAND PACK: _____

ELEVATION/DEPTH BOTTOM OF SCREEN: _____

ELEVATION/DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION/DEPTH OF HOLE: _____

NOT TO SCALE

This page intentionally left blank.

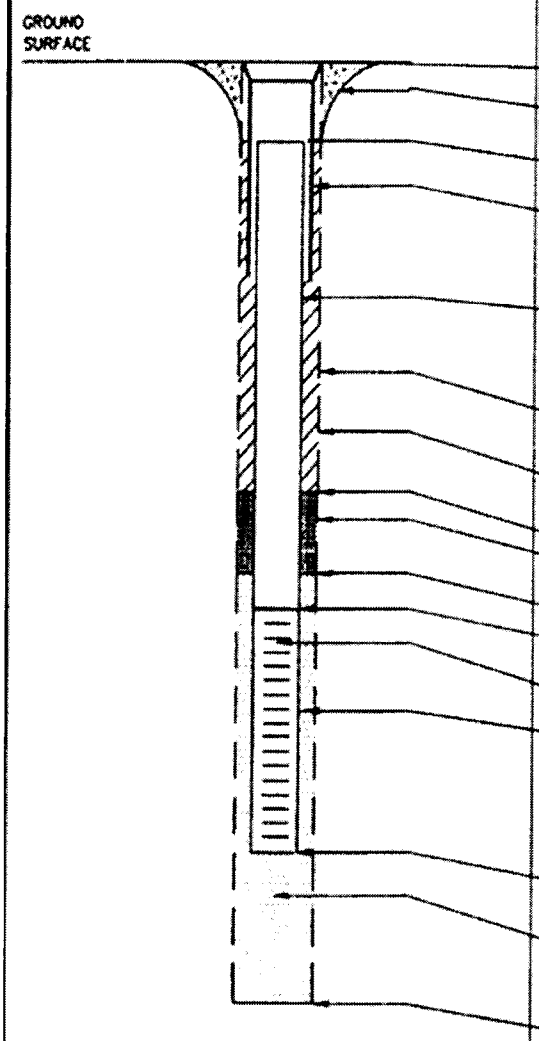
Figure C2-2. Overburden Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion

UNCONSOLIDATED
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. _____

PROJECT _____
PROJECT NO. _____
DATE _____ BORING NO.: _____
ELEVATION _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____
TYPE OF SURFACE SEAL: _____
GROUND SURFACE ELEVATION: _____
ELEVATION OF TOP OF RISER: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

BOREHOLE DIAMETER: _____

TYPE OF BACKFILL: _____

ELEVATION/DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____

ELEVATION/DEPTH TOP OF SAND PACK: _____
ELEVATION/DEPTH TOP OF SCREEN: _____

TYPE OF SCREEN: _____
SLOT SIZE X LENGTH: _____
TYPE OF SAND PACK: _____

ELEVATION/DEPTH BOTTOM OF SCREEN: _____
ELEVATION/DEPTH BOTTOM OF SAND PACK: _____
TYPE OF BACKFILL BELOW OBSERVATION WELL: _____

ELEVATION/DEPTH OF HOLE: _____

NOT TO SCALE

This page intentionally left blank.

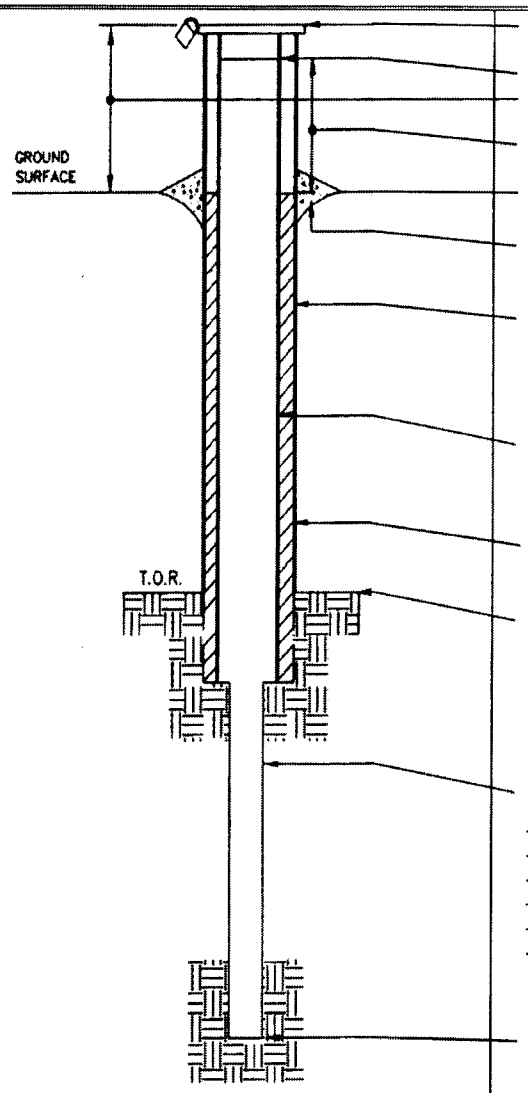
Figure C2-3. Double Cased Monitoring Well Construction Diagram

DOUBLE CASED
OPEN HOLE BEDROCK
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. _____

PROJECT _____
PROJECT NO. _____
DATE _____ BORING NO.: _____
ELEVATION _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF OUTER CASING: _____

ELEVATION OF TOP OF INNER CASING: _____
STICK-UP OF OUTER CASING: _____

STICK-UP OF INNER CASING: _____

GROUND SURFACE ELEVATION: _____

TYPE OF SURFACE SEAL: _____

I.D. OF OUTER CASING: _____
TYPE OF CASING: _____
DEPTH OF OUTER CASING: _____

I.D. OF INNER CASING: _____
TYPE OF CASING: _____
DEPTH OF INNER CASING: _____

TYPE OF CASING SEAL: _____

ELEVATION/DEPTH TO TOP OF ROCK: _____

DIAMETER OF HOLE IN BEDROCK: _____
DESCRIPTION OF BEDROCK:

ELEVATION/DEPTH OF HOLE: _____

Field Forms Templates (FF-4 BED-2CAS)
Proprietary Information

Version Date: 08/01/2001
Version 1

This page intentionally left blank.

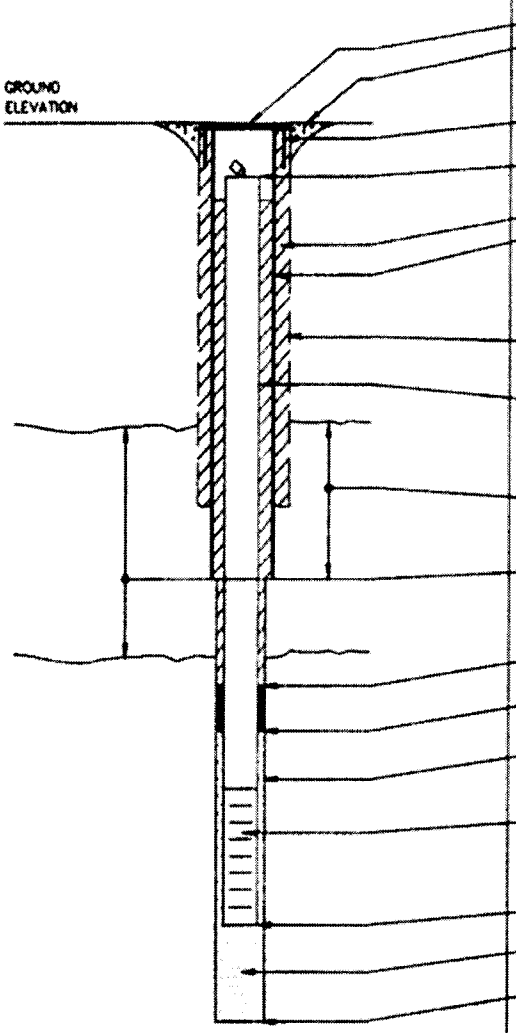
Figure C2-4. Double Cased Monitoring Well Construction Diagram for Wells with a Flush-Mount Surface Completion

DOUBLE CASED
MONITORING WELL
CONSTRUCTION DIAGRAM

WELL NO. _____

PROJECT _____
PROJECT NO. _____
DATE _____ BORING NO.: _____
ELEVATION _____
FIELD GEOLOGIST _____

DRILLER _____
DRILLING METHOD _____
DEVELOPMENT METHOD _____



ELEVATION OF TOP OF SURFACE CASING: _____
TYPE OF SURFACE SEAL: _____

I.D. OF SURFACE CASING: _____
TYPE OF SURFACE CASING: _____
ELEVATION OF TOP OF RISER: _____

TYPE OF BACKFILL: _____
I.D. OF UPPER AQUIFER CASING: _____
TYPE OF UPPER AQUIFER CASING: _____

BOREHOLE DIAMETER: _____

RISER PIPE I.D. _____
TYPE OF RISER PIPE: _____

DEPTH CASING IS SET IN CONFINING LAYER _____

APPROXIMATE THICKNESS OF CONFINING LAYER _____

ELEVATION/DEPTH TOP OF SEAL: _____
TYPE OF SEAL: _____
ELEVATION/DEPTH TOP OF SAND PACK: _____
TYPE OF SAND PACK: _____
BOREHOLE DIAMETER: _____

TYPE OF SCREEN: _____
SLOT SIZE X LENGTH: _____
I.D. OF SCREEN: _____

ELEVATION/DEPTH BOTTOM OF SCREEN: _____

TYPE OF BACKFILL BELOW OBSERVATION WELL: _____
ELEVATION/DEPTH OF HOLE: _____

NOT TO SCALE

This page intentionally left blank.

SOP C3 MONITORING WELL DEVELOPMENT

General Monitoring Well Development

Monitoring well development shall be preformed within one week after installation but no sooner than 48 hours after grout installation. The following procedure should be followed for the development of all newly installed wells on Base:

- Initial development will consist of swabbing, bailing, and pumping until little or no sediment enters the well (approximately 2 hours). Contain the development and purge water in a temporary tank to be installed at each wellhead.

- Following initial development, the well will be continuously pumped using an electric submersible or pneumatic drive positive displacement or bladder pump. Temperature, pH, specific conductivity, turbidity, dissolved oxygen, and oxidation-reduction potential will be monitored during pumping, and readings will be taken after every well volume is purged. Pumping will continue until these parameters have stabilized (less than 0.2 pH units or a 10 percent change for the other parameters between four consecutive readings) and the water is clear and free of fines. The main goal of well development is to reduce the turbidity to less than 10 NTUs (however, under 100 NTUs is acceptable). If these parameters have not stabilized after 4 hours of continuous pumping, the well will be allowed to sit overnight and development will continue the following day for a maximum of two hours. If the turbidity still does not fall below 100 NTUs, the client project geologist will be contacted and further direction will be sought.

- Development and purge water will not be containerized based on waste characterization through generator knowledge. Wastewater generated from well development will be discharged directly to the ground surface at the drilling location.

- The site geologist will monitor and record on the well development record form, depicted in Figure B3-1, and in the field log book all field parameters such as pumping rates, pH, temperature, specific conductance, dissolved oxygen, oxidation-reduction potential, and pertinent information.

References for Other Applicable ASTM Standards

ASTM D4750 – Determining Subsurface Liquid Levels in a Borehole or Monitoring Well

This page intentionally left blank.

Figure C3-1. Well Development Record and Water Quality Field Data Sheet

Well Development Record and Water Quality Field Data Sheet

Page 1 of _____

Project: _____ Well No: _____

Project No.: _____

Date: _____ *Samplers:* _____

Time Start: _____

Time Finish: _____ Checked by: _____

Well Information

Depth to Water: _____ ft. Casing Diameter: _____ in. = _____ ft. Casing Stickup: _____ ft.

Bottom of Screen: _____ ft. Borehole Diameter: _____ in. = _____ ft. Screened Interval: _____ ft.

Sample Depth: _____ ft. Saturated Screen Well Volume: _____ gallons

Drawdown Limit: _____ ft. Calculations: Casing Volume (CV) = $\pi (cr^2) h (7.48)$

Note: All depths measured from top of casing.

Filter Pack Volume (FPV) = $\pi (br^2 - cr^2)[BS-(TS \text{ or } H)] P (7.48)$

Saturated Screen Well Volume = CV + FPV

Calculation Notes: cr = casing radius; br = borehole radius; H = depth to water; h = bottom of screen – depth of water in ft.; P = estimated porosity of filter pack (35%); TS = top of screen; If TS>H use TS, if TS<H use H; BS = bottom of screen

Field Equipment

pH Meter: _____ Serial No.: _____ Water Level Meter: _____ Serial No.: _____

Conductivity Meter: _____ Serial No.: _____ Turbidity Meter: _____ Serial No.: _____

Temperature Meter: _____ Serial No.: _____ Bailer: _____ Size: _____

Sample Equipment *(check one)*

☐ *Submersible Pump* *Pump Type (circle one):* *Piston* *Bladder* *Impeller*

☐ *Disposable Teflon Bailer* *Pump Model:* _____

Serial No.: _____

Field Chemistry

pH _____ = @ _____ °C pH _____ = @ _____ °C pH _____ = @ _____ °C Time _____

Conductivity Standard: _____ µmhos/cm @ 25°C Reading _____ µmhos/cm @ _____ °C Time _____

Turbidity Standard: _____ N.T.U. @ 25°C Reading _____ N.T.U. @ _____ °C Time _____

This page intentionally left blank.

Figure C3-1. Well Development Record and Water Quality Field Data Sheet (Concluded)

Well Development Record and Water Quality Field Data Sheet

Page 2 of _____

Project:	_____	Well No:	_____
Project No.:	_____		_____
Date:	_____	*Samplers:*	_____
Time Start:	_____		_____
Time Finish:	_____	Checked by:	_____

Field Chemistry (cont'd)

Time	Volume gallons	Temp. °C	pH	Conductivity µmhos/cm	Turbidity N.T.U.	Comments

Was well sampled after development? ___YES ___NO

Sample Method:_____

Sample Name:_____

Analyses:_____

_____

_____

This page intentionally left blank.

SOP C4 LAND SURVEYS

A state-licensed professional surveyor will perform surveys. Signed and sealed originals of all field notes, survey plats and drawings shall be submitted to the Contractor. Surveys should at a minimum conform to the requirements stated in Article 12.8.2 of the New Mexico Administrative Code, Minimum Standards for Surveying in New Mexico. The methods and tolerances provided in USACE Engineering Manual (EM 1100-1-1005) should also be consulted when performing surveys.

Monitoring Wells—Coordinates and elevations will be established for each monitoring well. The coordinates will be to the closest 0.1 foot and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not available an existing local grid system will be used. A ground elevation to the nearest 0.01 foot and an elevation for the top of the well riser to the closest 0.01 foot will be obtained for each well. All positions and coordinates of all permanent points within the control traverse will be shown.

Soil Borings/Sampling Points—If collected, all soil sampling locations will be located horizontally and vertically as required following procedures outlined in the previous paragraph.

Physical Features—At each site, all aboveground and, where possible, underground physical features will be either verified with previous mapping or determined as required. All aboveground physical features will be located/verified to the nearest foot. Permanent control monuments will be placed in accessible locations within the limits of the work if no existing permanent monuments are located within 1,000 feet of a site. One set of monuments is allowable for adjacent sites. These monuments will be set no closer than 500 feet to each other. The permissible error for the traverse closure of permanent control monuments is 1/5,000 feet.

Documentation and Deliverables—The location, identification, coordinates, and elevations of the wells and monuments will be plotted on maps with a scale large enough to show their location with reference to other structures at the individual sites. A tabulated list of the monitoring wells and monuments, copies of all field books, and all computation sheets will be prepared and submitted to the Contractor. The tabulation will consist of the designated identification number of the well or monument, and its northing (X-coordinate), easting (Y-coordinate), and elevation.

This page intentionally left blank.

SOP C5 EQUIPMENT DECONTAMINATION

The objective of field decontamination is to remove contaminants of concerns from sampling, drilling, and other field equipment to concentrations that will **not** impact study objectives. This SOP was developed for use by field personnel who are responsible for cleaning sampling or other equipment in the field.

Specification for Decontamination Materials

- Use a standard brand of phosphate-free laboratory detergent, either liquid or powder, preferably Liquinox® or Alconox®.

- Use tap water from any municipal water treatment system or use bottled drinking water. Soap and tap water will remove the gross contamination from the sampling equipment.

Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Containers should be constructed of the proper materials to ensure their integrity. The following containers should be used for storing the specified cleaning materials:

- Soap—Keep in clean containers until use. It should be poured directly from the container into the wash bucket or tub.

- Tap water—Keep in clean tanks, hand-pressure sprayers, or squeeze bottles, or apply directly from a hose.

- Deionized water—Store in clean containers that can be closed when not in use. It may be applied from squeeze bottles.

Decontamination of Large Equipment

The following procedure will be used to decontaminate large pieces of equipment, such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods. This procedure shall also be employed for the decontamination of heavy machinery such as backhoes, excavators, etc.

- Wash the external surfaces of equipment with high-pressure hot water and Liquinox® or Alconox® or equivalent non-phosphate, laboratory-grade detergent. If necessary, scrub until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The inside surfaces of equipment which come in direct contact the media being sampled will also be washed as described above. Specific decontamination instructions will be included in the project-specific addenda.

- Rinse with potable water.

- This decontamination procedure will be performed before equipment is used and between each well or other sampling locations.

Decontamination fluids will be disposed as required by the project Investigation-Derived Waste Management Plan (Section 5 of the Work Plan).

Whenever possible, decontamination pads provided by Cannon AFB should be used to clean large equipment. In other instances, a decontamination pad may need to be constructed at the investigation site.

Construction of a Decontamination Pad

Decontamination pads constructed in the field should meet the minimum specifications described below:

- The pad should be constructed in an area known or believed to be free of surface contamination. A temporary pad should be lined with a water impermeable material with no seams within the pad. The material should be either easily replaced (disposable) or repairable.
- The location of the pad should be out of the work zone and situated not to interfere with other work in progress.
- The pad should not leak excessively. Any sump or pit should be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above the ground surface to prevent equipment for being splashed and re-contaminated.
- Water collected on the pad will be disposed of as per the Investigation-Derived Waste Management Plan. Small amounts of water will be left to evaporate.

Personal Protective Equipment

Personnel directly involved in equipment decontamination shall wear appropriate PPE as specified in the Basewide Health and Safety Plan (Foster Wheeler, 2000) and the SSHP (Appendix B to the Work Plan). The appropriate PPE is selected based on the level of contamination present or suspected at the site. Care should be taken so the selected PPE protects decontamination workers from unnecessary contact with soils or decontamination fluids. The following is a list of the minimum PPE required to perform decontamination activities:

- Safety glasses with splash shields or goggles and latex gloves will be worn during all cleaning operations. For decontamination activities involving large amounts of water, rain suits or aprons and rubber over-boots should also be worn.

No eating, smoking, drinking, chewing, or any hand-to-mouth contact should be permitted during cleaning operations.

References for Other Applicable ASTM Standards

ASTM D5088 – Decontamination of Field Equipment Used at Nonradioactive Waste Sites

ASTM D5608 – Decontamination of Field Equipment Used at Low Level Radioactive Waste Sites

References

Foster Wheeler (Foster Wheeler Environmental Corporation)
2000. Final Basewide Health and Safety Plan. Cannon Air Force Base, New Mexico.

This page intentionally left blank.

SOP C6 PH

The following procedure is used for measuring groundwater pH with a pH meter:

- The instrument and batteries should be checked and calibrated in the laboratory prior to initiation of the field effort.
- The accuracy of the buffer solutions used for field and laboratory calibration should be checked. Buffer solutions need to be changed due to degradation upon exposure to the atmosphere. The date of preparation of each buffer should be included on the bottle label.
- Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.
- Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
- Immerse the electrode(s) in a pH-7 buffer solution.
- Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.
- Adjust the pH meter to read 7.0.
- Remove the electrode(s) from the buffer and rinse well with deionized water. Immerse the electrode(s) in pH-4 (for water with pH of 1 to 7) or pH-10 (for water with pH of 7 to 12) buffer solution and adjust the slope control to read the appropriate pH. At least three successive readings during calibration, one minute apart, should be within +0.1 pH unit. For best results, the standardization and slope adjustments should be repeated at least once daily before use.
- Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the log book.
- Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH should be recorded to the nearest 0.1 pH unit. Also record the sample temperature.
- Rinse the electrode(s) with deionized water.

- Keep the electrode(s) immersed in water when not in use.

The sample used for pH measurement should never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions that may interfere with pH measurement, such as oily materials, or turbidity, should be noted in the field log book.

SOP C7 SPECIFIC CONDUCTANCE

The steps involved in taking specific conductance measurements are listed below:

- Check batteries and calibrate instrument before going into the field.
- Immerse the electrode in water overnight. If this is not possible due to field conditions, immerse the electrode at least one hour before use.
- Calibrate the instrument between each measurement or groups of closely spaced measurements. Potassium chloride standard solutions with a specific conductance closest to the values expected in the field should be used.
- Rinse the electrode with one or more portions of the sample to be tested.
- Immerse the electrode in the sample and measure the conductivity.
- Read and record the results in a field log book. Report the results to the nearest ten units for readings under 1000 micromhos per centimeter (μmhos/cm) and the nearest 100 units for readings over 1000 μmhos/cm. Adjust the temperature setting to the sample temperature.
- Repeat the procedure with fresh sample until reproducible (i.e., ± 5 percent) results are obtained.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Note that specific conductance is occasionally reported at temperatures other than ambient.

This page intentionally left blank.

SOP C8 WATER TEMPERATURE

Water temperature may be measured with either a thermometer or temperature meter. The following procedure is applicable to both instruments:

- Rinse the thermometer or temperature probe with a portion of the collected sample.
- Immerse the thermometer or probe in the sample until temperature equilibrium is obtained (1- to 3-minutes). To avoid the possibility of contamination, the thermometer should not be inserted into samples which will undergo subsequent chemical analysis.
- Record values in a field log book to the nearest 0.5°C.
- If a temperature meter or probe is to be used, the instrument should be calibrated according to the manufacturer's recommendations and a National Bureau of Standards (NBS) certified thermometer or one that is traceable to NBS certification before field use. Cross-checking and duplicate field analyses should agree within ± 0.5°C. A cross-check with a calibrated NBS certified thermometer will be made at least semiannually.
- Rinse the thermometer or probe with distilled water.

This page intentionally left blank.

SOP C9 DISSOLVED OXYGEN

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps should be used to measure the dissolved oxygen concentration:

- The equipment should be calibrated and its batteries checked in the laboratory before going to the field.
- The probe should be conditioned in a water sample for as long a period as practical before its use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument should be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubility as a function of temperature and salinity.
- The instrument probe should be immersed in a flow-through cell or directly into the water column of the well for the most accurate measurement.
- Record the dissolved oxygen content and temperature of the sample in a field log book. Read the dissolved oxygen dial to the nearest 0.1 milligram per liter (mg/L).
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions. Duplicate analyses should agree within ± 0.1 mg/L.

Note that although *in-situ* placement of the probe is preferable, since sample handling is not involved, this may not always be practical. Be sure to record whether the liquid was analyzed *in-situ*, or if a sample was taken. If a sample is taken special care should be taken during collection to avoid turbulence, which can lead to increased oxygen solubility and positive test interference.

This page intentionally left blank.

SOP C10 OXIDATION-REDUCTION POTENTIAL

The following procedure is used for measuring oxidation-reduction potential:

- The equipment should be calibrated and its batteries checked in the laboratory before going to the field.
- Check that the platinum probe is clean and the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aquaregia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.
- Thoroughly rinse the electrode with distilled water.
- Verify the sensitivity of the electrodes in accordance with the manufacturer's instructions.
- After the assembly has been checked for sensitivity, wash the electrodes with three changes of deionized water or with a flowing stream of water from a wash bottle. Place the sample in a clean glass beaker or sample cup and insert the electrodes. Set temperature compensator to the sample temperature. Provide adequate agitation throughout the measurement period. Read the millivolt (mV) potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more than 10 mV. A system that is very slow to stabilize properly will not yield a meaningful oxidation-reduction potential. Record all results in a field log book, including oxidation-reduction potential (to nearest 10 mV), sample temperature, and pH at the time of measurement.

This page intentionally left blank.

SOP C11 WATER LEVELS

Water levels will be measured using an electric water level indicator. The steps to be followed are as follows:

- Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment as required.
- Record all information specified below on a Groundwater Level Data form or in the field logbook if the form is not available.
- Record well number, top of casing elevation and surface elevation if available. Well diameter and total depth should be recorded. Water levels will be taken from the surveyed reference mark on the top edge of the inner well casing.
- Use a decontaminated water level indicator to record water level to the nearest 0.01 foot (0.3 cm).
- Record the time and day of the measurement.
- Many water level measuring devices have marked metal or plastic bands clamped at intervals along the measuring line used for reference points to obtain depth measurements. The spacing and accuracy of these bands will be checked frequently as they may loosen and slide up or down the line, resulting in inaccurate reference points.
- All groundwater level measurement devices must be cleaned before and after each use to prevent cross-contamination of wells.

This page intentionally left blank.

Figure C11-1. Groundwater Level Data Form

Page ____ of ____

Site: _____ Name: _____

Date: _____ Project: _____

Well ID	Time	Top of Casing	Well Depth (ft)	Depth to Water (ft)	Comments (pH, temperature, specific conductance)

Measurement Reference Point from: ___ Top of Ground or ___ Top of Casing

Weather Conditions:_____

_____

_____

Other Significant Observations:_____

_____

_____

This page intentionally left blank.

Appendix D
Application for Permit to Drill an Exploratory Well

TO BE COMPLETED BY DRILLING COMPANY ONCE WELL IS INSTALLED

File Number: _____
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO DRILL AN EXPLORATORY WELL

1. APPLICANT:

Name: Cannon AFB, 27 SOCES/CEAN
Contact: Anita Lafuente
Address: ### D.L. Ingram Blvd.

Work Phone: 575-784-1092
Home Phone: _____

City: Cannon AFB State: NM Zip: #####

2. LOCATION OF WELL (A, B, C, or D required, E or F if known):

A. ____1/4 ____1/4 ____1/4 Section:____ Township:____ Range:____ N.M.P.M.
in _____ County.

B. X =_____ feet, Y = _____ feet, N.M. Coordinate System
_____ Zone in the _____ Grant.
U.S.G.S. Quad Map _____

C. Latitude: 34 d 23 m 22.99 s Longitude: -103 d 18 m 07.74 s

D. East _____ (m), North _____ (m), UTM Zone 13, NAD _83 (27 or 83)

E. Tract No. _____, Map No. _____ of the _____ Hydrographic Survey

F. Lot No. _____, Block No. _____ of Unit/Tract _____ of the
_____ Subdivision recorded in _____ County.

G. Other: _____

H. Give State Engineer File Number of existing well: _____

I. On land owned by (required): U.S. Department of Defense, U.S. Air Force

3. WELL INFORMATION:

Approximate depth: 350 feet; Outside diameter of casing: 4 inches
Name of well driller and driller license number: WDC Exploration & Wells, License #1210

4. ADDITIONAL STATEMENT OR EXPLANATIONS:

_____
_____
_____
_____
_____
_____
_____
_____
_____

Do Not Write Below This Line

File Number: _____ Trn Number: _____
Form: wr-07

File Number: _____
(For OSE Use Only)

NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO DRILL AN EXPLORATORY WELL

ACKNOWLEDGEMENT

(I, We) Anita Lafuente; Cannon AFB 27 SOCES/CEAN affirm that the
(Please Print)
foregoing statements are true to the best of my knowledge and belief.

_____ _____.
Applicant Signature Applicant Signature

ACTION OF STATE ENGINEER

This application is approved/denied/partially approved provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare, and further subject to the following conditions: _____

_____
_____
_____
_____
_____
_____
_____
_____

Witness my hand and seal this _____ day of _____, 20 _____

_____, State Engineer

By: _____

Do Not Write Below This Line

File Number: _____ Trn Number: _____