WSMR 2002

DEPARTMENT OF THE ARMY
U.S. ARMY WHITE SANDS MISSILE RANGE
100 HEADQUARTERS AVENUE
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002-5000

REPLY TO
ATTENTION OF

May 20, 2002

Environment and Safety Directorate

Ms. Cheryl Frischkorn
Hazardous and Radioactive Materials Program
New Mexico Environment Department
2905 East Rodeo Park Road, Building 1
Santa Fe, New Mexico 87505-6303

Dear Ms. Frischkorn:

White Sands Missile Range has been performing preliminary release assessment fieldwork at the LC-38 Diesel Spill Site where diesel fuel was lost from an above ground fuel storage tank. The site was discovered and reported to Ms. Lorene Lithgow in the New Mexico Environment Department (NMED) Groundwater Bureau on August 25, 2000 since the Groundwater Bureau was the regulatory lead agency overseeing the investigation of all fuel releases from storage tanks at that time. Given our notification to the appropriate regulatory agency, we initiated initial assessment fieldwork to determine the existence of a release. Based upon the results of this initial work, we have prepared a workplan for a detailed investigation and delineation of the diesel fuel release previously reported to the Groundwater Bureau. However since the time of our last fieldwork, we understand that the Hazardous Waste Bureau has taken the regulatory lead for the investigation of non-hazardous materials such as fuels. Consequently, we are submitting the enclosed investigation workplan for the LC-38 Diesel Fuel Release Site for your review and comment. The workplan submitted for your review and ultimate approval is entitled:

Work Plan for the RCRA Facility Investigation at the Launch Complex 38 Site on White Sands Missile Range

We hope that the enclosed report satisfactorily addresses any questions regarding our completed assessment release results and proposed investigation fieldwork at the LC-38 Fuel Spill Site. After your review of our document, we would appreciate a formal notification from your office so that we can implement further work. Should you have any further questions please contact Mr. Hector Magallanes at (505) 678-2224.

Sincerely,

Thomas A. Ladd

Thomas A. Ladd
Director, Environment and
Safety Directorate

Enclosures

REPORT DOCUMENTATION PAGE			OMB No. 0704-0188
Public reporting burden for this collection of information estimated to average 1 hour per response, including the time for reviewing instructions. Send comments regarding this burden estimate or any other aspects of this collection information including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302 and to the Office of Management and Budget Paperwork Reduction Project (0704-0188), Washington DC 20503			
1. AGENCY USE ONLY (LEAVE BLANK)	**2. REPORT DATE** February 2002		**3. REPORT TYPE AND DATES COVERED** FINAL
4. TITLE AND SUBTITLE Work Plan for the RCRA Facility Investigation at the Launch Complex- 38 Site on White Sands Missile Range			**5. FUNDING NUMBERS**
6. AUTHOR(S) Kathy Davis, Geologist Chris Whitman, Geologist			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) MEVATEC Corporation Box 399 WSMR, NM 88002			**8. PERFORMING ORGANIZATION REPORT NUMBER** 700B2/01/002F
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Department of the Army U.S. Army White Sands Missile Range 100 Headquarters Avenue ATTN: CSTE-DTC-ES-ES-EC (Hector Magallanes) White Sands Missile Range, NM 88002			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER** WS-ES-EC-0165
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION AVAILABILITY STATEMENT			**12b. DISTRIBUTION CODE**
13. ABSTRACT (MAXIMUM 200 WORDS) A leak from piping associated with an above ground storage tank was identified at the LC-38 site during preparations to retire the facility. An estimated 31,000 gallons of diesel fuel was released. Preliminary investigations have confirmed the release of diesel-fuel to the subsurface at the site. This report presents the work plan for further investigations.			
14. SUBJECT TERMS Launch Complex 38, LC-38, RCRA, RFI, TPH, Soil Borings, Monitoring Wells, petroleum release **Mark Number: 200-1q**			**15. NUMBER OF PAGES** 38 **16. PRICE CODE**
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT**

WORK PLAN FOR THE
RCRA FACILITY INVESTIGATION AT THE LAUNCH COMPLEX-38 SITE ON
WHITE SANDS MISSILE RANGE

Submitted to:

U.S. Army
White Sands Missile Range
Environment and Safety Directorate
White Sands Missile Range, New Mexico 88002-5048

February 2002

Submitted by:

MEVATEC Corporation
Building 126
White Sands Missile Range, New Mexico 88002

EXECUTIVE SUMMARY

While preparing to retire a facility at LC-38, personnel could not account for an estimated 31,000 gallons of missing diesel fuel. Upon recognition of the potential release, product lines between the 150,000-gallon aboveground storage tank and the adjacent loading terminal were uncovered and inspected. A leak was located in the product line and was subsequently identified as the source as the release. A preliminary investigation included the collection of samples from three soil borings in the vicinity of the pipeline leak. This investigation confirmed the spread of the diesel fuel contamination within the vadose zone beneath the leak, and determined the vertical extent of contamination, to a depth of 75 feet below ground surface.

This is the Work Plan for the investigation of the release of the LC-38 site. The purpose of this investigation is to supplement previous investigations by obtaining information to further characterize the geology and hydrology of the site and the extent of soil contamination. This Work Plan documents the objectives of the investigation, and describes the details of the technical and analytical approach to accomplish this task. This Work Plan follows the guidance set forth for conducting a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Although this site has not formally been designated as a solid waste management unit, the RFI guidance was chosen as the appropriate mechanism to follow.

This investigation will be conducted to determine possible soil and/or groundwater contamination, determine possible contaminant transport pathways, and evaluate the potential for human or ecological exposure. Field activities to support these objectives will consist of the collection and analysis of soil samples from borings around the area of the release and installation and sampling of three down-gradient groundwater monitoring wells and one up-gradient well. Geotechnical samples and soil-gas samples will be collected for use in the evaluation of potential approaches for the selection of a remedy.

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS
continued

Section **Page**

List of Photographs

TABLE OF CONTENTS
concluded

Section **Page**

List of Tables

List of Figures

ACRONYMS

ASTM	American Society for Testing and Materials
ATEC	U.S. Army Test and Evaluation Command
bgs	below ground surface
cm	centimeter
CMS	Corrective Measures Study
DPM	Deputy Program Manager
DQO	data quality objectives
EOD	Explosive Ordnance Disposal
ft	feet
GFCI	ground fault circuit interrupter
GPS	global positioning system
HA	hand auger
HAZWOPER	hazardous waste operations
IDLH	immediately dangerous to life and health
IDW	investigation derived waste
LEL	lower explosive limit
m	meter
mg/kg	milligram(s) per kilogram
mg/l	milligram(s) per liter
ml	milliliter
MW	monitoring well
MTBE	methyl tertiary butyl ether
NASA	National Aeronautics and Space Administration
NMED	New Mexico Environment Department
O.D.	open diameter
OSHA	Occupational Safety and Health Administration
PEL	permissible exposure limit
PID	photo-ionization detector
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RPD	relative percent difference
SSHSP	Site Specific Health and Safety Plan
SWMU	Solid Waste Management Unit
SVOC	semi-volatile organic compound
TB	trip blank
TBD	to be determined
TDS	total dissolved solids
TI	Technical Inspector

ACRONYMS
(*concluded*)

TPH	total petroleum hydrocarbons
UEL	upper explosive limit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UXO	unexploded ordnance
VOC	volatile organic compound
WSMR	White Sands Missile Range

NMED Guidance Cross-Reference

NMED HRMB Standard Operating Procedures Facility Wide Work Plans Outline	Launch Complex-38 RFI Work Plan
1.0 Project Management Plan	Section 5.0 – Project Management
1.1 Background	5.0
1.2 Purpose and Scope	1.6
1.3 Project Structure	5.0, 5.1, 5.2
2.0 Facility Description	Section 1.0 - Introduction
2.1 Description	1.1, 1.2
2.2 Environmental Setting	1.3, 1.4, 1.5
3.0 Quality Assurance Project Plan	Section 2.0 – QA Project Plan
3.1 Background	2.1
3.2 Assessment Strategy	2.1, 3.0
3.3 Field Sampling	3.0, 4.0
3.4 Site Management and Record Keeping	4.0, 5.0
4.0 Records Management Plan	2.1.9
4.1 Organization	2.1.9
4.2 Description	2.1.9
4.3 Description of Records Management Facilities	N/A
4.4 Coordination	5.0
5.0 Health and Safety Plan	Appendix D – Site Safety and Health Plan
5.1 Introduction	1.0 of App. D
5.2 Personnel	2.0 of App. D
5.3 Site History and Description	4.0 of App. D
5.4 Hazard Assessment	4.3 of App. D
5.5 Personal Protective Equipment	4.4 of App. D
5.6 Decontamination	Appendix E
5.7 Emergency and Contingency Plan	4.5 of App. D
5.8 Record Keeping	5.0
6.0 Waste Management Plan	Appendix E – Decontamination and Investigation-Derived Waste Management Plan
6.1 Introduction	Appendix E
6.2 Regulatory Requirements	Appendix E
6.3 Waste Management	3.0 of App. E
7.0 Public Involvement Plan	Possible future action –
7.1 Introduction	to be determined
7.2 Involvement Process	to be determined

WORK PLAN FOR THE RCRA FACILITY INVESTIGATION AT THE LAUNCH COMPLEX-38 SITE ON THE WHITE SANDS MISSILE RANGE

1.0 INTRODUCTION

A strategic reserve of diesel fuel was stored in a 120,000-gallon aboveground storage tank (AST) at Launch Complex 38 (LC-38), just north of Nike Avenue, 13 miles (20.9 kilometers) east of the WSMR Post Headquarters. Preparatory to retiring the facility in the summer of 2000, White Sands personnel could not account for missing fuel estimated in the amount of 31,000 gallons. The tank was dedicated exclusively to diesel fuel storage throughout its service life at WSMR.

Immediately upon discovery that fuel was unaccounted for, product lines from the adjacent loading terminal to the AST were uncovered. The piping emerged from the north side of the AST and elbowed towards the west berm. Most of the pipeline was concealed underground; at the west berm, the piping angled up and reemerged at the loading terminal. A leak in the product line was apparent and is considered as the source of the fuel release. The New Mexico Environment Department's (NMED) Ground Water Quality Bureau was notified in accordance with section 1203 of the New Mexico Water Quality Control Commission (WQCC) Regulations (20 New Mexico Administrative Code 6.2). Corrective action for the diesel spill required under WQCC Regulations and the terms of the White Sands Missile Range Hazardous Waste Management permit (#NM 2750211235) includes an investigation to delineate the horizontal and vertical extent of soil and groundwater contamination.

In February, 2001 a preliminary investigation was performed to assess the vertical extent of contaminant migration and characterize the geologic materials in the intervening strata. Soil samples collected from the leak site and at locations immediately north and south of the source were analyzed at a laboratory. This preliminary fact-finding effort also served to define whether a perched or regional aquifer was impacted with diesel product. A full discussion of the activities performed during the preliminary investigation, and the results are provided in Section 1.6 and 1.7 and are summarized in a Letter Report, which is presented as Appendix A.

This is the Work Plan for the investigation of the release of the LC-38 site. The purpose of this investigation is to supplement previous investigations by obtaining information to further characterize the geology and hydrology of the site and the extent of soil contamination. This Work Plan documents the objectives of the investigation, and describes the details of the technical and analytical approach to accomplish this task. This Work Plan follows the guidance set forth for conducting a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Although this site has not formally been designated as a solid waste management unit, the RFI guidance was chosen as the appropriate mechanism to follow.

1.1 Location and Background of White Sands Missile Range

WSMR is a US Army Test and Evaluation Command (ATEC) installation. The majority of the installation is situated within the Tularosa Basin; with areas along the western and northwestern boundary extending into the Jornada del Muerto Basin. WSMR is located in Doña Ana, Socorro, Lincoln, Otero, and Sierra Counties, New Mexico. The Main Post area of WSMR is located at

1.2 Regional Geology and Hydrogeologic Setting

White Sands Missile Range lies within the Mexican Highland Section of the Basin and Range Province, and is characterized by a series of tilted blocks forming longitudinal, asymmetric ridges or mountains and broad intervening basins. The Tularosa Basin contains thick sequences of Tertiary and Quaternary age Alluvial and bolson fill deposits, which are coarse- to fine- grained unconsolidated sediments. These sediments, more than 5,000 ft (1,524 m) thick in some areas, consist mainly of silt, sand, gypsum and clay weathered from the surrounding mountain ranges.

Very little surface water exists at White Sands due to the low annual precipitation, high evaporation rate, and high infiltration characteristics of the soils. The Tularosa Basin is a closed basin with no surface water drainage outside of White Sands. Much of White Sands drains towards Lake Lucero, a large playa in the center of the basin.

The WSMR Main Post obtains its potable water supply from the aquifer in the upper bolson deposits. The majority of the groundwater recharge to this bolson aquifer occurs through the coarse, unconsolidated Tertiary/Quaternary alluvial fan deposits and arroyos along the eastern flank of the Organ, San Augustin and San Andres Mountains. This aquifer consists of a wedge-shaped belt of potable water more than 30 miles (48.27 km) long (from north to south), and 3 to 5 miles east from the mountain front. Groundwater in the vicinity of the Main Post is of sufficient quality (less than 1,000 mg/L total dissolved solids) for human consumption. McClean (1970) reported this freshwater zone extends down to about 1,800 feet (549 m) below ground surface.

To the east, groundwater becomes more mineralized, primarily with sulfate and chloride. This is probably attributed to the slow lateral migration rate of groundwater from recharge to discharge areas, and the presence of readily soluble minerals in the bolson sediments. Groundwater within the center basin is characterized by total dissolved solids (TDS) of generally more than 10,000 milligrams per liter (mg/L), and is representative of groundwater within a closed, arid basin. Groundwater with TDS concentrations above 10, 000 mg/L is not subject to the numerical water quality standards of 20 NMAC 6.2.3103.A. Other federal and state requirements for protection of human health and the environment do apply, including the prohibition on deliverate contaminant releases to waters with TDS concentrations greater than 10,000 mg/L.

Ground water was not encountered to a depth of 105 feet (32 meters) during drilling activities performed for the preliminary subsurface investigation (see Section 1.6) at LC-38. Depth to ground water at the site is not known precisely because the nearest well is Gregg Site supply well, which was drilled to a total depth of 478 feet (145.7 meters) in 1961 (Cooper, 1973). The Gregg Site supply well is 5.3 miles (8.6 kilometers) west of the LC-38 AST release site. At the time the well was drilled the ground water was non-potable due to high sulfate (8,830 mg/l) and chloride (744 mg/l) concentrations. However, the purpose of the supply well was to achieve cooling at the land surface by flood irrigation, thereby reducing heat shimmers that interfered with precision optical tracking. Static water level in the Gregg Well was measured at 214.54 feet (65.4 meters) below ground surface in the summer of 1984 (Cruz, 1984). Based on water level measurements recorded by White Sands Missile Range for wells on the Range, the regional flow direction is toward the southeast. Figure 1-3 presents the groundwater elevation contours in this area based on recent depth-to-water measurements.

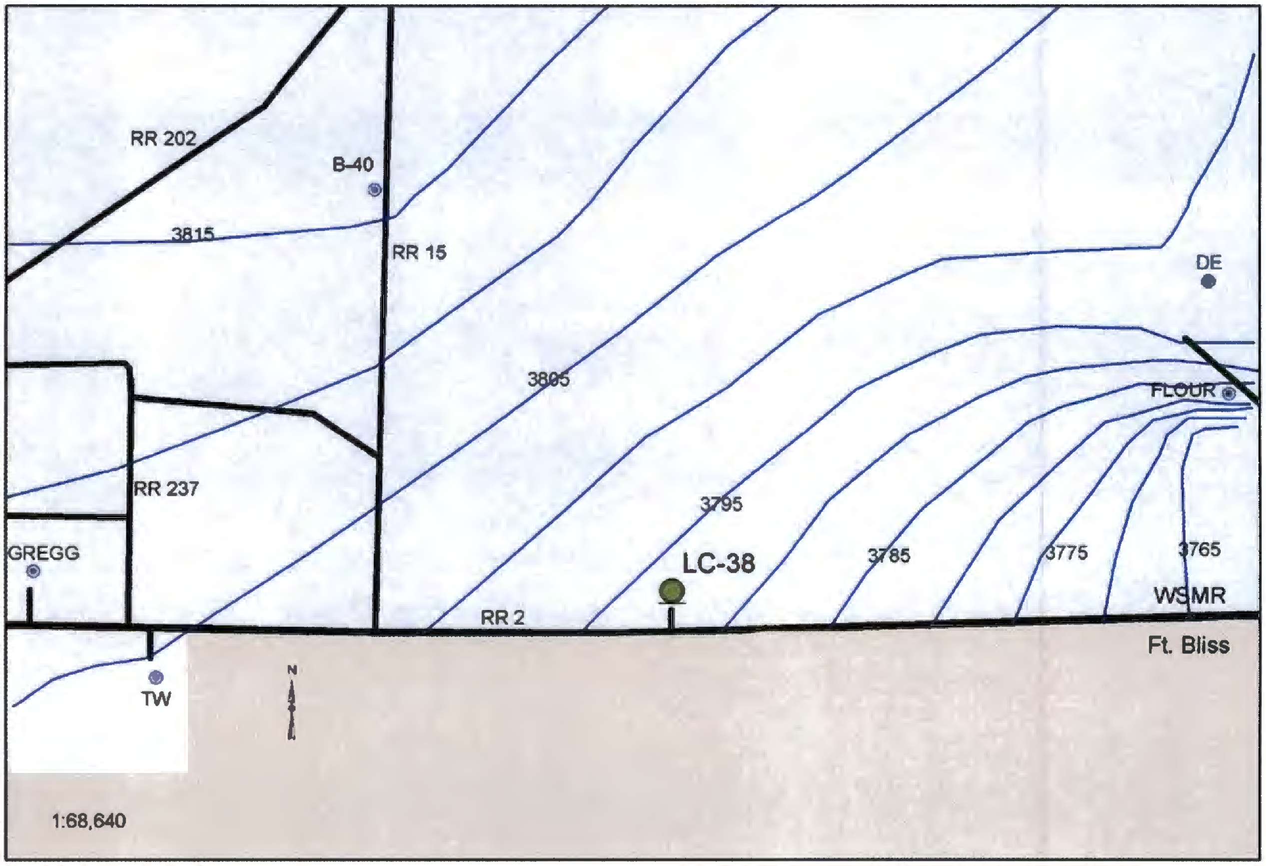


Figure 1-3.
Potentiometric Surface in Vicinity of LC-38, August 2001

1.3 Site History

Launch Complex-38 was developed to sustain missile-testing operations. The map of the site is presented in Figure 1-4. Part of the infrastructure included a stored supply of fuel. A photograph of the AST is shown in Photograph 1-1. In the summer of 2000 it was determined that approximately 31,000 gallons of fuel could not be accounted for. Immediately upon the discovery of the missing inventory, the product lines from the adjacent loading terminal to the AST were uncovered. A leak in the product line was apparent and considered as the source of the fuel release. A photograph of the leaking line is shown in Photograph 1-2.

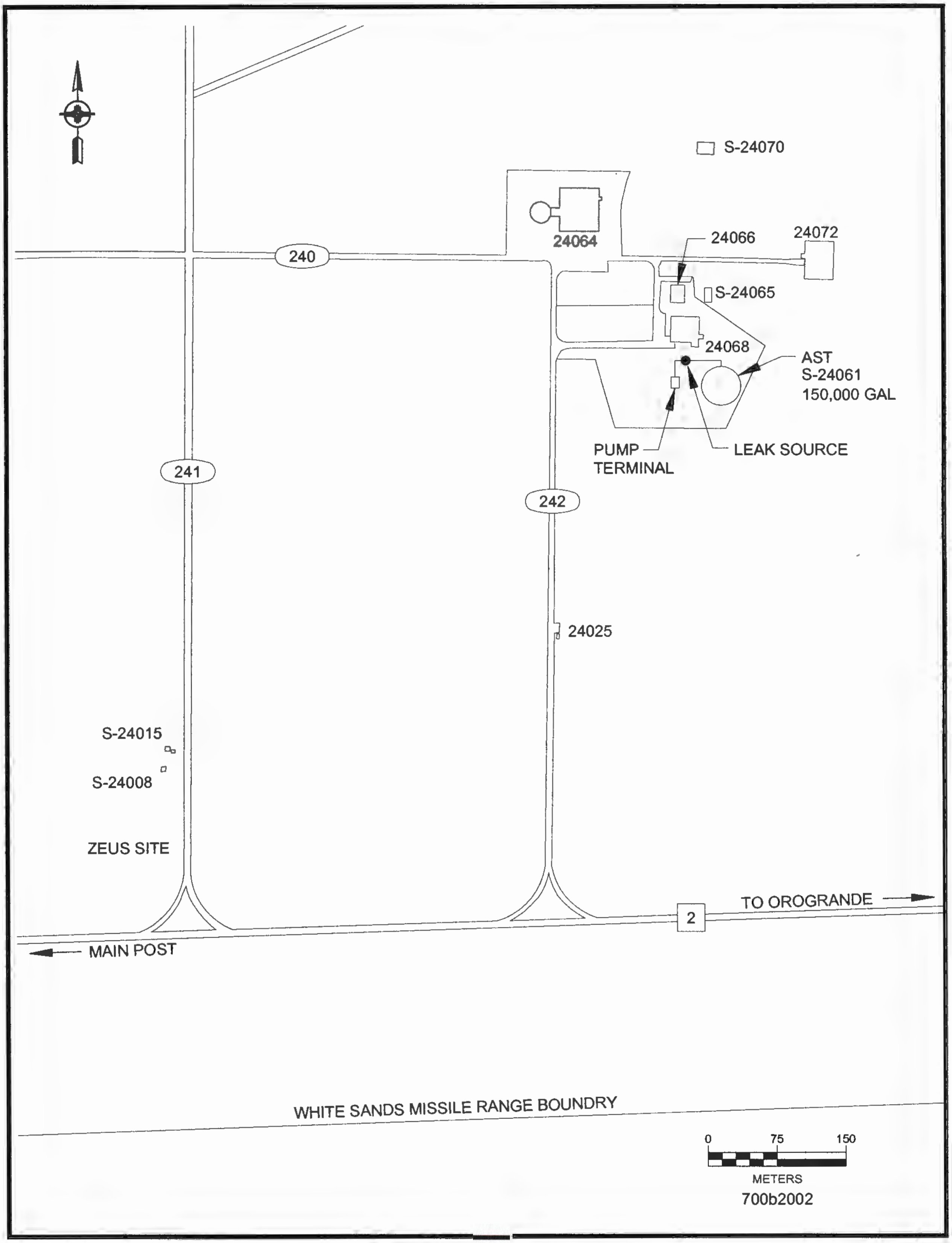


Figure 1-4.
Map of Physical Features at Launch Complex-38.

Photograph 1-1. AST at LC-38

Photograph 1-2. Pipeline leak identified at LC-38

1.4 Objectives and Scope

The purpose of this investigation is to supplement previous investigations by obtaining information to further characterize the geology and hydrology of the site area and extent of possible soil and groundwater contamination. This Work Plan is designed to document the objectives of the investigation, and describe the details of the technical and analytical approach to accomplish this task.

1.5 Approach and Implementation

The activities planned for this investigation will be conducted to further determine the extent of soil and/or possible ground-water contamination, determine possible contaminant transport pathways, evaluate the potential for human or ecological exposure and collect data to support the corrective measures study (CMS) for the selection of an appropriate remedy. Field activities to support these objectives will consist of the completion of 6 additional soil borings and the installation and sampling of three down-gradient and one up-gradient groundwater monitoring wells. Soil samples will be analyzed for the full suite of organic compounds (VOCs by Method 8260 and SVOCs by Method 8270), and TPH, by Method 8015 modified for diesel range hydrocarbons. Groundwater samples will be analyzed for total and dissolved metals, VOCs, SVOCs , TPH, and standard groundwater physical parameters and dissolved anions. In addition, geotechnical samples will be collected from the monitoring well location to support the CMS evaluations.

This Work Plan addresses each of these activities in detail. Each activity is intended to more fully characterize possible contamination, provide information to determine areas in which further data may be required, and provide data to conduct studies for corrective measures, if warranted. All aspects of quality assurance, quality control, data validation and data reporting will be in conformance with the White Sands Missile Range RCRA Part B Permit, the New Mexico Hazardous and Radioactive Materials Bureau Standard Operating Procedures Manual (NMED-HRMB, 1998) and OSWER Directive 9902.3-2A.

1.6 Previous Investigations

A summary of the preliminary investigation is provided in a Letter Report prepared under Contract DAAD07-95-C-0125, WAO No. 700-B2. This Letter Report is provided in Appendix A. At the time this letter report was prepared, it was understood that it was to be a preliminary report, and detailed descriptions of the activities conducted, plus the complete laboratory results would be provided in this Work Plan.

An environmental drilling contractor mobilized from Milan, New Mexico during February of 2001 to advance soil borings and retrieve core samples of the subsurface material. The WS-ES on-site contractor supplied a Geologist to supervise drilling and log the core samples. Drilling at the LC-38 AST diesel release site began on February 13, 2001 and concluded on February 16. Three exploratory holes were drilled in that time:

Site Name	Location	Total Depth
Soil Boring 1 (SB-01)	4ft (1.2 m) north of leak	TD at 105ft (32 m)
Soil Boring 2 (SB-02)	30ft (9.1 m) south of leak	TD at 80ft (24.4 m)
Soil Boring 3 (SB-03)	37ft (11.3 m) north of leak	TD at 82.5ft (25 m)

The locations of these borings are shown below in Figure 1-5.

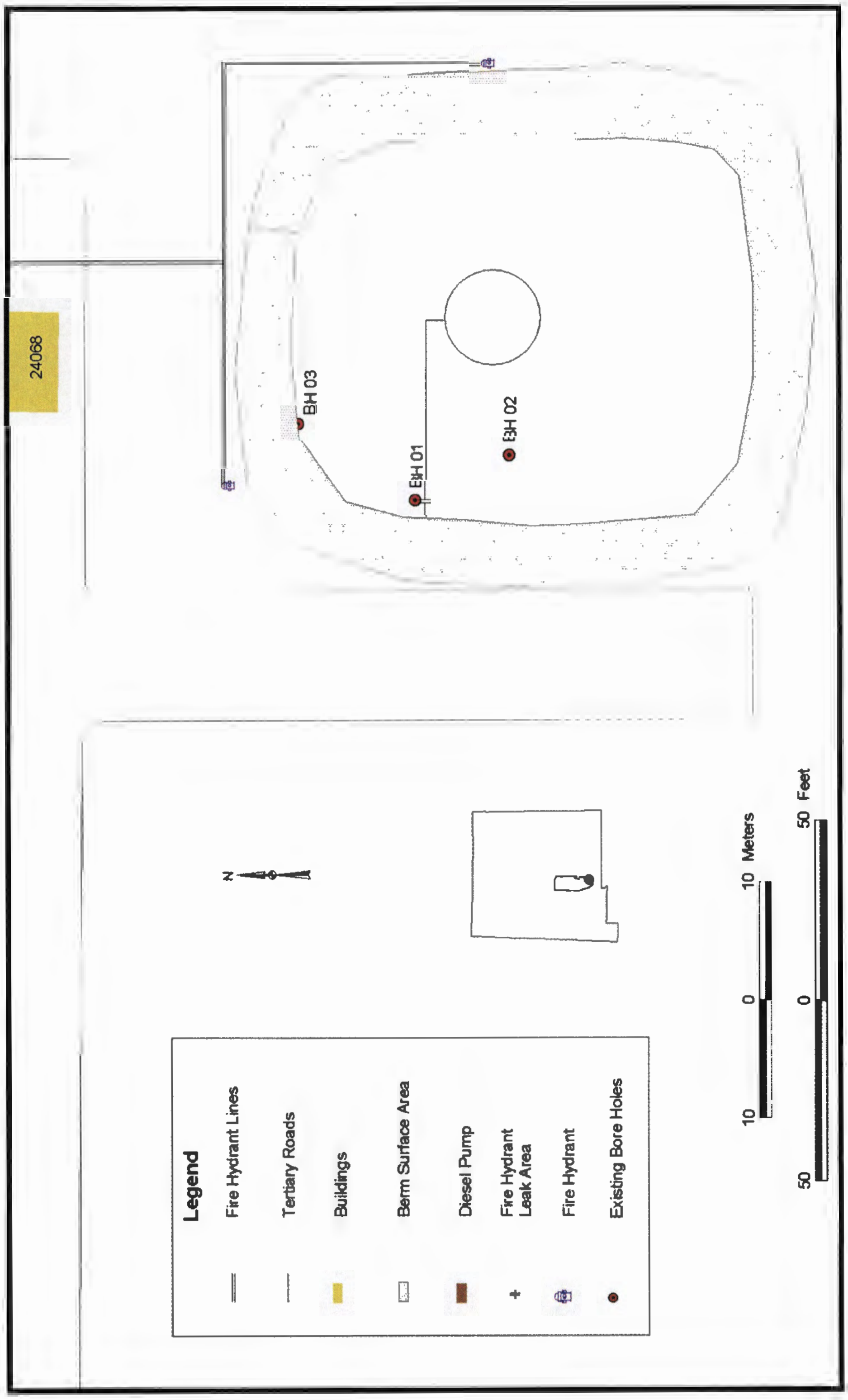


Figure 1-5.
Soil borings locations at LC-38, February 2001.

The drilling contractor used a hollow-stem auger with a 4.5-inch inside diameter through which a stainless steel, split-barrel core retrieval system (split spoons) passed. Two, (2.5-foot) long spoons were joined to equal the (5-foot) soil sampling interval. Employing this method allowed the Site Geologist to observe and record a nearly complete stratigraphic section. The split spoon apparatus was locked-in at the drilling bit and thereby collected undisturbed, in-place core as the drill string advanced.

Drillers retrieved the split-barrel core system via wire-line with each (5 feet) that the auger advanced. The geologic characteristics were logged as presented in Appendix B. A biased sampling approach dictated that soil was preferentially collected from the most obviously contaminated stratum within the designated sampling interval.

The biased samples were not homogenized prior to placing them into the sample containers. Instead, geologically similar materials were packed into clear glass jars with screw-on lids with Teflon septa. Packing the jars with sample minimized as much as possible the available headspace. Immediately following sample collection and labeling, each sample was stored in a cooler with ice prior to shipment to the laboratory.

1.7 Sample Analysis and Sample Results from the Preliminary Investigation

The following sections summarize the analytical results for the soil and groundwater samples collected during field activities. Additionally, this section presents a summary of the site geology and hydrogeology, as determined from the investigation. From these results, the vertical extent of diesel contamination can be delineated, although further investigation is required to determine the horizontal extent of the contamination.

1.7.1 Sample Analysis

Samples packed in ice were shipped by overnight express to the contract laboratory in Houston, Texas. The methods requested were Volatile Organic Compounds (SW-846 Method 8260), Semi-Volatile Organic Compounds (SW-846 Method 8270), Polynuclear Aromatic Hydrocarbons by High-Pressure Liquid Chromatography (HPLC; SW-846 Method 8310), and Total Petroleum Hydrocarbons (SW-846 Method 8015-modified for diesel-range compounds). All extractions from the samples were made within the corresponding method holding times. At the ground surface, and at the zones of relatively high diesel fuel contamination as determined by field indicators, samples were collected for RCRA metals analysis by 6000 and 7000 Series methods. Although RCRA metals are not components of the diesel fuel, samples were analyzed for metals on the off chance that mineralized metals were somehow chemically released through contact with the fuel. Following extraction, the laboratory experienced failure of their HPLC equipment. Using the 8270 method to analyze the samples extracted for HPLC, the laboratory was able to achieve detection limits similar to or lower than the HPLC method.

1.7.2 Sample Results

The raw laboratory data is provided as Appendix C. Only the detections are listed in the Appendix. The full laboratory reports are available through the Chemical Records Custodian, located on the third floor of Building 126 at WSMR.

The TPH results are summarized in Table 1-1. Note that the data is presented showing the boreholes as they are laid out from north to south. Where data is not presented for a depth, it is due to the fact that sampling was not always at the same depth in each hole

Table 1-1. Diesel Range Organics.

DIESEL RANGE ORGANICS, mg/Kg			
DEPTH, ft	**SB03**	**SB01**	**SB02**
4.5 - 5.0	1.4		16
9.5 - 10.0	1.8	14,000	6.1
14.5 - 15.0	1.4		8.4
17.5 - 18.0		11,000	
19.5 -20.0	1.4	11,000	24
24.5 - 25.0	15	17,000	14
29.5 - 30.0	3.6	21,000	
34.5 - 35.0	4.5	16,000	13
39.5 - 40.0	3.7	14,000	1.1
44.5 - 45.0	5,200	21,000	0.8
49.5 - 50.0		10,000	
53.7 - 54.2	30,000		
54.5 - 55.0	21,000	24,000	27
57.0 - 57.5			20,000
59.5 - 60.0	5,000	11,000	26,000
64.5 - 65.0	12,000	49,000	180
67.0 - 67.5	70,000		6,800
69.5 - 70.0	23	420	160
70.0 - 70.5		3,000	
74.5 - 75.0	56		1.4
79.5 - 80.0	1.2	2.2	
104.5 - 105.0		1.1	

The preliminary subsurface investigation of the LC-38 AST diesel fuel release had two main objectives. First, to determine if the fuel intersected a water table that could carry the contamination laterally away from the site. Second, to determine the maximum vertical extent of diesel contamination at the release point. Analytical data from the three soil borings answer both questions. The work plan is intended to build on this preliminary data to fully characterize the site both vertically and laterally.

1.7.3 Summary of Site Geology

Within the first one-hundred feet (30 meters) below the AST release site, two facies can be identified.

- Fine sand and silt facies - Predominantly very fine quartz sand and sandy silt, angular to subrounded grains, light tan occasionally grading to reddish brown. Lithic fragments up to 15% and volcanic fragments generally <5%.
- Clay facies - Clay, silt, and interbedded thin layers of fine quartz sand. Medium to dark brown, commonly with flattened, black carbon inclusions. Thin layers of caliche nodules and rip-up clasts common.

At the LC-38 AST diesel release site, the upper 35 feet (10.7 meters) of soil is dominated by the fine sand and silt facies. Below that is a transition zone where layers of both facies interfinger. Drilling encountered the clay facies from 60 feet (18.3 meters) to total depth (TD) in each of the three soil borings.

1.7.4 Interpretation of Results

The data shows that the diesel fuel flowed vertically to a depth of approximately 75 feet (23 meters) before it ran out of sufficient head force to drive it further. The investigating team encountered no ground water over this interval or even to a depth of 105 feet (32 meters). Total petroleum hydrocarbons analysis documented the mass distribution of contamination at approximately 5-foot (1.5-meter) intervals. The more compound-specific analyses, SW-846 8260 and 8270, were run on samples strategically spaced to maximize cost-benefit, but also verify the TPH results and provide for future risk screening. TPH results are provided in Table 1-1.

2.0 QA PROJECT PLAN

2.1 Data Quality Objectives Process

To support the overall investigation objectives, data quality objectives (DQOs) have been established. The DQOs are qualitative and quantitative statements that specify the quality of data required to meet the goals of the site characterization, risk assessment and remedial design. Data developed during the investigation will be used to determine the presence and lateral and vertical extent of possible soil and groundwater contamination, the direction as well as the rate of contaminant migration, if occurred. The evaluation of this data will be used to screen corrective measures, and implementation of corrective measures, if necessary.

DQOs will be used to:

- Ensure data comparability through the use of standard methods and controlled systems to collect and analyze samples;
- Provide analytical results of known and acceptable precision and accuracy; and
- Provide 95 percent data completeness for analytical results representing each matrix-method combination.

The level of analytical support to meet these goals will be between Level III and IV as described in "Data Quality Objectives for Remedial Response Activities: Development Process", U.S. Environmental Protection Agency, EPA 540/G-87/003, May 1987. As part of the analytical reporting requirements, all reporting laboratories will provide the following data:

- Sample identification numbers cross-referenced with laboratory identification numbers and QC sample numbers,
- Problems with arriving samples noted on chain-of-custody,
- Each analyte reported as an actual value or less than a specified detection limit, and
- Dilution factors, extraction dates, and analysis date.

QC samples results for laboratory blanks, surrogate spikes, matrix spikes, laboratory duplicates, field duplicates, field blanks, and trip blanks. The data developed during the investigation will meet the chosen objectives for precision, representativeness, accuracy, completeness, and comparability.

2.1.1 Accuracy

Accuracy is the degree to which a measurement agrees with the actual value, i.e., the amount of measurement bias. Accuracy is expressed as a percent recovery of a known concentration of reference material.

The accuracy of an analytical procedure is determined by the addition of a known amount of material (matrix spike) to a field sample matrix or a standard matrix. A standard matrix is made up of distilled water or sterile, clean soil with approximately the same physical properties (porosity, permeability, plasticity, grain size, etc.) as the field sample. The field sample matrix is described as all components of the sample mixture except the analyte (the compound being analyzed). The lab will be required to perform matrix spiking on 10% of field samples, as well as on 5 to 10% of standard matrix samples. Field sample matrix and standard matrix sample spiking show how the sample matrix-analyte chemical interactions affect the analytical results. The matrix behavior of the spiked field sample will be comparable to that of the matrix of the original sample. After analysis for the spike is completed, the accuracy of the procedure is expressed as a percent recovery as shown by the following equation:

$$\text{Percent Recovery} = \frac{(C_2 - C_1)}{C_0} \times 100\%$$

where: C_0 = amount of analyte added to the sample matrix,

C_1 = amount of analyte present in the unspiked sample matrix (equal to zero for the standard matrix), and

C_2 = amount of spiked material recovered in the analysis.

Typically, the amount of a reference analyte spiked into a field sample matrix is specified by the laboratory quality control program, or 3 to 5 times the background concentration of the analyte in the sample matrix. Samples cannot be spiked for all organic compounds which could possibly exist in the field sample matrix, however, a set of surrogate compounds, each of whose physical and chemical properties is similar, is used as surrogate matrix spikes, or surrogates. Acceptable recovery ranges for each class of organic compounds are discussed in the analytical methods for each parameter.

2.1.2 Precision

Precision is a measure of the degree of reproducibility of an analytical value and is used as a check on the quality of the sampling and analytical procedures. Precision is determined by analyzing replicate samples. The significance of a precision measurement depends on whether the sample is a field replicate, lab replicate, or a matrix spike replicate.

Field replicates are taken at the rate of 10% or one per batch (each daily shipment of samples from a site), whichever is greater. Precision of the analytical method, at each stage, is determined by calculation of a relative percent difference (RPD) between duplicate analytical recoveries of a sample component, relative to the average of those recoveries:

$$RPD = \frac{|C_2 - C_1|}{(C_2 + C_1)/2} \times 100\%$$

where: C_1 = analyte concentration in the sample,
C_2 = analyte concentration in the sample replicate, and
$| \ |$ = an absolute value (It is customary to express RPD as a positive number.

These calculations are usually performed on matrix spikes and matrix spike duplicates.

2.1.3 Completeness

Field completeness will be assessed by comparing the number of samples collected to the number of samples planned. Analytical completeness will be assessed by comparing the total number of samples with valid analytical results to the number of samples collected. The overall project completeness is, therefore, a comparison between the total number of valid samples to the number of samples planned. The results will be calculated following data validation and reduction.

Completeness (C) is determined by:

$$C = \frac{P_1}{P_0} \times 100\%$$

where: P_0 = total number of samples planned, and
P_1 = number of valid data points

A value of 90% or higher is the goal. For values less than 90%, problems in the sampling or analytical procedures will be examined and possible solutions explored.

2.1.4 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent actual site conditions. The determination of the representativeness of the data will be performed by:

- Comparing actual sampling procedures and chain of custody forms to those described in the work plan,
- Identifying and eliminating nonrepresentative data in site characterization activities,
- Evaluating holding times and condition of samples on arrival at the laboratory, and
- Examining blanks for cross contamination.

Representativeness is a qualitative determination. The objective of this work plan is to eliminate all non-representative data.

2.1.5 Comparability

Comparability is a qualitative measure of the confidence with which one data set can be compared to another. These data sets include data generated by different laboratories performed under this work plan, data generated by laboratories in previous investigative phases, data generated by the same laboratory over a period of several years, or data obtained using differing sampling techniques or analytical protocols. The comparability objectives of this work plan are (1) to generate consistent data using standard test methods; and (2) to salvage as much previously generated data as possible. Comparability will be evaluated by comparing the QA sample analyzed by an independent laboratory to its field replicate.

2.1.6 Sensitivity

Sensitivity is a general term referring to the calibration sensitivity and the analytical sensitivity of a piece of equipment. The calibration sensitivity is the slope of the calibration curve evaluated in the concentration range of interest. The analytical sensitivity is the ratio of the calibration sensitivity to the standard deviation of the analytical signal at a given analyte concentration. The detection limit, which is based on the sensitivity of the analysis, is the smallest reported concentration in a sample within a specified level of confidence. Quantitation limits represent the sum of all of the uncertainties in the analytical procedure plus a safety factor. The detection limit is a part of the quantitation limit. Quantitation limits are given in Table 2-1.

Table 2-1.
Laboratory reporting limits for organic constituents by analytical method.

Parameter	Method	Aqueous (µg/L)	Solid (µg/Kg)
Diesel range TPH	8015B	250	8,250
VOCs			
1,1,1,2-Tetrachloroethane	8260B	1.0	5.0
1,1,1-Trichloroethane	8260B	1.0	5.0
1,1,2,2-Tetrachloroethane	8260B	1.0	5.0
1,1,2-Trichloroethane	8260B	1.0	5.0
1,1-Dichloroethane	8260B	1.0	5.0
1,1-Dichloroethene	8260B	1.0	5.0
1,1-Dichloropropene	8260B	1.0	5.0
1,2,3-Trichlorobenzene	8260B	1.0	5.0
1,2,3-Trichloropropane	8260B	1.0	5.0
1,2,4-Trichlorobenzen	8260B	1.0	5.0

Parameter	Method	Aqueous (µg/L)	Solid (µg/Kg)
1,2,4-Trimethylbenzene	8260B	1.0	5.0
1,2-Dibromo-3-chloropropane	8260B	1.0	5.0
1,2-Dibromoethane	8260B	1.0	5.0
1,2-Dichlorobenzene	8260B	1.0	5.0
1,2-Dichloroethane	8260B	1.0	5.0
cis-1,2-Dichloroethene	8260B	1.0	5.0
trans-1,2-Dichloroethene	8260B	1.0	5.0
1,2-Dichloropropane	8260B	1.0	5.0
cis-1,2-Dichloropropene	8260B	1.0	5.0
trans-1,2-Dichloropropene	8260B	1.0	5.0
1,3,5-Trimethylbenzene	8260B	1.0	5.0
1,3-Dichlorobenzene	8260B	1.0	5.0
1,3-Dichloropropane	8260B	1.0	5.0
1,4-Dichlorobenzene	8260B	1.0	5.0
1-Chlorohexane	8260B	1.0	5.0
2,2-Dichloropropane	8260B	1.0	5.0
2-Butanone	8260B	5.0	10
2-Chlorotoluene	8260B	1.0	5.0
2-Hexanone	8260B	5.0	10
4-Chlorotoluene	8260B	1.0	5.0
4-Methyl-2-pentanone	8260B	5.0	10
Acetone	8260B	5.0	10
Benzene	8260B	1.0	5.0
Bromobenzene	8260B	1.0	5.0
Bromochloromethane	8260B	1.0	5.0
Bromodichloromethane	8260B	1.0	5.0
Bromoform	8260B	1.0	5.0
Bromomethane	8260B	2.0	5.0
n-Butylbenzene	8260B	1.0	5.0
sec-Butylbenzene	8260B	1.0	5.0
tert-Butylbenzene	8260B	1.0	5.0
Carbon Tetrachloride	8260B	1.0	5.0
Chlorobenzene	8260B	1.0	5.0
Chloroethane	8260B	2.0	5.0
Chloroform	8260B	1.0	5.0
Chloromethane	8260B	2.0	5.0
Dibromochloromethane	8260B	1.0	5.0
Dibromomethane	8260B	1.0	5.0
Dichlorodifluoromethane	8260B	2.0	5.0
Ethylbenzene	8260B	1.0	5.0
Hexachlorobutadiene	8260B	1.0	5.0
Isopropylbenzene	8260B	1.0	5.0
p-Isopropyltoluene	8260B	1.0	5.0
Methylene Chloride	8260B	2.0	5.0
Methyl tertiary butyl ether (MTBE)	8260	1.0	25.0
Naphthalene	8260B	1.0	5.0
n-Propylbenzene	8260B	1.0	5.0
Styrene	8260B	1.0	5.0
Tetrachloroethene	8260B	1.0	5.0
Toluene	8260B	1.0	5.0

Parameter	Method	Aqueous (µg/L)	Solid (µg/Kg)
Trichloroethene	8260B	1.0	5.0
Trichlorofluoromethane	8260B	1.0	5.0
Vinyl Chloride	8260B	1.0	5.0
Xylene (total)	8260B	1.0	5.0
SVOCs			
1,2,4-Trichlorobenzene	8270B	10	330
1,2-Dichlorobenzene	8270B	10	330
1,3-Dichlorobenzene	8270B	10	330
1,4-Dichlorobenzene	8270B	10	330
2,2'-Oxybis(1-Chloropropane)	8270B	10	330
2,4,5-Trichlorophenol	8270B	25	830
2,4,6-Trichlorophenol	8270B	10	330
2,4-Dichlorophenol	8270B	10	330
2,4-Dimethylphenol	8270B	10	330
2,4-Dinitrophenol	8270B	25	830
2,4-Dinitrotoluene	8270B	10	330
2,6-Dinitrotoluene	8270B	10	330
bis-(2-Chloroethoxy)methane	8270B	10	330
bis-(2-Chloroethyl)ether	8270B	10	330
bis-(2-Chloroisopropyl)ether	8270B	10	330
2-Chloronaphthalene	8270B	10	330
2-Chlorophenol	8270B	10	330
bis-(2-Ethylhexyl)phthalate	8270B	10	330
2-Methylnaphthalene	8270B	10	330
2-Methylphenol	8270B	10	330
2-Nitroanaline	8270B	25	830
2-Nitrophenol	8270B	10	330
3,3'-Dichlorobenzadine	8270B	10	330
3-Nitroanaline	8270B	25	830
4,6-Dinitro-2-methylphenol	8270B	25	830
4-Bromophenyl-phenyl ether	8270B	10	330
4-Chloro-3-methylphenol	8270B	10	330
4-Chloroanaline	8270B	10	330
4-Chlorophenyl-phenyl ether	8270B	10	330
4-Methylphenol	8270B	10	330
4-Nitroanaline	8270B	25	830
4-Nitrophenol	8270B	25	830
Acenaphthene	8270B	10	330
Acenaphthylene	8270B	10	330
Anthracene	8270B	10	330
Benzo(*a*)anthracene	8270B	10	330
Benzo(*a*)pyrene	8270B	10	330
Benzo(*b*)fluoranthene	8270B	10	330
Benzo(*g,h,I*)perylene	8270B	10	330
Benzo(*k*)fluoranthene	8270B	10	330
Benzoic Acid	8270B	25	830
Benzyl Alcohol	8270B	25	830
Butylbenzyphthalate	8270B	10	330
Carbazole	8270B	10	330
Chrysene	8270B	10	330

Parameter	Method	Aqueous (µg/L)	Solid (µg/Kg)
Di-*n*-butylphthalate	8270B	10	330
Di-*n*-Octylphthalate	8270B	10	330
Dibenzo(*a,h*)anthracene	8270B	10	330
Dibenzofuran	8270B	10	330
Diethylphthalate	8270B	10	330
Dimethylphthalate	8270B	10	330
Fluoranthene	8270B	10	330
Fluorene	8270B	10	330
Hexachlorobenzene	8270B	10	330
Hexachlorobutadiene	8270B	10	330
Hexachlorocyclopentadiene	8270B	10	330
Hexachloroethane	8270B	10	330
Indeno(1,2,3-*c,d*)pyrene	8270B	10	330
Isophorone	8270B	10	330
Naphthalene	8270B	10	330
Nitrobenzene	8270B	10	330
N-Nitrosodimethylamine	8270B	10	330
N-Nitrosodiphenylamine	8270B	10	330
N-Nitroso-di-*n*-propylamine	8270B	10	330
Pentachlorophenol	8270B	25	830
Phenanthrene	8270B	10	330
Phenol	8270B	10	330
Pyrene	8270B	10	330
RCRA Metals			
Arsenic	6010A	0.005	1.0
Barium	6010A	0.006	10.0
Cadmium	6010A	0.0005	1.00
Chromium	6010A	0.004	1.0
Lead	6010A	0.03	1.0
Mercury	7000A	0.002	0.10
Selenium	6010A	0.005	1.0
Silver	6010A	0.01	1.0
Additional water quality parameters			
Sulfate	300	5	
Chloride	300	2	
Alkalinity	310.1	1	
TDS	60.1	10	
conductivity	20.1	1 µmho/cm	
Laboratory pH	150.1	0.01 pH	

2.1.7 Chemical Data Validation

Raw laboratory data are typically reduced at the laboratory, resulting in a report containing the analytical data and the laboratory QC results. If needed, calibration and internal standards information, raw data, and all instrumentation output will be provided by the laboratory. Following receipt of chemical laboratory data, the validation process will include the following:

- Review of laboratory testing methods, detection limits, holding times, data qualifiers, etc.
- Review of data summaries and reports for transcriptional and typographical errors
- Review to determine propriety of sampling protocols
- Review to compare the data against trip blanks to detect contamination from sampling
- Review to compare field sampling replicates
- Review to compare field sampling replicates (QC samples)
- Review of laboratory QC including laboratory blanks, spike recovery and duplicates
- Review chain-of-custody forms, sample receipt data, damages sample containers, etc.

2.1.8 Field Data and Measurements

All field instruments will be properly calibrated and used as directed by the manufacturer. Validation of field data will be determined primarily by making several readings and checking for reproducibility. All field personnel will be knowledgeable on the use and calibration of field instruments, the oversight of field data collection, validation, and record keeping. All field data will be recorded in the site logbook and presented in the Investigation Summary Report.

Field measurements will be performed to Level I (USEPA, 1983) standards. These will include measurement of pH, conductivity, and temperature on groundwater samples. Precision on field measurements will be assessed by duplicate measurements to determine reproducibility. These consecutive readings should be $\pm 1^{\circ}$ F for temperature, $\pm$ 0.02 units for pH, and $\pm$ 10% for conductivity.

2.1.9 Technical Data

Technical data refers to data of several types, such as potentiometric surface measurements, groundwater flow calculations, and lithologic thicknesses generated from geologic and geophysical field data, isopleth profiles of contaminants and groundwater models. This information will be recorded in the site logbook as it is collected. Anomalous readings or results will be rechecked and presented to the Task Manager for verification. Technical data will be evaluated and reported in the Investigation Summary Report.

3.0 RCRA FACILITY INVESTIGATION APPROACH

Several conclusions can be reached from the field data acquired and these conclusions support the rationale for the RFI workplan presented herein.

- The vertical extent of diesel contamination in the immediate proximity of the leak source is 22 meters (72 feet) deep
- Ground water was not encountered during subsurface drilling to a depth of 32 meters (105 feet)
- The release of diesel fuel is confined to the vadose zone above the clay layer.
- The lateral extent of contamination has not been delineated.
- Very fine-grained clastic material (clays and silts) with high porosity absorbed and retain a significant volume of diesel fuel

Field activities, including six soil borings to 100 feet (30.5 meters), and the installation of three down-gradient and one up-gradient water table monitoring wells for this investigation will help determine the horizontal and vertical extent of any possible soil and water contamination around the perimeter of the releases and determine if any migration of contamination has occurred. In addition, it will resolve the question of whether the soil and/or groundwater contain hazardous waste and/or hazardous waste constituents. Geotechnical samples collected from the monitoring well borehole will provide data for evaluation of remedial alternatives in the Corrective Measures Study, should selection of a remedy be warranted. The proposed locations for the borings and the monitoring wells are shown in Figure 3-1 below.

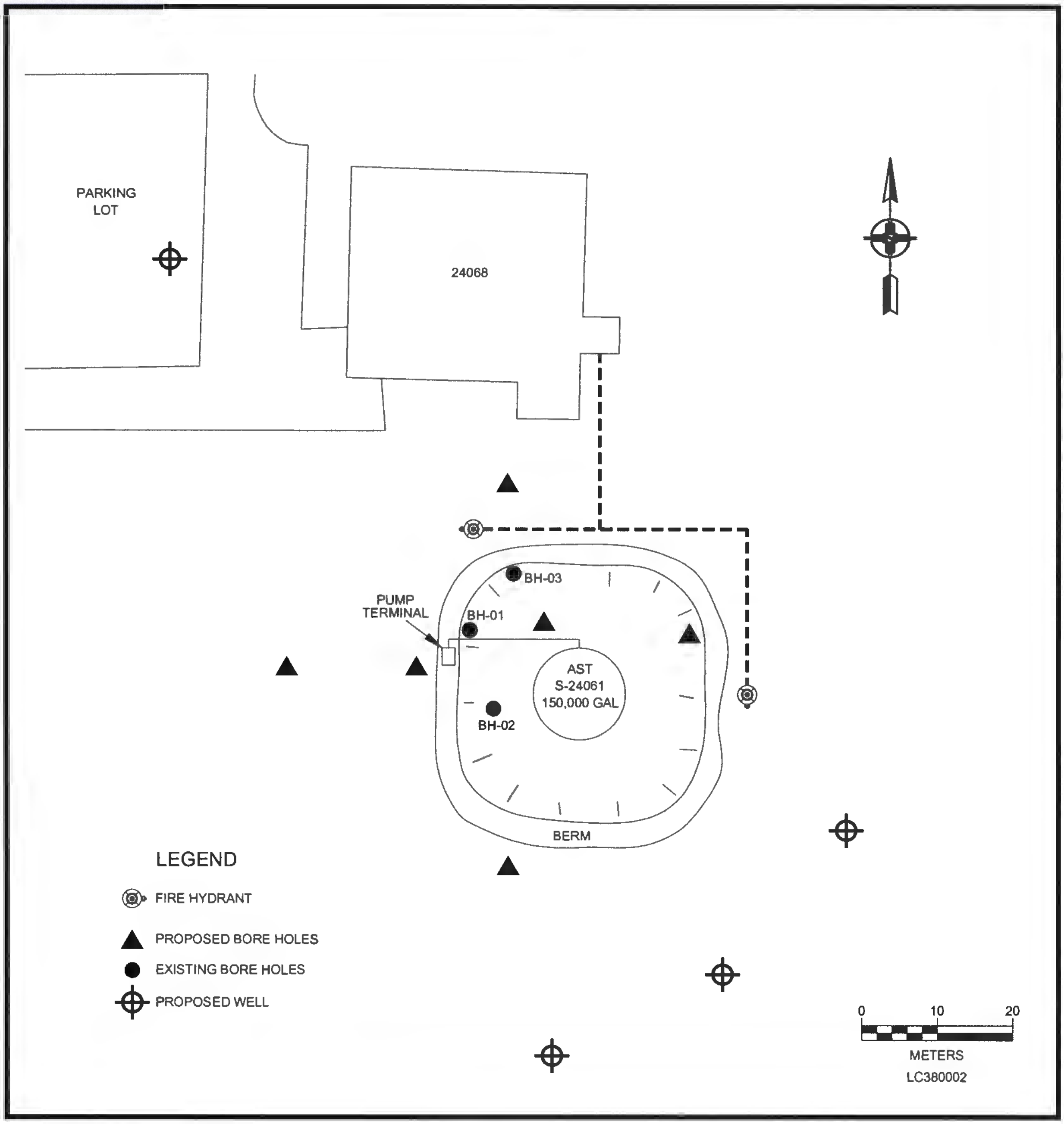


Figure 3-1. Proposed Sampling Locations at LC-38.

3.1 Soil Borings

The soil borings will be drilled using a hollow-stem rig supervised by a qualified scientist using industry-standard methods. Each soil boring will be drilled to 100 feet (31 meters) in depth. The proposed soil boring locations are shown in Figure 3-1, in addition to the existing three locations, also shown. As detailed in Section 1.6, the three existing soil borings provided contaminant concentration data at the leak source and along a north-south plane radiating outward to a distance of approximately 35 feet (10.7 meters) from the source. The proposal is to place soil borings at a similar distance from the source on an east-west plane, and then step out at the compass points to ring the leak with soil borings at a distance of approximately 100 feet (31 meters) from the leak source.

Continuous soil cores will be collected. If continuous coring is not possible, split spoon samples will be collected over each 5-foot (1.5 m) length of the drill stem using a wireline retrieval system for the split-barrel core apparatus. The site geologist will inspect the core as it is retrieved for any evidence of diesel contamination. Soil type will be logged from the core by the site geologist. An organic vapor analyzer using a flame ionization detector will be used to provide additional screening for contaminants, in addition to its primary function of monitoring the drill crew breathing space as discussed in the site health and safety program. Where field screening indicates no organic contaminants, samples will be collected on a 10-foot (3-meter) interval and analyzed for TPH by SW-846 Method 8015-Modified for the diesel fuel range hydrocarbons. Wherever diesel fuel is encountered in the drill cuttings or in the core, the sampling interval will shift to 5 feet (1.5 meter) for analytical methods SW-846 Methods 8260 and 8270. The detection levels proposed for the VOC and SVOC constituents to be quantified by these methods are listed in Table 2-1.

If the field screening methods fail to detect the presence of diesel fuel, and if the geology across the site is uniform as it was in the first three soil borings, soil samples for SW-846 Methods 8260 and 8270 will be collected 4 inches (10-centimeters) above and 4 inches below the sand/clay contact along which the fuel spread laterally as show by the preliminary subsurface investigation (see Section 1.6). If no evidence of contamination is found in a particular soil boring, drilling will be halted at a depth of 100 feet (30.5 meters) and the boring will be backfilled with hydrated bentonite. In soil borings where diesel contamination is encountered, the staff geologist will drill at least 15 feet (4.6 meters) beyond the last field evidence of organic vapors and sample for SW-846 Method 8015-Modified on a 5-foot (1.5-meter) interval. The total depth of borings where diesel contamination is encountered will be 100 feet (30.5 m), or greater if contamination is encountered below 85 feet (26 m), to ensure samples are collected at least 15 ft (5 meters) below the last field evidence of organic vapors.

Backfilling of the open boreholes will be accomplished using a 5% bentonite grout using a tremmie pipe. This method will prevent bridging and ensure that the open borehole is sealed to prevent creation of a migration pathway.

One borehole, of the two to be drilled closer to the location of SB-01, will not be backfilled, but will be equipped for soil gas sampling and evaluation. A 10-foot (3 m) length of coarse screen will be installed in the zone of the highest readings from the field screening. This soil gas monitoring well will be available for the Corrective Measures Study (CMS) for data collection, such a soil gas sampling, pressurization studies or a pilot study for vapor extraction.

These data could be used during the CMS to evaluate natural attenuation, soil vapor extraction, air sparging and other active remediation alternatives, should the preparation of a CMS be warranted by the results of this investigation.

3.2 Ground Water Sampling

A set of four wells, three down-gradient and one up-gradient, is proposed to determine depth to water, the TDS concentration of the first water, and the presence or absence of organic contamination. The proposed locations of the wells are shown in Figure 3-1. The three down-gradient wells are to be located approximately 200 feet (61 meters) down-gradient of the diesel fuel leak. The up-gradient well will be approximately 200 ft (61 meters) up-gradient.

Prior to drilling the well a cultural and natural resources survey will be conducted. If required, the location for the monitoring well and decon pad will be shifted up to 75-feet (22.9 m) down-gradient (to the southeast) and/or 100 feet (31 m) along the gradient.

The wells will be constructed as detailed in Appendix F. The wells will be developed a minimum of 48 hours after installation and prior to sampling by surging and bailing. When the produced water is clear and the physical parameters (pH, specific conductance and temperature) have stabilized, an additional seven well volumes will be pumped out and containerized. Sampling will be conducted a minimum of 24 hours following well development.

Groundwater samples will be analyzed for organic contaminants associated with diesel fuel according to the list of parameters in Table 2-1 using the aqueous matrix reporting limits. Additionally, the ground water constituents will be characterized by using the analyses listed in Table 2-1. All parameters will be analyzed as dissolved concentrations except that the samples for metals will be analyzed for both total (unfiltered) and dissolved (filtered) concentrations.

In addition, geotechnical samples will be collected from the middle well of the three down-gradient wells. Samples for geotechnical analysis will be collected every ten feet (3 m), starting at 15 feet (4.6 m) below ground surface, and at every 5 feet (1.5 m) from 60 to 80 feet (18.3 to 24.4m), for a total of 10 samples. The samples will be collected from a borehole drilled with a hollow-stem auger drilling rig, using continuous coring, or split-spoon samples if continuous coring is not possible. Following collection of the geotechnical samples, the borehole will be abandoned as described in Section 3.1. A mud-rotary rig will be used to drill the actual monitoring well at a location 10 to 20 feet (3 to 6.1 m) from the borehole. At the judgment of the Site Geologist and the drilling contractor, the same borehole location can be used, by overdrilling the initial 80 feet (24 m) and then continuing to drill the well.

No soil samples for laboratory chemical analysis will be collected from this well location. It is expected that the location is outside the zone of contamination from the release. If contamination is indicated by field screening, samples for laboratory analysis for organics will be collected at five foot intervals until 15 feet (4.6 m) below the last indication of contamination from the field screening. The borehole will be abandoned as described in Section 3.1. A new location for the monitoring well will be selected, at least 100 feet (30.5 m) downgradient of initial location.

4.0 DATA COLLECTION DESIGN AND PROCEDURES

4.1 Field Activities

The principal operations of the field investigation will be soil-sampling, installation of monitoring wells, groundwater sampling, management of investigation-derived wastes (IDW), horizontal and vertical surveying and various field measurements. Due to the location of Launch Complex-38, a utility clearance will be obtained before commission of field activities. The field investigation will be enveloped by the field QA/QC program in order to ensure that the data quality objectives are met.

This section defines, in general terms, the procedures for the identification and collection of soil and groundwater samples, installation of monitoring wells, and decontamination of drilling and sampling equipment. All field activities will conform to MEVATEC Standard Operating Procedures (MSOPS), where applicable. These MSOPS are included in this document in Appendix F.

4.1.1 Near Surface Soil Sampling Procedures

Near surface soil samples will be collected using a decontaminated, hand driven, stainless steel auger. All sampling equipment will be decontaminated prior to sample collection using decontamination procedures presented in Appendix C. Before and during sampling, all decontaminated sampling equipment and bottles will be placed on clean plastic sheeting to avoid contamination. Soil from the auger will be placed in a stainless steel bowl. Samples will be collected in conformance with MSOP 3.0 (Appendix F).

The soil will be placed into the sampling jars. Excess soil around the top of the sample jars will be wiped away with a clean cloth or paper towel to ensure the cap will fit tightly. When all sample jars required are filled, excess soil will be containerized with other soil cuttings and properly disposed.

New, disposable gloves will be worn to collect each soil sample. Prior to leaving the sample location, a surveying stake with the location number written on it will be placed at or immediately adjacent to the actual sampling location. The boring location coordinates will be taken using a Global Positioning System (GPS).

At a minimum, the following information will be recorded in a bound field logbook for each sample collected:

- Date and time of collection,
- Sample location,
- Sample number,
- Weather conditions,
- Depth of sample collection,
- Number of cores collected to obtain adequate sample volume,
- Sample type (duplicate, split, field blank if applicable),
- Visual observation of soil (color, layers, Unified Soil Classification System (USGS) description, etc.), and
- Sampler's name and personnel present.

4.1.2 Soil Boring Sampling Procedures

Subsoil samples for chemical analysis will be collected using continuous coring or split-spoon samplers. All sampling and sample composite equipment will be decontaminated according to the procedures in Appendix E and applicable MSOPs. All investigation derived waste will be managed in accordance with procedures described in Section 4-6 and Appendix E.

When the split-barrel is removed from the boring and opened, any material appearing to be slough will be removed. The remaining material will be mixed in a stainless steel bowl prior to filling the sample containers. The sampling team members collecting each sample will wear new, disposable gloves.

4.1.3 Groundwater Sampling And Analysis

One up-gradient and three down-gradient monitoring wells will be installed in accordance with the procedures described in Appendix F and applicable MSOPs. Along with the sample collection, the field parameters of pH, temperature, and conductivity will be measured. To evaluate groundwater flow direction and aquifer characteristics, a groundwater level measurements will be taken in each well.

4.1.3.1 Groundwater Level Measurements

Prior to sampling the monitoring well, the water level will be measured to the nearest 0.01 ft. with an electronic water level indicator. Measurements in the monitoring well will be measured at a mark or notch at the top of the stainless steel casing. The water level indicator probe will be decontaminated prior to and after use by rinsing with water meeting requirements of ASTM Type II reagent water. The probe and tape will be decontaminated in the same manner as sampling equipment if it becomes excessively soiled. Procedures for decontamination are contained in Appendix E.

4.1.3.2 Groundwater Sampling Procedure

Prior to sampling, the monitoring well will be purged in order to obtain samples of formation water. Purging of the well will be performed with a portable, decontaminated, electric, submersible pump. Purging of all wells will continue until at least three casing volumes are removed and the field parameters of pH, temperature and conductivity are stable. These parameters are considered stable when three consecutive readings have a temperature $\pm$ 0.5° C, pH is $\pm$ 0.1 units and conductivity is $\pm$ 1%. All purged water will be containerized in approved containers at the well location. Investigation derived waste, including purge water, will be managed in accordance with the procedures described in Section 4.6 and Appendix E.

After purging is satisfactorily completed, the water level will be measured with an electronic water level indicator and then the well will be sampled as soon as possible with a PVC bailer. The bailer will be rinsed with ASTM Type II water prior to sampling. New nylon or poly bailer cord will be used with the bailer at each well. If the well recharges slowly, sampling will begin as soon as sufficient recharge occurs to fill sampling containers. Sample containers will be filled directly from the bailer. All containers will be new and level I certified according to USEPA quality assurance cleaning protocols. The sampling team members at each well will wear new, disposable gloves. Preservatives, if required by the analytical method, will be added to the containers by the sampling team. It is possible that the laboratory could supply sample containers that contain EPA approved preservatives. In this case, additional preservatives will not be added. Preservatives are shown in Table 4-1 in Section 4.3.6.

4.1.3.3 Groundwater Sampling Documentation

At a minimum, the following information will be recorded in a bound field logbook for each sample collected:

- Date and time of collection
- Sample location
- Sample number
- Water level and time of measurement
- Total depth and diameter of the well
- Depth of water column and minimum purge volume
- Sample type (duplicate, split)
- Purging and sampling method (bailer, hand pump, submersible electric pump, etc.)
- Temperature, conductivity, and pH of well water during purging until stable readings are obtained
- Color and turbidity of sample (if applicable)
- Volume purged prior to sampling,
- Sample preparation and preservation (filtering, NaOH etc.),
- Instrument calibration check,
- Sampler's name and personnel present, and
- Remarks on any special problems or observations.

4.2 Field Quality Assurance/Quality Control (QA/QC) Procedures

In order to ensure that sampling equipment is cleaned properly, proper sampling procedures are implemented, and that laboratory performance is adequate to produce quality data, several forms of QA/QC samples will be collected and analyzed as part of the investigation. QC samples are collected in the field and sent to the same laboratory as the rest of the field samples. QC samples include trip blanks, field blanks, and replicates.

4.2.1 Replicate Samples

Replicate samples are extra samples collected at a location. In theory, they are identical to the field sample collected. Care is taken to ensure that all the samples collected from a specific location are as identical as possible. Replicate samples are used as duplicates of the field samples for QC purposes. Replicate samples will be collected in duplicate at a frequency of 1 per 20 samples, with a minimum of one per day. The samples will go to the primary laboratory as a regular field sample and labeled as a "blind" duplicate.

4.2.2 Field Measurements

Field instruments will be required to measure groundwater parameters. Reliable measurements are dependent on proper calibration and use.

Field equipment for the investigation will include meters to measure groundwater pH, temperature, and conductivity of water samples. All meters and monitoring equipment will be properly calibrated and used according to manufacturer's instructions.

Groundwater pH, temperature, and conductivity will be measured following the MSOPs presented in Appendix F. Water level indicators to be used are manufactured by Solinst or equivalent. All indicators have tapes or cables marked in increments of 0.01 feet. Copies of the owner's manual will be kept on-site for reference on the proper calibration, operation, and troubleshooting of equipment.

The pH probe will be calibrated daily, and more often if necessary, using 4.01, 7.00 and 10.00 pH buffers. The two buffers expected to bracket the groundwater pH should be used (most commonly 4.01 and 7.00). The calibration for pH will be performed using the following steps:

- Rinse probe with distilled water and shake off excess water.
- Immerse probe in pH 7.00 buffer. Observe temperature and check chart on buffer bottle to see what pH the buffer should be at this temperature. Set temperature knob on meter to correct value.
- Immerse probe in pH 7.00 buffer and allow reading to equilibrate.
- Turn adjustment knob until correct pH of 7.00 buffer is displayed.
- Rinse probes with distilled water, shake off excess, and calibrate with either 4.01 or 10.00 buffer depending on expected pH range of groundwater.
- Check temperature of second buffer and adjust temperature knob if needed. Determine pH of buffer at this temperature from chart on bottle.
- Immerse probe in buffer and allow reading to equilibrate.
- Adjust knob labeled "SLOPE" until display reads buffer pH value.
- Rinse probes off with distilled water and immerse in pH 7.00 buffer and check reading. Correct if necessary by adjusting the adjustment knob. Recheck second buffer and change adjustment if necessary.

Field pH buffer solution will be used daily for calibration. The calibration will be checked frequently during the day and adjusted if necessary. All pH meter calibrations and checks are recorded in the field logbook.

Conductivity measurements on the Hydac meter cannot be adjusted in the field. However, the probe can be checked using standard solutions. At the start of field activities, the conductivity probe will be checked according to manufacturer's instructions using a 1,000-microsiemen/cm standard solution. The reading obtained will be divided by the conductivity of the standard solution to obtain a correction factor for the probe. All readings should then be multiplied by this correction factor to obtain the correct reading. The meter will compensate for temperature and display the conductivity at 25 °C that is known as "specific conductance." The programmed amount of compensation (1.8-1.9% / °C) is accurate unless the water contained total dissolved solids of 10,000 mg/L or higher.

Measurement of all three groundwater parameters will be accomplished by immersing the probe in a clean polyethylene container containing at least 250 ml of water. Probes will be moved slightly to minimize effects of the container wall on probe performance and to keep the sample from stagnating during measurement.

4.3 Sample Handling and Testing

4.3.1 Sample Numbering

All samples, except trip blanks, collected for this investigation will be assigned sample numbers as follows:

For surface and subsurface soil samples: #### xxyy (zzz.z) $$

where:	####	= site identification or well number prefix
	xx	= sample location type where: HA = hand auger BH = borehole MW = monitor well
	yy	= sample location number
	zzz.z	= sample depth interval
	$$	= QC modifier when needed, where: QC = QC field replicate for the contract lab

Trip blanks will be numbered according to the number of the sample it is sent with followed by "TB".

Monitoring well samples will also have a unique numbering system. The groundwater samples collected from the monitoring wells will be labeled according to their site designation, well designation, and month/year sampled.

4.3.2 Sample Labeling and Documentation

Labeling and field documentation are of great importance in order to identify all sample containers and record adequate information about the sample. Samples with no labels or conflicting information must often be discarded since their source is unknown or their integrity is compromised. Improper documentation of sample collection may result in data being generated that is useless because the location, depth of collection, or other vital information was not recorded.

All sample containers will be labeled with water-resistant adhesive labels. Black permanent ink felt-tipped markers will be used to complete labels. At a minimum, the following information will be recorded:

- Date and Time of Collection,
- Sampler's Name,
- Unique Sample Number,
- Method of Preservation (if applicable), and
- Requested Analysis.

All pertinent information about each sample will be recorded in a bound field logbook using permanent ink pens. Any procedures performed and problems encountered are documented in the logbook. Corrections to items placed in the logbook will be made by a single line through the information with the corrector's initials by the line.

4.3.3 Sample Containers and Preservation

The appropriate type and number of sample containers will be used for each class of contaminants. These requirements are summarized in Table 4-1. All containers will have Teflon-lined caps or septa. All sample containers will be purchased as new containers, cleaned according to standard USEPA cleaning protocols, and packaged in custody-sealed boxes.

4.3.4 Sample Preparation and Shipment

Sample bottles will be prepared and packaged for shipment to minimize bottle breakage and to provide adequate sample temperature. Samples will be sent to all laboratories by overnight courier in large, rigid, plastic ice chests or coolers. Arrangements will be made with each laboratory, prior to sample shipment so that a person is available to receive and handle the samples. This is to ensure that sample temperatures and holding times are not exceeded.

Prior to shipment, the bottles and coolers will be packed according to the following procedures.

- Vermiculite, foam, or other inert packing material will be placed upon the floor of the cooler,
- Bottles will be wrapped in bubble wrap or placed in plastic sleeves to prevent bottle-to-bottle or bottle-to-cooler contact (no packing materials containing adhesives will be used on VOA vials too prevent potential contamination),
- Bottles or groups of bottles will be placed into clear Ziploc plastic bags and sealed,
- Bottles will then be placed into coolers in an upright position. Packing material will be placed around bottles so that they do not touch during shipment,
- Ice will be put into Ziploc bags and placed around and among the sample bottles,
- Adequate packing material will be placed within the empty spaces to prevent potential movement of bottles during shipment,
- The completed chain-of-custody form will be placed into a Ziploc bag, sealed and taped to the inside cover of the corresponding cooler,
- The cooler drain shall be taped shut,
- The cooler lid will be secured by wrapping the cooler in two different locations with strapping tape,
- The completed shipping label will be attached to the top of the cooler so that it is unobscured, and

The signed custody seal forms shall be affixed upon the front right and back left of each cooler/lid interface and covered with clear packing tape.

4.3.5 Laboratory Receiving

Upon receipt of the sample coolers at the appropriate laboratory, the laboratory will check the following items:

- The cooler will be checked for damage or leakage and verification that the chain-of-custody seals have not been broken,

- Contents of the cooler will be compared with the chain-of-custody to verify that all sample numbers and requested analyses match and that no samples are missing,
- Bottles will be inspected for breakage or leakage and the field personnel will be notified immediately so that another sample can be collected (due to site inaccessibility, extra caution will be taken to prevent this occurrence),
- The temperature of the bath ice will be measured (to verify that the contents of the cooler were kept below 4°C) and recorded on the chain-of-custody form,
- The pH of liquid samples will be measured and recorded on the chain-of-custody form,
- Any discrepancies between cooler contents and chain-of-custody forms will be noted and/or comments provided regarding damaged samples or problems in the "Remarks" section of the chain-of-custody form, and
- The date, time, and signature should be recorded on the chain-of-custody form acknowledging the condition and receipt of samples.

Once the laboratory has signed the chain-of-custody, it has assumed responsibility for the proper storage, analysis and disposal of the samples.

4.3.6 Laboratory Test Methods and Detection Limits

The analytical test methods are derived from SW-846 (USEPA, 1986) or USEPA 600 Series (USEPA, 1983). The test required methods, sample containers, preservatives, and maximum sample holding times for all chemical parameters and sample matrices are shown in Table 4-1.

Table 4-1. Sample Containers, Test Methodologies, Hold Times, and Preservatives for Soils and Water.

Analytical Parameter	Analytical Method	Soil*		Groundwater		
		Container	Max. Hold Time	Container	Max. Hold Time	Preservative
Physical Characteristics Specific Conductivity Laboratory pH Total Dissolved Solids	 EPA 120.1 EPA 150.1 EPA 160.1	NA	NA	1 liter Polyethyl.	7 days	None (4 °C)
Dissolved Chloride	EPA 300.0	NA	NA	1 liter Polyehtyl.	28 days	None (4 °C)
Dissolved Sulfate	EPA 300.0	NA	NA	1 liter Polyethyl.	28 days	None (4 °C)
Alkalinity	SM 2320B	NA	NA	1 liter Polyethyl.	28 days	None (4 °C)
Metals	SW 846 6010	8 oz. Glass	180 days	1 liter Polyethyl.	180 days	HNO3 pH<2
VOCs	SW 846 8260	4 oz. Glass	14 days	3-40 ml Glass	14 days	HCl pH<2
SVOCs	SW 846 8270	4 oz. Glass	14 days	2-1 Liter Amber Glass	7 days extraction / 40 days analysis	None (4 °C)
Total Petroleum Hydrocarbons - DRO	SW 846 8015B Modification	4 oz. Glass	14 days	3-40 ml Glass	14 days	HCL1 PH<2

NA - Not applicable to this analysis
* preservation for all soil samples is chilling to and maintaining the sample at 4°C (39.2°)

4.3.7 Laboratory Blanks and Standards

The QA/QC procedures of the laboratory require various blanks and standards to be analyzed along with samples. Method blanks and reagent blanks verify the presence of interference and background levels of reagents and chemicals used in the analysis.

Check standards, surrogate standards, internal standards, and standard reference materials provide information regarding the level of confidence in reporting a concentration of an unknown sample. Matrix spikes and matrix spike duplicates evaluates the effect of the sample matrix upon the analytical method.

4.4 Sample Integrity and Documentation

Because analytical results are suspect if the integrity of samples is compromised, measures will be taken to protect the integrity of samples from the time of collection until analysis is complete. Integrity largely involves the security of the sample so that it is known that samples have not had an opportunity to be altered nor compromised. A large part of providing a program where all samples can be identified and that information about their collection is known is the proper documentation of the sample collection and labeling of containers. Procedures for protecting the integrity of collected samples and properly documenting their collection are described below.

4.4.1 Security

Security will entail procedures for protecting monitoring wells from potential tampering by unauthorized personnel from the time of collection until analysis is complete. Security procedures are described below.

4.4.1.1 Monitoring Well Security

To prevent unauthorized access to monitoring wells, No.1 or No.3 Master locks (or equivalent) will be placed on all well caps. Only authorized personnel will possess keys. As part of the well sampling procedures, any signs of tampering or damage to wells will be noted in the field logbook.

4.4.1.2 Sample Security in the Field

All samples collected in the field will remain in the possession of the sampling crew until shipment. Samples will be promptly placed in coolers. Locked vehicles or trailers will be used for interim storage as necessary. If coolers must be left unattended for extended periods of time, signed custody seals will be placed on the coolers.

4.4.1.3 Sample Security in the Laboratory

Once the sample coolers arrive at the laboratory, intact with unbroken custody seals, sample security and integrity will be the laboratory's responsibility. Upon arrival, the laboratory will check the temperature of the cooler contents, verify pH of water samples for metals, check cooler contents versus chain-of-custody, inspect contents for damaged or leaking containers, and verify the accuracy of paperwork.

It will be the responsibility of the laboratory to store the samples in a secure area that is accessible only to authorized personnel.

4.4.2 Custody

Sample custody consists of the forms and labels that document that the samples have been released and received by the proper individuals and that shipping containers have not been opened prior to receipt by the laboratory. Chain-of-custody forms and custody seals are commonly used to accomplish this as discussed in the following sections.

4.4.2.1 Chain-of-Custody Forms

The chain-of-custody form is used to record the sample number, number of containers, date and time of collection, requested analyses, and any remarks for each sample collected. It is also used to record the signatures of persons releasing and receiving the samples. Typically, the chain-of-custody form is filled out and signed by the sampler and then signed again by the receiving individual at the laboratory. Both the sampler and the laboratory retain a copy of the chain-of-custody form. The laboratory customarily provides these forms.

4.4.2.2 Custody Seals

To ensure that unauthorized personnel have not opened sample coolers during shipment, signed custody seals will be placed on at least two locations. The individual preparing the samples will sign and date the custody seals and place one on the front right and one on the back left side of the cooler/lid interface. The seals will be covered with clear packing tape. The laboratory will note upon receipt whether or not the seals were intact. Instances of broken seals will be noted on the chain-of-custody form.

4.4.2.3 Bill of Lading

The shipper's bill of lading can also serve as documentation of sample integrity. It documents the transfer of the samples from the sampler to the shipper since the shipper is not able to sign the chain-of-custody form. The sampler will retain a copy of the shipper's bill.

4.5 Corrective Action

Corrective actions that will be taken in response to nonconformances with established quality control procedures are described in USEPA's "A Compendium of Superfund Field Operations Methods".

4.5.1 Field Activities

Field activities that are improper will be corrected as quickly as possible. The project technical coordinator will be responsible to see that corrective action is initiated and documented whenever the error has the potential to compromise the quality of the data being generated or whenever there is a possibility that the error might be repeated.

4.5.2 Field Data

Corrective action for poor field data quality (as determined by replicate measurements or prior expectations) consists of remeasurement until successive readings agree within reasonable limits. Examples of frequently made measurements and limits to which they should agree include the following:

- Temperature - measurements should agree within 0.2°C,
- pH - measurements should agree within 0.1 pH unit,
- Conductivity - measurements should agree within 1%,
- Depth and water level measurements - readings should agree within 0.01 ft.

If remeasurement is not successful, then instrument calibration, operation, and the user's technique will be evaluated.

4.5.3 Laboratory

Laboratory corrective action is described in the analytical method for that analysis.

4.5.4 Implementation and Reporting

Following problem identification, the responsible individual, as assigned by the Principle Geologist, will identify the root cause(s) of the problem and develop a corrective action. As appropriate, a corrective action report will be prepared. The report will describe the problem, potential ramifications, the corrective action, implementation, results of the implementation, and effectiveness of the corrective action.

Corrective action should be implemented at the lowest possible level. Corrective action that involves correcting a mistake with little potential of repetition need not be reported as long as the error is not repeated. For example, an erroneous water level measurement, such as 40 feet in a 30-foot well, would be corrected by taking several additional readings that agreed with each other and looked reasonable. It would not be necessary to report this error.

Corrective action involving a potentially repetitive error of one that had been reported should be documented in writing. For example, an erroneous water level measurement due to a low battery in the water level indicator should be documented because previous suspect water levels may need to be flagged and/or checked.

4.6 Investigation Derived Waste

Several waste streams will be produced during this investigation. These wastes include drill cuttings, monitoring well development and purge water, decontamination wastewater, and personal protective equipment (PPE). In order to protect human health and the environment, these items will be considered hazardous and managed as such until analysis proves otherwise. To minimize waste generation, the following guidelines will be followed:

- Removal of as much soil or sediment and other contamination from sampling equipment as possible before washing to minimize the quantity of wastewater generated.

- Avoid excessive travel through areas of known contamination to reduce the need for personal and/or vehicle contamination.
- Avoid excessive well development and purging of monitoring wells.

The site specific Decontamination and Investigation Derived Waste Plan (Appendix E) will be reviewed and adhered to by MEVATEC representatives and subcontractors. The following sections generally describe IDW management procedures.

5.0 PROJECT MANAGEMENT

White Sands will utilize its environmental contractor, MEVATEC Corporation, to execute the requirements within this Work Plan. The project organization reflects the relationship between Regulatory oversight of the project (NMED), White Sands Technical Inspector (TI), and the MEVATEC team assembled to plan, organize, control, and executes this investigation. Within the MEVATEC's project management system, the key positions are the Program Manager, Principal Engineer and the Principal Site Geologist. The following sections list the responsibilities within the MEVATEC team.

5.1 Duties and Responsibilities

5.1.1 Program Manager

The Program Manager is the senior MEVATEC representative on the project, and functions as the focal point for White Sands. For this project, the Program Manager's responsibilities include:

- Overall project management
- Total planning, organization, and execution of the Workplan
- Maintaining contact with the WSMR TI throughout the work
- Directing the Principal Engineer in conducting a successful project
- Providing resources to the Principal Engineer to accomplish project responsibilities
- Guiding the Principal Engineer on the approach to a public relations program
- Reviewing and approving all deliverables

Dr. Donald K. Emig, P.E. serves as the Program Manager for MEVATEC.

5.1.2 QA/QC Manager/Deputy Program Manager

The Deputy Program Manager for this project is responsible for the following:

- Acting for the Program Manager in his absence
- Reviewing project progress
- Ensuring project QC protocols and procedures are followed
- Conducting audits to ensure that all deliverables are properly reviewed and checked
- Documenting that all quality objectives have been met
- Assisting the Principal Engineer in evaluating alternatives to meeting project objectives
- Providing guidance on the allocation of resources

Mr. Fred Bourger serves as the Deputy Program Manager and QA/QC Manager for MEVATEC.

5.1.3 Principal Engineer

The Principal Engineer for this project will be responsible and accountable to the Program Manager for overall direction and performance of the project including the following:

- Developing and executing the Workplan
- Directing the Principal Site Geologist
- Keeping Program Manager and WSMR TI appropriately informed
- Approving uses of technical resources
- Coordinating all assigned resources
- Periodic review of progress and progress reporting
- Resolving Sampling and Analysis Plan issues
- Schedule and budget tracking
- Quality and timeliness of deliverables
- Work performed by subcontractors
- Technical liaison between the Principal Site Geologist and the Program Manager

Ms. Kathy Davis will serve as the Principal Engineer for this project.

5.1.4 Principal Site Geologist

The Principal Site Geologist will be responsible for coordinating all site activities, including those of the on-site contractors, and all laboratory activities. These include execution of the fieldwork in accordance with appropriate sections of this Work Plan. Specific responsibilities include:

- Assist the Principal Engineer with development of the Work Plan
- Day to day execution of the Work Plan
- Reporting project progress to the Principal Engineer
- Coordinating, directing, and overseeing field technical support staff
- Providing overall direction and supervision of the drilling, well installation, geophysical logging, location surveys, surface soil sampling, data validation, and related activities
- Ensuring that all staff and subcontractors meet White Sands security requirements
- Completing all appropriate field logs for project activities
- Providing overall supervision of the collection, handling, and shipping of all samples
- Monitoring all drilling and sampling operations to ensure that all project site personnel are fully implementing and executing the provisions of this Work Plan
- Understanding the quality requirements of each field task, and bringing to the attention of management, conditions which may adversely impact the quality of the data or other work product.
- Execution of all field QC procedures

The Principal Site Geologist for this project will be Mr. Jeffrey Swanson.

5.1.5 Site Health and Safety Officer

The Site Health and Safety Officer will report to the Deputy Program Manager and be responsible for:

- Directing all health and safety activities on site
- Reporting safety-related incidents or accidents to the Deputy Program Manager
- Temporarily suspending field activities, if health and safety of personnel are endangered
- Maintaining health and safety equipment on-site
- Conducting daily health and safety meetings
- Verifying personnel working on the site have completed medical surveillance and health and safety training.
- Maintaining documentation of health and safety measures taken at the site, including
- Communication of provisions of the Site Safety and Health Plan
- Levels of protection and required upgrades
- Incident reporting
- Upgrading or downgrading levels of protection in response to field conditions

Mr. Joel Giblin will also serve as the Site Health and Safety Officer. The Principal Site Geologist will perform site-specific health and safety implementation.

5.2 Data Management and Reporting

MEVATEC Corporation will provide personnel, services and equipment necessary for the completion of the scope of work described in this Work Plan. This section provides a description of the work to be performed and the items to be delivered to White Sands Missile Range. The work will be performed in general accordance with the approved Phase II RFI Work Plan and the site-specific Work Plans contained herein.

5.2.1 Work Plan

This Work Plan will be submitted to the New Mexico Environment Department for review and approval. The Work Plan contains detailed plans for sampling and analysis for the project sites. The Work Plan also contains a Site Specific Health and Safety Plan, Monitoring Well Installation Plan, and Decontamination and Investigation Derived Waste Management Plan as Appendices B, C and D.

5.2.2 Site Specific Health and Safety

MEVATEC prepared a Site Specific Health and Safety Plan for this project to serve as an addendum to the Accident Reporting and Safety Program dated 14 September 1995, developed by MEVATEC Corporation, for all activities conducted at WSMR. The Accident Reporting and Safety Program provides minimum safety standards and accident prevention fundamentals to cover a range of activities at WSMR and its satellite installations. To supplement the information in the Accident Reporting and Safety Program, this plan describes specific activities to complete this site investigation. A copy of the Site Specific Health and Safety Plan is in Appendix D.

5.2.3 Letter Report of Generated Wastes

Not later than 60 days following the completion of drilling and sampling activities, a letter report will be submitted to White Sands Missile Range that outlines the analytical results of wastes generated during field investigation activities. Characterized wastes include drill fluids and cuttings, well development and purge water and wastewater generated during decontamination activities. The total quantity of materials will be presented along with recommendations for proper disposal.

5.2.4 Monthly Status Reports

MEVATEC will submit to WS-ES, a monthly progress report that describes the work performed since the previous report, work currently underway, and work anticipated during the next month. The monthly status report will also outline any technical problems or other issues that could cause project delays.

5.2.5 Site Characterization Report

A Site Characterization report will be prepared to summarize the findings of the investigation, present conclusions drawn from the findings, and make recommendations for further action at the site. These recommendations will provide a basis for the completion of a feasibility study for remedial alternatives.

The format for the Site Characterization Report will consist of, but is not limited to the following:

Executive Summary

1.0 Introduction
- 1.1 Purpose
- 1.2 Site Background
  - 1.2.1 Site Description
  - 1.2.2 Site History
  - 1.2.3 Previous Investigations

2.0 Study Area Investigation (Discussion of field activities conducted for site characterization)
- 2.1 Surface Features
- 2.2 Contaminant Source Investigations
- 2.3 Geological Investigations
- 2.4 Hydrological Investigations
- 2.5 Soil and Vadose Zone Investigations
- 2.6 Groundwater Investigations

3.0 Physical Characteristics of the Study Area (Results of field activities)
- 3.1 Surface Features
- 3.2 Meteorology
- 3.3 Surface Water Hydrology
- 3.4 Geology
- 3.5 Soils
- 3.6 Hydrogeology
- 3.7 Demography and Land Use
- 3.8 Land use

4.0 Nature and Extent of Contamination
- 4.1 Source(s)
- 4.2 Soils and Vadose Zone
- 4.3 Groundwater

5.0 Contaminant Fate and Transport
- 5.1 Routes of Migration
- 5.2 Contaminant Persistence
- 5.3 Contaminant Migration (results of modeling)

6.0 Baseline Risk Assessment
- 6.1 Human Health Evaluation
- 6.2 Environmental Evaluation

7.0 Summary and Conclusions

8.0 Recommendations

Appendices
- Laboratory Data and QA/QC Evaluation Results
- Risk Assessment Methods
- Field Data

REFERENCES

Cooper, J.B., 1973. *Summary records of test and supply wells in range areas, White Sands Missile Range, New Mexico:* U.S. Geological Survey open-file report, 132 p.

Cruz, R.R., 1984. *Annual Water-Resources Review, White Sands Missile Range, New Mexico.* U.S. Geological Survey Open-File Report 85-645, Albuquerque, New Mexico.

McClean, J.S. 1970. Saline Groundwater Resources of the Tularosa Basin, New Mexico: Department of the Interior, U.S. Office of Saline Water Research and Development Progress Report 561, 128 p.

APPENDIX A

LETTER REPORT

LETTER REPORT

The following letter report was prepared under Contract DAADO7-95-C-0125, WAO No. 700-B2

1. **Initial Field Effort to Delineate Depth of Diesel Contamination at Bldg. 24068 (LC-38)**

2. **Introduction**
The WAO 700-B2 outlines the RCRA corrective action approach for a release of diesel fuel discovered in the summer of 2000. This letter report summarizes a preliminary field effort designed to obtain information that will guide and focus the RCRA Facility Investigation.

3. **Background**
A release of an estimated 31,000 gallons of diesel fuel from an AST was reported to WS-ESEC in August 2000. A Work Assignment Order was issued to MEVATEC that specified delineation of the extent of environmental contamination, in accordance with the corrective action terms in the WSMR RCRA Part B permit for hazardous waste management. A WAO response was prepared and approved, however, in a pre-response meeting on 11 September WS-ES-EC requested that the delineation of the vertical migration of diesel from the source be delineated prior to RH work plan preparation and submission to NMED. The vertical delineation was accomplished from 13 February through 17 February, 2001. The following discussion describes work accomplished and the data collected.

4. **Discussion**
Soil borings were advanced at 3 locations on north-south axis using a hollow-stem auger and soil samples were collected for laboratory analysis at 5-foot intervals. The first soil boring was located 4 feet from the release source. When field instrumentation indicated that, at the 75-foot level, the boring exceeded the depth of diesel contamination, the soil boring was extended to 100 feet. Not encountering ground water in this interval, MEVATEC collected a soil sample and backfilled the boring with hydrated bentonite (*314* in. hole plug).

A second soil boring was drilled 30 feet north of the source and a third was drilled 25 feet south of the source. Both encountered similar subsurface geology and contaminated intervals. The contaminated zone was from roughly 50 to 70 feet (laboratory verification is currently pending analysis of the soil samples collected at 5-foot intervals) in these holes, whereas at the source soil was contaminated from the near-surface source to 70 feet bgs.

5. **Analysis**
Sedimentary geologic strata below the site control the extent of contamination below the leak source. Deposition of clay encountered at 60 to 80 feet in the 3 soil borings indicates a meandering fluvial system was likely active in the basin during a slightly cooler

climatic period. The basin was arid at that time as evidenced by caliche horizons at several levels. The sediments above the clay are dominated by very fine sands and silts, suggesting a transition from eolian deposition near the surface to fluvial deposition at depth. The sediments were unsaturated with respect to water prior to the diesel fuel release and, therefore, the forces of liquid-surface tension on the sediment grains are opposing the force of gravity which created head driving the diesel down.

6. Conclusions

Diesel flowed downward through the permeable, sandy units, which have less grain surface area relative to the clay, in somewhat of a columnar pattern. When diesel encountered the unsaturated clay, the decrease in permeability caused the diesel to migrate laterally (were it was detected in the outer borings at roughly 60 feet bgs). But the diesel was also being adsorbed to the individual clay particles by the higher surface tension force (relative to sand) caused by the tabular grains. So, while the clay unit impeded the vertical migration of the fuel and caused it to spread laterally, it also absorbed a significant volume of diesel in an interval approximately 10 to 20 feet thick. While it is not known how far the contaminated clay extends laterally, the clay cannot release the diesel to coarser-grained sediments below until the clay reaches saturation and breakthrough. It is not known if these saturated conditions have been reached away from the source, but breakthrough from the clay was not apparent directly below the source.

7. Recommendations

The lateral extent of contamination should be delineated and compared with the volume of fuel lost to see if the two can be correlated. Delineation of extent was provided for in the original tasking from WS-ES-EC that initiated WAO 700-B2. MEVATEC recommends proceeding as defined in the original WAO tasking.

8. MEVATEC Task Manager and Task Coordinator / phone no.:

William Little, Task Manager, 678-2853
Kathy Davis, Task Coordinator, 678-3397

APPENDIX B

DRILLING LOGS

Hole No.

DRILLING LOG

DIVISION	
INSTALLATION	
SHEET 1 OF 2 SHEETS	
1. PROJECT	WAD 700-B2
2. LOCATION (Coordinates or Station)	LC-38 Bldg. 24068
3. DRILLING AGENCY	
4. HOLE NO. (As shown on drawing title and file number)	Soil Boring 01
5. NAME OF DRILLER	Stewart Bros.
6. DIRECTION OF HOLE	☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	
8. DEPTH DRILLED INTO ROCK	
9. TOTAL DEPTH OF HOLE	
10. SIZE AND TYPE OF BIT	
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	
12. MANUFACTURER'S DESIGNATION OF DRILL	Failing F-10
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED: ; UNDISTURBED:
14. TOTAL NUMBER CORE BOXES	
15. ELEVATION GROUND WATER	
16. DATE HOLE	STARTED 2-13-01; COMPLETED 2-14-01
17. ELEVATION TOP OF HOLE	
18. TOTAL CORE RECOVERY FOR BORING	%
19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH Ft. b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
					0.0	surface
	5		silty clay, reddish brown	100	5.0-5.5	silty clay w/ caliche; leak source → 5
	10		vy fine sand, lt tan; 80% qtz - angular; 15% lithics; <5% volcanics	15:40; 90	9.5-10	vy fine sand — 10; thin caliche at 13' hard drilling
	15			16:10; 80	17.5-18	vy fine sand
	20		fine sandy silt, reddish brn	16:25; 70	19.5-20	sandy silt
	25		fine sand, lt tan; 80% qtz, 20% lith, minor vol	16:35; 70	24.5-25	fine sand
					29.5-30	fine sand
	30			16:35 chg 45; 70		30
	35		3" pink clay, gypsiferous; yellowish brn sandy silt	17:00; 70	34.5-35	sandy silt; hard drilling
	40		vy fine sand, lt. tan; 1.0 pink-white gyp clay, vy fine sand, lt. tan; 1ft reddish brn clay	17:25; 100	39.5-40	vy fn snd; hard drilling — 40
	45		2ft dk brn clayey silt	17:50; 100	44.5-45	silty fine sand; shut down 2/13; 2-14-01 ↓
	50		predominantly vy fine sand (fine stringers noted) >90% qtz subrounded, 5% liths and minor volcanics; 1.5 ft silt, dk brn	10:30; 100	49.5-50	fine sand — 50
	55		SSS	10:55; 100	54.5-55	fine sand; 1" caliche-cem. sand recovered; *ANS kit shows product in sand
	60		59.5 clay, med brn, 2ft black, flattened organic nodules; sand, fine lt. tan subround qtz	11:25; 100	59.5-60	clay; soil pilling — 60
	65		20" clay; silt - 6" with some clay, med brn; 3.5" clay, dark brn, caliche nodules	11:50; 100	64.5-65	silt; pilled cuttings; *ANS kit inconclusive
	70		silt 1ft med brn; 3ft, 8" clay, dk brn with organic nods. <5mm	12:20; 100	69.5-70; 70.0-70.5	clay; silt — 70
	75		silt ~6" med brn; clay silty clay with caliche nods and organic decomposed	12:40; 100	74.5-75; 75-75.5	silt; silt
	80			13:20	79.5-80	silty clay
	85					14
	90					1430 slow drilling binding on augers
	95					
	100					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT | HOLE NO.

Hole No.

DRILLING LOG	DIVISION	INSTALLATION	SHEET 2 OF 2 SHEETS

1. PROJECT: WAO 700-B2	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY: LC-38 Bldg. 24068	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number): Soil Boring 01	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER: Stewart Bros. Grants, NM	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH Ft b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Fine sand, subround to round lithic abundant, sorted stringers of clay <1"	50	104.5-105	Sand
	105					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. PROJECT HOLE NO.

Hole No.

DRILLING LOG

DIVISION:

INSTALLATION:

SHEET 1 OF 1 SHEETS

1. PROJECT: WAC 700-B2
2. LOCATION (Coordinates or Station): LC-38 Bldg 24068
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): Soil Boring 02
5. NAME OF DRILLER: Stewart Bros.
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT:
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL: Failing F-10
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED 2-15-01 COMPLETED 2-15-01
17. ELEVATION TOP OF HOLE:
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH ft b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			sand fill	80		
	5		sandy silt, lt tan, wht caliche nod and loose cem		0948 4.5-5	sandy silt w/caliche cem.
				50		
	10		silty vy fine sand no caliche; grades down to sorted vy fine sand = >90% qtz 5% lithics		0952	silty sand
				60		
	15		clayey silt, 10" reddish brown		1003	clayey silt
			fine sand, lt. tan sorted, subangs.	65		
			2" brn silt w/ caliche nod 1-3mm		1019	sand
	20		fine sand; thin clasts ≤15 mm long	75		
	25	2" stringer	well rounded pebbles 4-8mm, clay in sand rip ups		1033	sand; pebbles are lime and caliche cemented sand
			fine sand	65		
			1" caliche cement; fine sand			
	30				1047	sand
			3" med sand grains (lithics) 10% in fine sand; small rip up clasts <5mm	65		
	35		fine sand, lt tan		1059	sand
			clayey silt, lt brown	70	1147	clayey silt; swelled spoons
	40		silty, vy fn sand med tan; 95% qtz subround - rounded			
			2 ft clay, dk brn, blk organic streaks	100		caliche nodule in clay
	45		vy fine sand, lt tan, subround, minor silt		1314	sand
				80	1336	
	50		silt lt. tan, 1.5" layer of caliche cement w/ blk organic			silt
			sandy silt, med tan	85		
	55				1352	sandy silt
			fn sand	75		
			clay dk brn, caliche nods <10mm organic		1421	sand / clay / silt; augers binding
	60		sandy silt, med tan			
			clay med brn	100		
			7" fn sand			sand
	65		clay dk brn lrg caliche nodule 5-35mm		1438 / 1446	clay / clay; diesel prod on core leaking on PVC
			14" vy fine, med tan clay	100	1450	sand
					1455	silt
	70		silt caliche nod 30mm			
			clay dk brn, caliche nodules	100		
			6" silt med brn; 6" clay dk brn; 6" silt, lt brn		1513	clayey silt
	75		dk brn clay; clayey silt 1 ft	100		
					1534	clayey silt
	80		clayey silt med brn			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE.

PROJECT | HOLE NO.

Hole No.

DRILLING LOG	DIVISION	INSTALLATION	SHEET 1 OF SHEETS

1. PROJECT: WAO 700-B2	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station): LC-38 Bldg. 24068	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL: Failing F-10
4. HOLE NO. (As shown on drawing title and file number): Soil Boring 03	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER: Stewart Bros., Grants NM	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE: STARTED 2-16-01 COMPLETED 2-16-01
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH Ft. b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g	
			silty sandy fill reddish brn	65			0
	5		Caliche stage 4		0955	caliche	
			clayey silt, med. brn, w/caliche nods, 40mm vertical caliche (root casts?) to 120mm	100			
	10				1026	clayey silt	10
			fine sand, lt tan ≥90% qtz subangular 5% lithics, minor volcs.	50			
	15				1050	sand	
				50			
			1ft med brn clay, abund. organic film		1108	silt	
	20		clayey silt, dk tan				20
			2" med brn clay, caliche nod + blk flakes	60			
			fine sand		1129	sand	
	25		silty fine sand				
			fine sand	30			
	30		silt tan w/ caliche cem., root casts		1156	silt	~80 mm sand/caliche nodule at interface (see photo)	30
			silty vf fn sand	60			
	35		3' → stage 3 caliche in fn sand, above		1214	silty sand		4·
			sandy silt / 2' clay — clay, med brn	80			
			22 ft fn sand		1302	sand		40
	40		2in. Stage 2 caliche, brown clay laminae on top			clay	1st thick nodular calcite 40–50 mm
			lt brn clay / med brn clay	100	1320		
	45		silt, tan		1318	silt	diesel odor in silt 2nd nod calcite layer
			15' clay, lt brn laminated along silty planes	85			
	50		silty clay, laminated organic remains		1333	silty clay		50
			fn sand, sub round, sorted med tan	65	1345	sand	
	55		sandy silt dk yellowish tan		1348	silt	
			sandy silt, caliche matrix lt colored	90			
			silt med tan				
	60		clay med brn, w/ organic lams		1358	clay		60
			silt lt brn				
			8" clay dk brn, silt lams, blk organic streaks	80			
			silty vy fn sand lt. brn				
	65	NR	clay		1417,18,19	clay	
			silt med tan	85			
			sand silty 10" dk tan		1500	sand	
	70		clay med brn, organic streaks, silt lens		1511	clay	wet clay - diesel	70
		NR	clayey silt				
			6" sandy silt	85	1611	sandy silt	
	75		Clay dk brn, abun organic streaks caliche nods 20–50mm		1613	clay	
		72	silt, med brn 1ft grades down to	100	1632	silt	no odor
	80		clay dk brown, organic streaks		1648	clay		80
		TD	3" sandy silt, reddish brn	110	1705	silt	caliche nods 40 mm at 81'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT | HOLE NO.

APPENDIX C

ANALYTICAL RESULTS

Positive Result Summary
LC38 – February 2001

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB01-(0.0)-0201	Arsenic, Total	S 6010B	0.352	1.54	mg/Kg	
24068-SB01-(0.0)-0201	Barium, Total	S 6010B	0.7	110	mg/Kg	
24068-SB01-(0.0)-0201	Chromium. Total	S 6010B	0.7	3.3	mg/Kg	
24068-SB01-(0.0)-0201	Lead, Total	S 6010B	0.352	7.3	mg/Kg	
24068-SB01-(0.0)-0201	Mercury, Total	S 6010B	0.03	0.1	mg/Kg	
24068-SB01-(0.0)-0201	Selenium, Total	S 6010B	0.352	0.384	mg/Kg	
24068-SB01-(0.0)-0201	Naphthalene	S 8260B	5.1	5.4	ug/Kg	
24068-SB01-(5.0 - 5.5)-0201	Arsenic, Total	S 6010B	0.376	3.68	mg/Kg	
24068-SB01-(5.0 - 5.5)-0201	Barium, Total	S 6010B	0.75	100	mg/Kg	
24068-SB01-(5.0 - 5.5)-0201	Chromium. Total	S 6010B	0.75	7.4	mg/Kg	
24068-SB01-(5.0 - 5.5)-0201	Lead, Total	S 6010B	0.376	6.11	mg/Kg	
24068-SB01-(5.0 - 5.5)-0201	Selenium, Total	S 6010B	0.376	0.725	mg/Kg	
24068-SB01-(5.0 - 5.5)-0201	2-Methylnaphthalene	S 8270C	19000	34000	ug/Kg	
24068-SB01-(5.0 - 5.5)-0201	1,2,4-Trimethylbenzene	S 8260B	2300	49000	ug/Kg	
24068-SB01-(5.0 - 5.5)-0201	1,3,5-Trimethylbenzene	S 8260B	2300	160000	ug/Kg	
24068-SB01-(5.0 - 5.5)-0201	Toluene	S 8260B	2300	47000	ug/Kg	
24068-SB01-(5.0 - 5.5)-0201	Xylene (Total)	S 8260B	2300	24000	ug/Kg	
24068-SB01-(9.5 - 10.0)-0201	Diesel Range Organics	S 8015A	2200000	14000000	ug/Kg	
24068-SB01-(17.5 - 18.0)-0201	Diesel Range Organics	S 8015A	2600000	11000000	ug/Kg	
24068-SB01-(19.5 - 20.0)-0201	Diesel Range Organics	S 8015A	2300000	11000000	ug/Kg	
24068-SB01-(24.5 - 25.0)-0201	Diesel Range Organics	S 8015A	2200000	17000000	ug/Kg	
24068-SB01-(29.5 - 30.0)-0201	2-Methylnaphthalene	S 8270C	18000	61000	ug/Kg	
24068-SB01-(29.5 - 30.0)-0201	Dibenzofuran	S 8270C	18000	11000	ug/Kg	J
24068-SB01-(29.5 - 30.0)-0201	Fluorene	S 8270C	18000	12000	ug/Kg	J
24068-SB01-(29.5 - 30.0)-0201	Naphthalene	S 8270C	18000	13000	ug/Kg	J
24068-SB01-(29.5 - 30.0)-0201	Phenanthrene	S 8270C	18000	19000	ug/Kg	

Positive Result Summary
LC38 – February 2001
(continued)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB01-(29.5 - 30.0)-0201	Diesel Range Organics	S 8015A	2200000	21000000	ug/Kg	
24068-SB01-(34.5 - 35.0)-0201	Diesel Range Organics	S 8015A	2400000	16000000	ug/Kg	
24068-SB01-(39.5 - 40.0)-0201	Diesel Range Organics	S 8015A	880000	14000000	ug/Kg	
24068-SB01-(44.5 - 45.0)-0201	2-Methylnaphthalene	S 8270C	37000	100000	ug/Kg	
24068-SB01-(44.5 - 45.0)-0201	Fluorene	S 8270C	37000	19000	ug/Kg	J
24068-SB01-(44.5 - 45.0)-0201	Naphthalene	S 8270C	37000	21000	ug/Kg	J
24068-SB01-(44.5 - 45.0)-0201	Phenanthrene	S 8270C	37000	28000	ug/Kg	J
24068-SB01-(44.5 - 45.0)-0201	Diesel Range Organics	S 8015A	2300000	21000000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Arsenic, Total	S 6010B	0.399	2.13	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Barium, Total	S 6010B	0.8	110	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Chromium. Total	S 6010B	0.8	4.3	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Lead, Total	S 6010B	0.399	6.44	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Mercury, Total	S 6010B	0.04	0.09	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Selenium, Total	S 6010B	0.399	1.17	mg/Kg	
24068-SB01-(49.5 - 50.0)-0201	Naphthalene	S 8260B	5.1	5.4	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	2-Methylnaphthalene	S 8270C	20000	38000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Phenanthrene	S 8270C	20000	12000	ug/Kg	J
24068-SB01-(49.5 - 50.0)-0201	Diesel Range Organics	S 8015A	1000000	10000000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	1,2,4-Trimethylbenzene	S 8260B	4800	35000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	1,3,5-Trimethylbenzene	S 8260B	4800	110000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Ethyl benzene	S 8260B	4800	44000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Isopropylbenzene	S 8260B	4800	21000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Toluene	S 8260B	4800	33000	ug/Kg	
24068-SB01-(49.5 - 50.0)-0201	Xylene (Total)	S 8260B	4800	30000	ug/Kg	
24068-SB01-(54.5 - 55.0)-0201	Diesel Range Organics	S 8015A	2300000	24000000	ug/Kg	

Positive Result Summary
LC38 – February 2001
(continued)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB01-(59.5 - 60.0)-0201	Diesel Range Organics	S 8015A	940000	11000000	ug/Kg	
24068-SB01-(64.5 - 65.0)-0201	Diesel Range Organics	S 8015A	5000000	49000000	ug/Kg	
24068-SB01-(69.5 - 70.0)-0201	Diesel Range Organics	S 8015A	250000	420000	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Acenaphthene	S 8270C	19	440	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Fluorene	S 8270C	19	720	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Naphthalene	S 8270C	19	580	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Phenanthrene	S 8270C	96	1600	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Pyrene	S 8270C	19	49	ug/Kg	
24068-SB01-(70.0 - 70.5)-0201	Diesel Range Organics	S 8015A	240000	3000000	ug/Kg	
24068-SB01-(75.0 - 75.5)-0201	Naphthalene	S 8270C	18	14	ug/Kg	J
24068-SB01-(79.5 - 80.0)-0201	Diesel Range Organics	S 8015A	9800	2200	ug/Kg	J
24068-SB01-(104.5 - 105.0)-0201	Naphthalene	S 8270C	19	10	ug/Kg	J
24068-SB01-(104.5 - 105.0)-0201	Diesel Range Organics	S 8015A	9400	1100	ug/Kg	J
24068-SB02-(4.5 - 5.0)-0201	Diesel Range Organics	S 8015A	9100	16000	ug/Kg	
24068-SB02-(9.5 - 10.0)-0201	Diesel Range Organics	S 8015A	8700	6100	ug/Kg	J
24068-SB02-(14.5 - 15.0)-0201	Diesel Range Organics	S 8015A	9200	8400	ug/Kg	J
24068-SB02-(19.5 - 20.0)-0201	Diesel Range Organics	S 8015A	8600	24000	ug/Kg	
24068-SB02-(24.5 - 25.0)-0201	Diesel Range Organics	S 8015A	8500	14000	ug/Kg	
24068-SB02-(29.5 - 30.0)-0201	Naphthalene	S 8270C	17	9.9	ug/Kg	J

Positive Result Summary
LC38 – February 2001
(continued)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB02-(34.5 - 35.0)-0201	Diesel Range Organics	S 8015A	8600	13000	ug/Kg	
24068-SB02-(39.5 - 40.0)-0201	Diesel Range Organics	S 8015A	9200	1100	ug/Kg	J
24068-SB02-(44.5 - 45.0)-0201	Diesel Range Organics	S 8015A	8600	820	ug/Kg	J
24068-SB02-(54.5 - 55.0)-0201	Diesel Range Organics	S 8015A	9300	27000	ug/Kg	
24068-SB02-(57.0 - 57.5)-0201	Diesel Range Organics	S 8015A	2200000	20000000	ug/Kg	
24068-SB02-(58.5 - 59.0)-0201	2-Methylnaphthalene	S 8270C	1900	5400	ug/Kg	
24068-SB02-(58.5 - 59.0)-0201	Dibenzofuran	S 8270C	380	660	ug/Kg	
24068-SB02-(58.5 - 59.0)-0201	Fluorene	S 8270C	380	910	ug/Kg	
24068-SB02-(58.5 - 59.0)-0201	Naphthalene	S 8270C	380	930	ug/Kg	
24068-SB02-(58.5 - 59.0)-0201	Phenanthrene	S 8270C	380	1600	ug/Kg	
24068-SB02-(59.5 - 60.0)-0201	Diesel Range Organics	S 8015A	2400000	26000000	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	1,2,4-Trimethylbenzene	S 8260B	610	17000	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	1,3,5-Trimethylbenzene	S 8260B	610	56000	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	Ethyl benzene	S 8260B	610	13000	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	Isopropylbenzene	S 8260B	610	8300	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	Toluene	S 8260B	610	6700	ug/Kg	
24068-SB02-(62.3 - 62.7)-0201	Xylene (Total)	S 8260B	610	8900	ug/Kg	
24068-SB02-(62.4 - 62.8)-0201	2-Methylnaphthalene	S 8270C	200000	630000	ug/Kg	
24068-SB02-(62.4 - 62.8)-0201	Fluorene	S 8270C	200000	110000	ug/Kg	J
24068-SB02-(62.4 - 62.8)-0201	Naphthalene	S 8270C	200000	120000	ug/Kg	J
24068-SB02-(62.4 - 62.8)-0201	Phenanthrene	S 8270C	200000	180000	ug/Kg	J
24068-SB02-(64.5 - 65.0)-0201	Diesel Range Organics	S 8015A	53000	180000	ug/Kg	

Positive Result Summary
LC38 – February 2001
(continued)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB02-(65.0 - 65.1)-0201	Arsenic, Total	S 6010B	0.413	6.61	mg/Kg	
24068-SB02-(65.0 - 65.1)-0201	Barium, Total	S 6010B	0.83	26	mg/Kg	
24068-SB02-(65.0 - 65.1)-0201	Chromium. Total	S 6010B	0.83	8.3	mg/Kg	
24068-SB02-(65.0 - 65.1)-0201	Lead, Total	S 6010B	0.413	10.6	mg/Kg	
24068-SB02-(65.0 - 65.1)-0201	Mercury, Total	S 6010B	0.04	0.06	mg/Kg	
24068-SB02-(67.0 - 67.5)-0201	Diesel Range Organics	S 8015A	470000	6800000	ug/Kg	
24068-SB02-(69.5 - 70.0)-0201	Diesel Range Organics	S 8015A	50000	160000	ug/Kg	
24068-SB02-(74.5 - 75.0)-0201	Diesel Range Organics	S 8015A	9800	1400	ug/Kg	J
24068-SB02-(79.5 - 80.0)-0201	Naphthalene	S 8270C	19	13	ug/Kg	J
24068-SB03-(4.5 - 5.0)-0201	Diesel Range Organics	S 8015A	9000	1400	ug/Kg	J
24068-SB03-(9.5 - 10.0)-0201	Diesel Range Organics	S 8015A	9600	1800	ug/Kg	J
24068-SB03-(14.5 - 15.0)-0201	Diesel Range Organics	S 8015A	8500	1400	ug/Kg	J
24068-SB03-(19.5 - 20.0)-0201	Diesel Range Organics	S 8015A	9700	1400	ug/Kg	J
24068-SB03-(24.5 - 25.0)-0201	Diesel Range Organics	S 8015A	8600	15000	ug/Kg	
24068-SB03-(29.5 - 30.0)-0201	Diesel Range Organics	S 8015A	9000	3600	ug/Kg	J
24068-SB03-(34.5 - 35.0)-0201	Diesel Range Organics	S 8015A	9700	4500	ug/Kg	J
24068-SB03-(39.5 - 40.0)-0201	Diesel Range Organics	S 8015A	8600	3700	ug/Kg	J
24068-SB03-(44.5 - 45.0)-0201	Diesel Range Organics	S 8015A	920000	5200000	ug/Kg	

Positive Result Summary
LC38 – February 2001
(continued)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB03-(49.5 - 50.0)-0201	2-Methylnaphthalene	S 8270C	20000	72000	ug/Kg	
24068-SB03-(49.5 - 50.0)-0201	Dibenzofuran	S 8270C	20000	11000	ug/Kg	J
24068-SB03-(49.5 - 50.0)-0201	Fluorene	S 8270C	20000	14000	ug/Kg	J
24068-SB03-(49.5 - 50.0)-0201	Naphthalene	S 8270C	2000	9600	ug/Kg	
24068-SB03-(49.5 - 50.0)-0201	Phenanthrene	S 8270C	20000	25000	ug/Kg	
24068-SB03-(54.5 - 55.0)-0201	Diesel Range Organics	S 8015A	2300000	21000000	ug/Kg	
24068-SB03-(53.7 - 54.2)-0201	Diesel Range Organics	S 8015A	2200000	30000000	ug/Kg	
24068-SB03-(59.5 - 60.0)-0201	Diesel Range Organics	S 8015A	2500000	5000000	ug/Kg	
24068-SB03-(64.5 - 65.0)-0201	Diesel Range Organics	S 8015A	2500000	12000000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	1,2,4-Trimethylbenzene	S 8260B	290	3700	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	1,3,5-Trimethylbenzene	S 8260B	290	15000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Acetone	S 8260B	590	16000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Ethyl benzene	S 8260B	290	9000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Isopropylbenzene	S 8260B	290	15000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	n-Butylbenzene	S 8260B	290	9100	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	n-Propylbenzene	S 8260B	290	5900	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Naphthalene	S 8260B	290	27000	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	p-Isopropyltoluene	S 8260B	290	4100	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	sec-Butylbenzene	S 8260B	290	9400	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Toluene	S 8260B	290	9100	ug/Kg	
24068-SB03-(64.5 - 64.9)-0201	Xylene (Total)	S 8260B	290	55000	ug/Kg	
24068-SB03-(64.4 - 64.8)-0201	2-Methylnaphthalene	S 8270C	7800	41000	ug/Kg	
24068-SB03-(64.4 - 64.8)-0201	Dibenzofuran	S 8270C	2000	4500	ug/Kg	
24068-SB03-(64.4 - 64.8)-0201	Fluorene	S 8270C	2000	5700	ug/Kg	
24068-SB03-(64.4 - 64.8)-0201	Naphthalene	S 8270C	2000	6100	ug/Kg	

Positive Result Summary
LC38 – February 2001
(concluded)

SAMPLE ID	ANALYTE	METHOD	DL	RESULT	UNIT	QUALIFIER
24068-SB03-(64.4 - 64.8)-0201	Phenanthrene	S 8270C	2000	11000	ug/Kg	
24068-SB03-(67.0 - 67.5)-0201	Diesel Range Organics	S 8015A	4900000	70000000	ug/Kg	
24068-SB03-(69.5 - 70.0)-0201	Diesel Range Organics	S 8015A	10000	23000	ug/Kg	
24068-SB03-(73.0 - 73.5)-0201	2-Methylnaphthalene	S 8270C	400	510	ug/Kg	
24068-SB03-(73.0 - 73.5)-0201	Phenanthrene	S 8270C	400	230	ug/Kg	J
24068-SB03-(74.5 - 75.0)-0201	Diesel Range Organics	S 8015A	51000	56000	ug/Kg	
24068-SB03-(79.5 - 80.0)-0201	Diesel Range Organics	S 8015A	9900	1200	ug/Kg	J

APPENDIX D

HEALTH AND SAFETY PLAN

In Case of Emergency, contact:

Fire

Land Line on WSMR: 117
Land Line/Cell Phone: 678-9128
Or 678-9129
Off Range: 911

Police

Land Line/Cell Phone: 678-1234
Off Range: 911

Main Post Clinic

Land Line/Cell Phone: 678-2882

TABLE OF CONTENTS

Section **Page**

TABLE OF CONTENTS

LIST OF ACRONYMS

AST	Aboveground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
C	Celsius
dBA	decibels, A-weighted
DPM	Deputy Program Manager
F	Fahrenheit
LC	Launch Complex
LEL	Lower Explosive Limit in air by volume at room temperature
mg/kg	milligrams per kilogram
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
OSHA	Occupational Safety and Health Administration
PID	Photo-ionization Detector
POL	Petroleum/Oil/Lubricant
QA/QC	Quality Assurance/Quality Control
ppm	parts per million
SSHSP	Site Specific Health and Safety Plan
UEL	Upper Explosive Limit in air by volume at room temperature
UST	Underground Storage Tank
UXO	Unexploded Ordnance
White Sands	White Sands Missile Range

REVIEWS AND APPROVALS

This plan serves as a site-specific addenda to the Accident Reporting and Safety Program dated 14 September 1995, developed by MEVATEC Corporation, for all activities conducted at White Sands Missile Range (White Sands). The Accident Reporting and Safety Program provides minimum safety standards and accident prevention fundamentals to cover a range of activities at White Sands. To supplement the information in the Accident Reporting and Safety Program, this plan describes specific activities to complete the soil and preliminary groundwater investigation at the LC-38 Diesel Spill Site. This Site-Specific Health and Safety Plan was approved by the following individuals:

____________________ Joel Giblin Health and Safety Officer MEVATEC Corporation	__________ Date
____________________ Jeffrey D. Swanson Site Health and Safety Officer MEVATEC Corporation	__________ Date
____________________ William Little Task Manager MEVATEC Corporation	__________ Date
____________________ Fred Bourger Deputy Program Manager MEVATEC Corporation	__________ Date
____________________ Donald K. Emig, Ph.D., P.E. General Manager MEVATEC Corporation	__________ Date

SITE SPECIFIC HEALTH AND SAFETY PLAN
SOIL INVESTIGATION AT LC-38 DIESEL SPILL SITE

1.0 INTRODUCTION

A strategic reserve of diesel fuel was stored in a 150,000-gallon aboveground storage tank (AST) at Launch Complex 38 (LC-38), just north of Nike Avenue (Figure 1-1). Preparatory to retiring the facility in the summer of 2000, White Sands personnel could not account for missing fuel estimated at 31,000 gallons. Immediately upon discovery that fuel was unaccounted for, product lines from the adjacent loading terminal to the AST were uncovered. A leak in the product line was apparent and considered the source of the release. The New Mexico Environment Department's (NMED) Ground Water Quality Bureau was immediately notified in accordance with Section 1203 of the New Mexico Water Quality Control Commission (NMWQCC) Regulations (20 New Mexico Administrative Code 6.2). In August 2000, MEVATEC Corporation completed a preliminary assessment of the site to determine the location and severity of the release. The preliminary results indicate a substantial spill did occur at the site. Proposed action for the diesel spill at LC-38 includes an investigation to delineate the horizontal and vertical extent of soil and groundwater contamination.

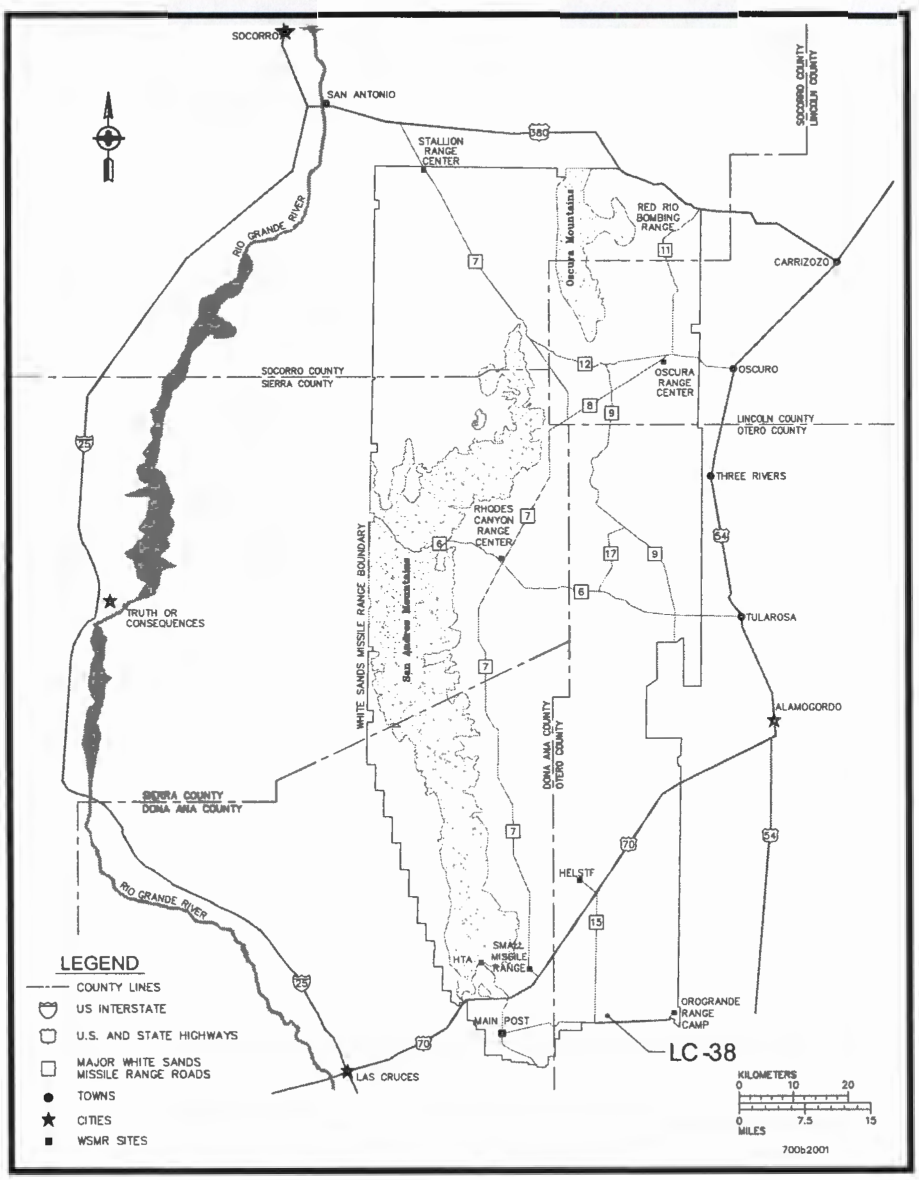


Figure 1-1. Site Location Map.

2.0 HEALTH AND SAFETY ORGANIZATION

2.1 Project Organization

The project organizational structure and key project personnel are shown on Figure 2-1. The MEVATEC personnel assigned specific health and safety responsibilities are identified below.

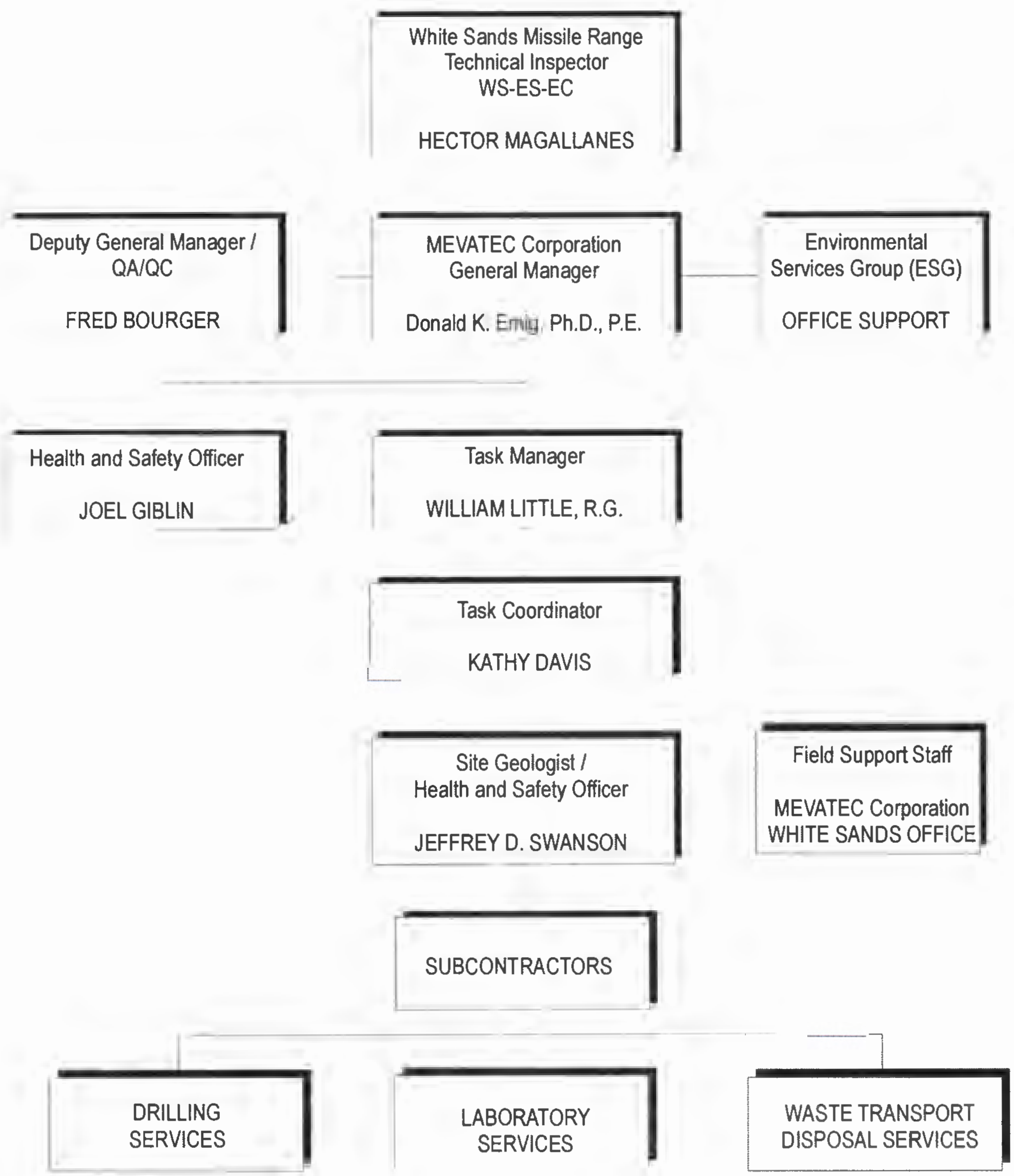


Figure 2-1. Project Personnel Organization Chart

Donald K. Emig General Manager MEVATEC Corporation	• Overall hazardous material program responsibility.
Fred Bourger Deputy General Manger (DGM) / QA/QC Manager MEVATEC Corporation	• Responsible for oversight of Quality Assurance / Quality Control (QA/QC) and Health & Safety Programs
William Little Task Manager MEVATEC Corporation	• Responsible for all site activities.
Kathy Davis Task Coordinator MEVATEC Corporation	• Responsible for assembly of the Site Specific Health and Safety Plan • Responsible for all site coordination issues during site activities.
Jeffrey D. Swanson Site Geologist/Site Health and Safety Officer MEVATEC Corporation	• Responsible for execution of the Site Specific Health and Safety Plan (SSHSP).
Joel Giblin Health & Safety Officer MEVATEC Corporation	• Responsible for project review of health and safety issues and implementation of the SSHSP.

2.2 Responsibility and Authority of Key Personnel

The responsibility and authority of key personnel relative to the implementation of this SSHSP are described below.

2.2.1 Task Manager

The Task Manager has the following responsibilities:

- Reporting to the Program Manager.
- Providing oversight of all health and safety matters.
- Reviewing and recommending approval of the SSHSP.
- Verifying that the project is performed in a manner consistent with the SSHSP.
- Approving the Site Health & Safety Officer for the project.
- Temporarily suspending field activities if the health and safety of personnel are endangered.
- Reporting all infractions of the SSHSP to the MEVATEC DPM.

William Little will be the Task Manager for this project. In his absence, the Deputy Program Manager will assume his responsibilities.

2.2.2 Task Coordinator

The Task Coordinator has the following responsibilities:

- Executing the SSHSP for the project.
- Interfacing with the Site Safety Officer and Task Manager in matters of health & safety.
- Directing daily site health and safety activities and reporting results to Site Health & Safety Officer.
- Monitoring compliance with the SSHSP.
- Assisting the Site Safety Officer in maintaining health and safety equipment for the project.
- Verify personnel working onsite have completed medical surveillance and health & safety training.
- Directing personnel to change work practices if they are deemed hazardous to the health and safety of the personnel.
- Removing personnel from the site if their action or condition endangers their health and safety or the health and safety of their co-workers.
- Performing and recording integrated personal air monitoring to characterize each employee's task exposure.
- Temporarily suspending field activities, if health and safety of personnel are endangered, pending further consideration by the Health and Safety Officer.

Kathy Davis will serve as the Task Coordinator for this project.

2.2.3 Site Health & Safety Officer

The Site Health and Safety Officer responsibilities include:

- Reporting and coordinating with the DPM / QA/QC Manager on health and safety matters.
- Monitoring ambient conditions at the site during operations.
- Reporting safety-related incidents or accidents to the highest authority onsite person.
- Implementing the components of the SSHSP.
- Maintaining health and safety equipment onsite, as specified in the SSHSP.
- Maintaining documentation of health and safety measures taken at the site, including:
  - Communication of the SSHSP;
  - Levels of protection and required upgrades;
  - Environmental monitoring results; and
  - Incident reporting.
- Upgrading or downgrading levels of protection in response to field conditions.
- Temporarily suspending field activities, if health and safety of personnel are endangered, pending further consideration by the DPM.
- Report all infractions of the SSHSP to the DPM.

Jeffrey D. Swanson will serve as the Site Health & Safety Officer for this project.

3.0 SITE WORK PLAN SUMMARY

3.1 Project Objective

This plan serves as site-specific addenda to the Accident Reporting and Safety Program dated 14 September 1995, developed by MEVATEC Corporation, for all activities conducted at White Sands. The Accident Reporting and Safety Program provides minimum safety standards and accident prevention fundamentals to cover a range of activities at White Sands. The components of this Site-Specific Health and Safety Plan cover site work for the completion of six soil borings near the leak source and the installation of one down-gradlent groundwater monitoring well (Figures 3-1).

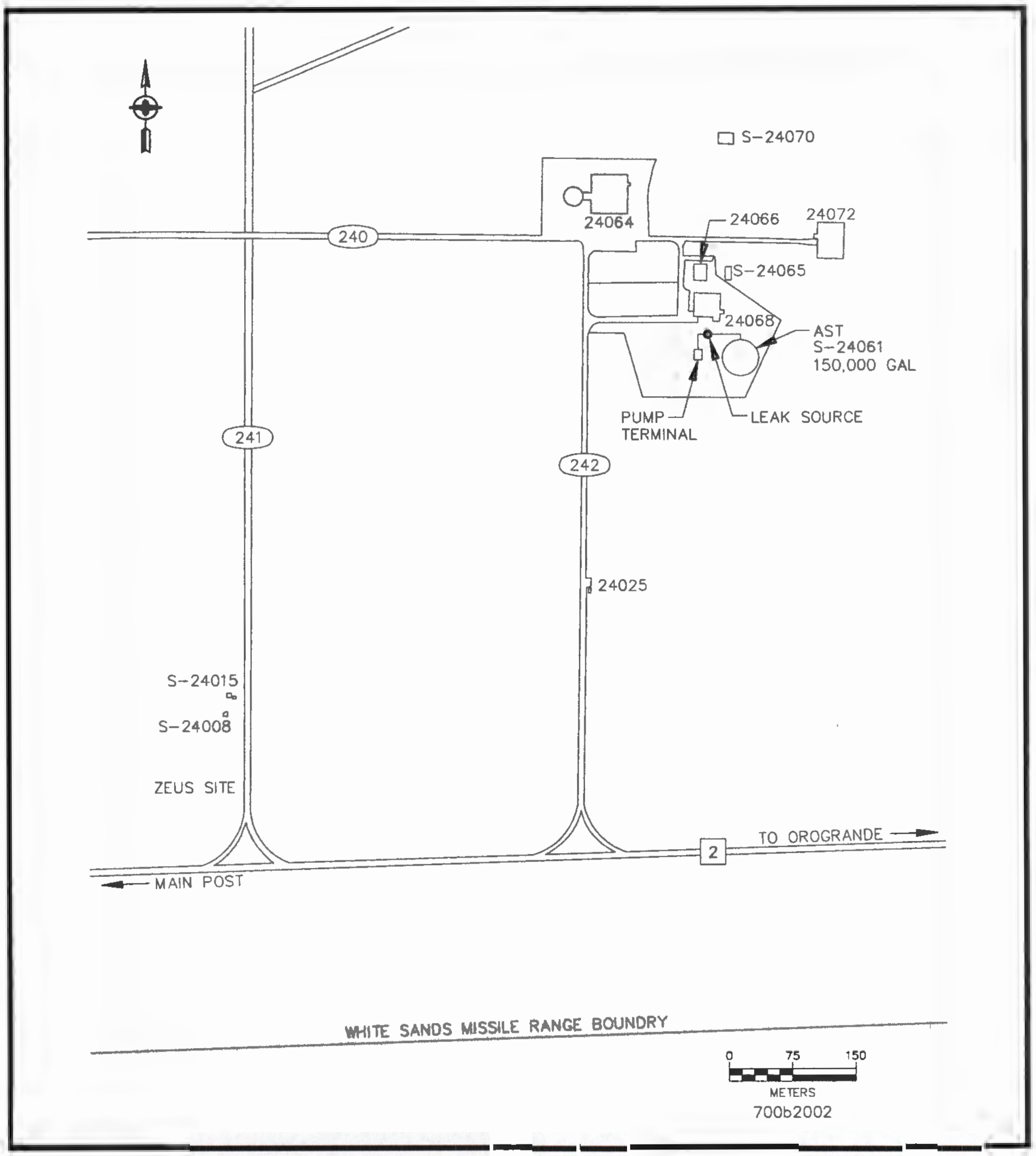


Figure 3-1. Location of Project Site, LC-38 Diesel Spill.

3.2 Project Tasks

- Drill and sample soil borings
- Drill and sample one groundwater monitoring well
- Manage and disposal of investigation derived waste
- Site restoration

Personnel Requirements: Minimum four, maximum seven onsite employees

Note: All personnel on this site shall receive a copy of this site-specific health and safety plan and be aware of potential site hazards prior to entering the site, as listed in Sections 4.0 and 6.0 of this SSHSP.

4.0 SITE CHARACTERIZATION AND ANALYSIS

4.1 General Site Information

The LC-38 Diesel release occurred from tank S-24061, located immediately south of Building 24068. The site is accessed from Nike Avenue (Range Road 2) as shown in Figure 3-1.

White Sands is considered arid, with an average rainfall of only 10.8 inches (27.4 centimeters), mostly occurring during late summer as thunderstorms. Average summer high temperature is 92° F (33.3° C) with lows of about 65° F (18.3° C). During winter months, the average high is 57° F (13.9° C) with an average low of 36° F (2.2° C). Average annual humidity readings are about 37 percent. Regional geology is characterized primarily as fine- to medium-grained unconsolidated quartz-sands with occasional thin clay or silt stringers. The predominant soil type encountered during the hand auger investigation (to 10 feet below ground surface) was a sandy loam.

4.2 Anticipated Hazards

4.2.1 Chemical Hazards

Petroleum hydrocarbons, specifically diesel fuel, will be encountered in soils during drilling activities. The following section provides a hazard analysis of toxicity and exposure information for diesel / petroleum hydrocarbons. The hazard analysis utilizes exposure and toxicity information generated by the Occupational Safety and Health Administration (OSHA), American Conference of Governmental Industrial Hygienists, the National Institute for Occupational Safety and Health, the National Toxicology Program, and International Agency for Research on Cancer and accepted industry data.

Diesel Fuel

Route of Entry:	Inhalation, Skin Absorption, Ingestion, Eye Contact
Target Organs:	Eyes, Skin, Respiratory System, Central Nervous System, Liver, Kidneys
Hazard:	Eye, skin, and mucous membrane irritation; fatigue; blurred vision; dizziness; blurred speech; confusion; convulsions; chemical pneumonia.

First Aid:	Eye: Irrigate eyes immediately for 15 minutes Skin: Soap and water wash immediately Breathing: Remove from vicinity to ventilated area. If persistent, seek medical attention for respiratory support to stabilize breathing Ingestion: Medical attention immediately
Chemical Properties:	Lower Explosive Limit: 1.4% Upper Explosive Limit: 7.6%

Liquid and vapor are irritating to the eyes, nose, throat, and skin. Repeated skin contact may produce a dry, scaly, and fissured dermatitis. Acute exposure to high concentrations may produce irritation of the mucous membranes of the upper respiratory tract, nose, and mouth, followed by symptoms of narcosis, cramps and death due to respiratory center paralysis.

4.2.2 Physical Hazards

Drilling activities include possible physical hazards which could result in cuts or punctures from sharp objects, falls from uneven terrain, steep grades or slippery surfaces, sprains and strains from lifting activities, noise, and detonation of unexploded ordnance (UXO). Personnel should be aware that as the level of personal protective equipment increases, dexterity and visibility may be impacted and performing some tasks may be more difficult.

Rotary drilling and other heavy equipment operations present inherent safety hazards. Employee experience in the use of such equipment and awareness to potential hazards will reduce risk. All equipment operations must be in accordance with guidelines set forth in applicable OSHA regulations.

The Accident Prevention Plan provided in Section 6.0 contains specific practices used to reduce or eliminate anticipated physical hazards (listed below) which may be present and encountered during the site operations. Below each indicated hazard is a list of operations and/or tasks that may involve the indicated hazard. An "X" indicates specific actions that will be taken to control the respective hazards. These control measures may include work practice controls, engineering controls, and/or use of appropriate personal protective equipment.

- Hazards Associated with Potential Exposure to Hazardous Chemicals or Materials
- Fire Hazards Associated with Handling or Working Near Flammable or Combustible Materials
- Slip, Trip, Fall Hazards
- Hazards Associated with Elevated Work
- Hazards Associated with Operation of Heavy Equipment
- Hazards Associated with Working in Hot Environments
- Hazards Associated with Working in Cold Environments
- Hazards Associated with Insects, Snakes, or Wild Animals
- Hazards Associated with Falling Objects
- Hazards Associated with Electricity
- Hazards Associated with Materials Handling
- Hazards Associated with Limited Communication Due to Location, Distance, or Noise
- Hazards Associated with Noise
- Hazards Associated with Underground or Overhead Utilities

- Hazards Associated with Unauthorized Personnel Onsite, and in Controlled Work Zones
- Hazards Associated with Excessive Traffic Through or Near the Work site
- Hazards Associated with Unexploded Ordnance

4.2.3 Unexploded Ordnance

Although the potential is low, there is the potential that UXO or explosive materials may be present at the work area. However, this does not eliminate the potential for the presence or absence of potential subsurface UXO. All field personnel are required to review the UXO Orientation video and sign the orientation sheet prior to the start of field activities. Additionally, all field personnel will receive a temporary Visitors Badge that must be kept on hand at all times. The badge will indicate that the bearer of the badge has received proper UXO training. Finally, all field personnel will be verbally briefed daily regarding procedures to follow if ordnance is discovered.

4.2.4 Noise

Noise may be generated during site activities. As a precautionary measure, hearing protection, either ear muffs or ear plugs, are mandatory while working adjacent to the drill rig. A noise meter will be onsite to monitor noise conditions (see Section 5.0).

4.2.5 Electrical Hazards

Electrical shock can occur by direct contact with live wires or with electrical equipment and instruments that are wet or have faulty wiring. Any extension cords used with the equipment should be checked for cuts or loose connections in the coating protecting the wires prior to use. All extension cords will also be connected to ground-fault circuit interrupters. Use of properly grounded and/or double insulated tools will also reduce the potential for electric shock. Due to the release of unleaded gasoline at the site, a potential exists for electrical induced explosion. The site will be monitored by a combustible gas meter to minimize the potential for explosion (see Section 5.0).

4.2.6 Underground Utility Lines

Underground utility lines will be marked at the surface. In the event of an unmarked buried utility line is damaged, work operations shall halt immediately and all fieldwork shall be stopped until the nature of the line is discovered, any required repairs completed, and safe drilling locations re-established. A copy of the signed utility clearance documentation will be on-hand at the site.

4.2.7 Biological Hazards

The field team should be aware that site activities may disturb the local wildlife population. Therefore, there is potential for field personnel to be bitten by snakes, animals, and insects. Prompt first aid measures are extremely important. All field team members should be properly briefed regarding the potential for encountering wildlife, as well as prompt first aid procedures in the event of a snake, insect, or animal bite.

Normally, the noise created by a person approaching a snake is sufficient to frighten snakes away. However, extreme caution is necessary when exploring areas where snakes might be found, such as behind rocks, under bushes, or in holes, crevices, and abandoned pipes. The rules to follow if bitten by a snake are:

- Do no cut the bite area, since it will exacerbate the effect of the venom;
- Do not apply suction to the wound, since this is minimally effective in removing venom;
- Do not apply a tourniquet since venom is most dangerous when concentrated in a small area;
- Do not allow the victim to run for help, since this accelerates circulation;
- Do seek immediate medical attention;
- Do keep the victim calm and immobile; and
- Do have the victim hold the affected extremity lower than the body while waiting for medical assistance.

4.2.8 Heat Stress

Elevated temperatures may be a concern at this site. Heat stress monitoring and prevention procedures will be initiated. Heat stress reduction procedures shall consist of the following:

- Field personnel will be encouraged to drink fluids (chilled, potable water) frequently.
- When temperatures exceed 90 degrees Fahrenheit, all field personnel working outdoors will measure their heart rates no less than hourly. If the heart rate exceeds 110 beats per minute, the individual will rest for 10 minutes, drinking fluids throughout the rest period. If the heart rate has dropped below 110 beats per minute at the end of the rest period, the individual may return to work. If the heart rate exceeds 110 beats per minute, contact the onsite health and safety officer.
- Any personnel displaying signs or symptoms of heat stress will stop work and rest for at least 15 minutes. If symptoms persist beyond this rest period, the onsite health and safety officer will be contacted. Personnel displaying symptoms of heat stroke should immediately be taken to the nearest medical facility.

Symptoms of heat exhaustion included dizziness, light-headedness, nausea, slurred speech, fatigue, copious perspiration, cool clammy skin, and an increased resting heart rate. Symptoms of heat stroke included delirium, fainting, and hot, dry, flushed skin. Heat stroke is a life threatening condition, and immediate medical attention is required if any symptoms of heat stroke are observed.

4.2.9 Cold

Extreme cold temperatures may also be a concern at this site. Cold stress monitoring and prevention procedures will be initiated. Precautionary measures shall consist of the following:

- Field personnel will be encouraged to wear thermal underwear, long pants, long sleeve shirts, sweaters, sweatshirts, gloves, thick socks, and/or jackets to prevent problems related to cold exposure.
- Field personnel will be encouraged to drink fluids frequently.

- If temperatures drop below freezing and windchill causes subzero-degree (Fahrenheit) working conditions, field work will be limited to the warmest hours of the day or in extreme cases all work at the site will cease until temperatures and weather return to a safe level.
- Any personnel displaying signs or symptoms of hypothermia will stop work and add additional layer(s) of warmth to themselves. If symptoms persist beyond this, the onsite health and safety officer will be contacted. Personnel displaying symptoms of frostbite should immediately be taken to the nearest medical facility.

Symptoms of hypothermia include reduced feeling or tingling in affected area, especially in the fingers, toes, ears and face, slight numbness, and loss of color. Symptoms of frostbite include loss of feeling and movement in affected area and extreme change in color. Frostbite is preventable with the use proper attire and precautions. Frostbite can result in amputation of the affected appendage if medical attention is not administered promptly.

4.3 Personal Protection for Site Work

Prior to entering the area of activity, all personnel will be required to read and sign the Compliance Agreement (Section 7.0) to verify compliance with the provisions of this SSHSP and sign the daily Health and Safety Briefing Compliance Agreement (Section 8.0). The level of protection expected for this site work will Level D; gloves (leather and/or latex), hard-hat, steel-toed boots, and safety glasses. Visitors are expected to comply with relevant OSHA regulations and provide their own protective equipment. Continuous monitoring will be conducted to verify the safety of all site personnel.

4.4 Emergency Contact Numbers

Table 4-1 on the following page, provides name and telephone numbers for emergency contact personnel. In the event of a medical emergency, personnel will take direction from the onsite senior responsible individual and notify the appropriate emergency organization. In the event of a fire or spill, the onsite senior responsible individual will notify the appropriate White Sands Fire Department followed by the Emergency Operations Center. In the case of a spill of hazardous materials, the White Sands Missile Range representative will be responsible for notification of the appropriate local, state, and federal agencies.

Medical emergencies that occur will be taken to the LC-38 Fire Station (Fire Station No. 2), as shown on Figure 4-1. From the project site, proceed to Range Road 2, then west to Fire Station No. 2. If additional medical attention is required, the injured individual will be transported via ambulance to the appropriate medical facility.

4.5 Smoking

SMOKING WITHIN 50 FEET OF THE DRILL RIG, CONTAMINATED SOIL, OR AST IS PROHIBITED. **A SMOKING AREA WILL BE LOCATED GREATER THAN 50 FEET FROM THE DRILL RIG. ALL CIGARETTE BUTTS WILL BE PLACED IN A BUCKET FILLED WITH SAND, WHICH WILL BE LOCATED AT THE SMOKING AREA.**

Table 4-1. Emergency Contact Telephone Numbers.
(Fire and medical emergency numbers are bolded)

Organization	Contact	Telephone*
Fire Station #2 (Nike Avenue at LC-38)		**Land Line on WSMR: 117 Land Line/Cell Phone: 678-9128 Off Range: 911**
Fire Station #1 (Main Post)		**Land Line on WSMR: 117 Land Line/Cell Phone: 678-1234 Off Range: 911**
HELSTF Ambulance Service/ Medical Aid Station (Building 26020)		**Land Line/Cell Phone: 679- 5164 or 679-5167 Off Range: 911**
Post Clinic Emergency Room (Building 530)		**Land Line/Cell Phone: 678-2882**
Memorial Medical Center Emergency Room (Las Cruces, NM)		**Land Line/Cell Phone: 521-2286 or 911**
Police		Land Line on WSMR: 118 Land Line/Cell Phone: 678-1234 Off Range: 911
Emergency Operations Center After Hours – Staff Duty Officer		678-3803
White Sands Missile Range Environment and Safety Directorate		678-2224
WS-ES-EC Technical Inspector (desk)	Hector Magallanes	678-2073
MEVATEC Corp. Office, Building 126, White Sands, NM, Front Desk	Beatriz Delgadillo	678-0263
Site Safety and Health Representative	Jeffrey D. Swanson	678-0297
MEVATEC Corporation, Task Manager	William Little	678-2853
MEVATEC Corp. Deputy Program Manager / Principal Engineer / QA/QC Manager	Fred Bourger	678-3426
MEVATEC Corporation, Health and Safety Officer	Joel Giblin	678-0910
MEVATEC Corporation, General Manager	Donald K. Emig, Ph.D., P.E.	678-7907
NMED Hazardous Waste Bureau (Project Regulatory Agency)	Cheryl Frischkorn	(505) 827-1961

* - all phones numbers are within the 505 area code.

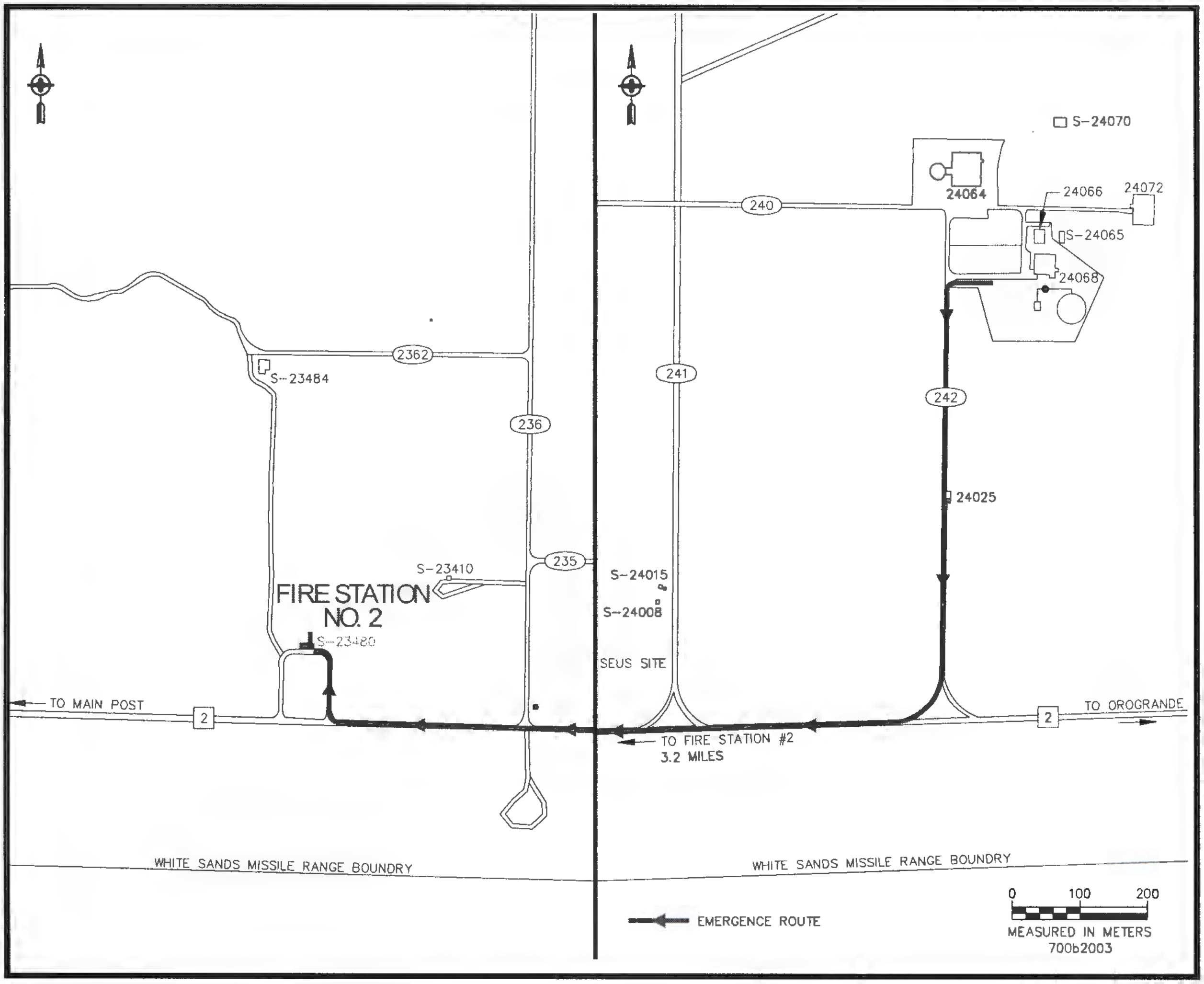


Figure 4-1. Emergency Route to Medical Facility from the Project Site.

5.0 SITE MONITORING

Hazardous materials may be encountered during drilling or monitor well installation. Site monitoring will be conducted to verify the safety of workers. Table 5-1 describes the site monitoring to be conducted.

Table 5-1. Site Monitoring Summary.

Chemical / Physical Agent	Action Level	Monitoring Equipment	Sampling and Analysis	Frequency of Analysis
Volatile Organic Compounds	20 ppm[a] in the breathing zone	PID	Direct Reading	During drilling within the contaminated zone
Explosive Conditions	LEL: 1.4% UEL: 7.6%	Combustible Gas Meter	Direct Reading	During drilling within the contaminated zone
Noise Levels	85 dBA[b]	Sound Level Meter	Direct Reading	During all drilling activities

Notes a: ppm – parts per million
B: dBA – decibels, A-weighted

In the event that the action level is exceeded for volatile organic compounds or explosive conditions, the area will be immediately evacuated and the contaminant allowed to dissipate. MEVATEC will contact the WS-ES-EC Technical Inspector prior to commencing with work. Following instructions from WS-ES-EC, the field crews will don the appropriate clothing, respirator, and retest the site conditions. If levels continue, the MEVATEC Health and Safety representative will contact the WS-ES-EC Technical Inspector for further instructions. In the case of noise, exceedance of the action level will trigger the use of hearing protection.

6.0 ACCIDENT PREVENTION PLAN

Hazards Associated with Potential Exposure to Hazardous Chemicals or Materials:

- Drill and sample soil borings
- Install and sample groundwater monitoring well(s)
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Minimize free liquids to reduce airborne vapor concentrations.
_X_ Tops shall be securely attached to chemical containers when not in use to minimize airborne vapor concentrations.
_____ Utilize wet methods to control airborne dusts emissions.
_X_ Delineate and control access into the Exclusion Zone(s) and Contamination Reduction Zone(s).
_____ Utilize Chemical Protective Clothing and Equipment
_____ Decontaminate or remove outer protective clothing in the Contamination Reduction Zone, prior to entering the Support Zone from the Exclusion Zone.
_X_ Decontaminate all equipment leaving the Exclusion Zone in the Contamination Reduction Zone, prior to entering the Support Zone.
_X_ Wash hands and face prior to drinking/smoking breaks.
_____ Personnel working in the Exclusion Zone will be required to shower out at the end of the workday, prior to leaving the work site to go home.

Fire Hazards Associated with Handling or Working near Flammable or Combustible Materials:

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Install and sample groundwater monitoring well(s)
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Monitor work environment as necessary with a combustible gas meter to determine the percent LEL concentration of combustible gases and vapors.
_X_ Should concentrations exceed 10% of the LEL (see Section 5.0) in a work area, operations within the area will cease immediately, and all potential sources of ignition removed from the area.
____ All "Hot Work" performed in hazardous locations shall require the issuance of a Hot Work Permit issued by White Sands Missile Range safety office. Combustible or flammable materials shall be purged of combustible gasses and vapors (less than 10 percent LEL) prior to being cut.
_X_ Smoking shall not be permitted onsite, except in designated areas.
_X_ All containers of flammable or combustible materials must be properly labeled to indicate its contents and appropriate fire hazard.

Slip, Trip, Fall Hazards:

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Workers shall ensure that walking/working surfaces are kept free of potential slip, trip, fall hazards.
_X_ Whenever possible, avoid routing cords, ropes, hoses, etc. across isles and walking paths.
_X_ Flag and/or cover inconspicuous holes to protect against accidental trips and falls.
____ Delineate and/or guard open excavations to protect against falls.

Hazards Associated with Operations of Heavy Equipment or Motor Vehicles

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Personnel operating heavy equipment or vehicles shall maintain a constant awareness of personnel and stationary objects in the areas adjacent to its operation.
_X_ Spotters shall be utilized to assist operators in manipulating vehicles and equipment into tight or confined areas.
_X_ Equipment operators shall inspect their equipment prior to and during each use, to ensure it is working properly, and that all safety devices are functioning as they should.
_X_ Ensure operators are adequately trained and/or licensed as necessary to operate their equipment or motor vehicles.

_X_ All moving heavy equipment must have properly functioning backup alarms.
_X_ Motor vehicle operators are responsible for conducting a pre-trip vehicle safety inspection prior to its use. No motor vehicle with any known mechanical defect which endangers the safety of the driver or passengers shall be used.

Hazards Associated with Working in Hot Environments

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Site restoration

Actions to be taken to control heat stress:

_X_ Drink plenty of fluids, preferably water before, during and after each activity
_____ Acclimate to site conditions by slowly increasing work loads
_X_ Use cooling devices to aid natural body ventilation
_____ Conduct field activities in early morning or evening
_____ Use shelter to protect against heat stress
_____ Rotate shifts of workers

Hazards Associated with Working in Cold Environments

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:
_X_ Adequate protective clothing shall be worn at all times
_____ Provide shelter from wind and cold temperatures
_____ Do not remove chemical-protective equipment unless sheltered from wind and cold temperatures.
_X_ Field activities shall be curtailed if equivalent chill temperature is below zero degrees F.

Hazards Associated with Insects, Snakes, or Wild Animals

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Ensure that personnel are aware of such hazards, and encourage them to be constantly on the lookout.
_____ Maintain a supply of insecticide sprays to be used as necessary to kill flying or crawling insects.
_____ Utilize heavy equipment to clear areas where high grass and brush have grown, prior to accessing these areas on foot.

Hazards Associated with Falling Objects

Operations and/or Tasks Associated with the Above-Referenced Hazards

- Drill and sample soil borings

Actions to be Taken to Control Hazards:

_X_ Require that hard hats be worn at all times by onsite personnel except in break areas.
_X_ Whenever possible, personnel will avoid walking or working beneath areas where overhead work is being performed.
_____ All overhead work platforms will be equipped with standard toe board to reduce the potential of objects falling from them.

Hazards Associated with Electricity

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

_X_ Ground Fault Circuit Interrupters (GFCIs) shall be used whenever possible, to protect workers from shock or electrocution while working with electrical equipment.
_X_ Repair or remove from service all damaged electric cords.
_X_ Route extension cords in a manner and/or location that would prevent potential damage to the cord.
_X_ All electrically powered hand tools shall be of the grounded or double-insulated type.
_X_ Obtain proper utility clearances prior to the start of field activities.

Hazards Associated with Materials Handling

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Mechanical equipment (i.e., dolly, hoist, fork lift) shall be utilized whenever possible to minimize manual labor.
_X_ Size up the job before lifting and get help if needed. The maximum weight to be manually lifted by MEVATEC and/or subcontractor personnel is 60 pounds (27.2 kilograms).
_X_ Personnel will be reminded during daily safety meeting to utilize proper lifting methods to avoid muscle or back strains.

Hazards Associated with Limited Communication Due to Location, Distance, or Noise

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Where direct verbal communication is limited, portable 2-way radios, and/or hand signals shall be utilized to facilitate communication among workers.
_X_ Where work sites are in remote locations without access to nearby existing telephones, a cellular telephone (if service is available) or two-way radios shall be maintained onsite for use in the event of an emergency.

Hazards Associated with Noise

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

_X_ Appropriate hearing protection shall be provided to and worn by personnel working in areas where noise levels are known or suspected to exceed 85 dBA (See Section 5.0).
_X_ Inspect noise control devices (i.e., mufflers) on equipment to ensure they are working properly.
_X_ Periodically inspect pressurized systems (i.e., compressed air or steam) for leaks that create potential noise hazards, and if any are found, repair as soon as possible.
_X_ Whenever possible, start noise equipment in a remote area to reduce the potential for personnel exposure to noise, and to facilitate verbal communication among personnel.

Hazards Associated with Underground or Overhead Utilities

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings

Actions to be Taken to Control Hazards:

_X_ White Sands Missile Range National Range Support shall be contacted to establish the location of underground utilities and communication lines through the area of anticipated excavation.
_X_ When excavating with heavy equipment near underground utilities, personnel on the ground will assist in probing to find the exact location of lines, and will use hand shovels to carefully remove the soil immediately adjacent to the lines.
_X_ When operating machinery near overhead electrical distribution and transmission lines, refer to 29 CFR 1926.550 (a)(15)(I)-(vii) for minimum clearances, and safe work practices.

Hazards Associated with Unauthorized Personnel Onsite and in Controlled Work Zones

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_X_ Install temporary fencing, traffic cones, or other appropriate barriers to delineate the work site, and to deter unauthorized personnel from entering the work site. If necessary, post security guards at each point of access into the work site.
_X_ Maintain a visitors sign in/out log.
_____ Post warning signs "Authorized Personnel Only" at all entrances to the work site.
_X_ Utilize badge identification system.
_X_ Delineate controlled work zones with temporary fencing and/or caution tape.
_____ Post hazard warning sign at the entrances into controlled work zones.
_____ Utilize security guards to provide site security during off-hours.
_X_ Prior to entry into contaminated zone, ensure that all personnel have a current 40-hour OSHA HAZWOPER certification card or appropriate identification.

Hazards Associated with Traffic Through or Near the Work Site

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

Actions to be Taken to Control Hazards:

_____ Personnel working in areas where traffic hazards exist shall wear brightly colored orange traffic vest.
_____ Flagmen will be utilized as necessary to direct traffic through or around the work site.

_X_ Barricades and traffic cones and signs shall be utilized as necessary to aid in directing traffic through or around the work site.

Hazards Associated with Unexploded Ordnance

Operations and/or Tasks Associated with the Above-Referenced Hazards:

- Drill and sample soil borings
- Handling and disposal of investigation derived waste
- Site restoration

_X_ All field personnel will review the UXO Orientation Video prior to field activities.
_X_ All field personnel will be required to sign the UXO Orientation sheet following review of orientation video.
_X_ All field personnel will receive a UXO Range Hazards Card and will be required to keep the card on-hand at all times.
_X_ If UXO is identified, all field personnel will be verbally notified to follow directions listed on UXO Range Hazards Card.

7.0 COMPLIANCE AGREEMENT

This SSHSP applies to all MEVATEC personnel and their contractors performing field activities. I have read this SSHSP and hereby agree to abide by its provisions and to aid the Site Safety Officer and his representative in its implementation. I understand that it is in my best interest to see that site operations are conducted in the safest manner possible; therefore, I will be alert to site health and safety conditions at all times.

Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date
Name	Date

8.0 DAILY HEALTH AND SAFETY BRIEFING COMPLIANCE AGREEMENT

Topics covered during today's ( ) health and safety briefing:

I have hereby agree to abide by its provisions of the SSHSP, issues discussed in today's health and safety briefing, and to aid the Site Health and Safety Officer or his representative in its implementation. I understand that it is in my best interest to see that site operations are conducted in the safest manner possible; therefore, I will be alert to site health and safety conditions at all times.

Name	Name
Name	Name
Name	Name
Name	Name
Name	Name

APPENDIX E

DECONTAMINATION AND INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT PLAN

APPENDIX E
DECONTAMINATION AND INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT PLAN

TABLE OF CONTENTS

APPENDIX E
DECONTAMINATION AND INVESTIGATION DERIVED WASTE (IDW) MANAGEMENT PLAN

1.0 INTRODUCTION

In order to maintain sample integrity and minimize the spread of contamination between samples, well locations, and personnel, the decontamination of all equipment and management of investigation derived wastes (IDW) will receive high priority. Equipment requiring decontamination will include drill rigs, soil augers, rods and split-barrel samplers, well casing material, groundwater purge pumps and bailers, soil samplers, and associated bowls and implements. IDW requiring management includes spent drill fluid and cuttings, soil boring cuttings, well development and purge water, decontaminated water from cleaning of drill rig and sampling equipment.

2.0 DECONTAMINATION

Prior to the collection of each sample, all sampling equipment that will come in physical contact with the matrix of interest will be thoroughly decontaminated. This will minimize potential cross-contamination of samples from different locations. Procedures for decontaminating the types of equipment and material anticipated to be used are described below.

2.1 Drilling Equipment

Upon arriving at the site, the drill rig will be inspected for leaks (e.g. hydraulic fluid, oil, gasoline, diesel fuel, etc.) that could contaminate the boring. All equipment must be free of leaks. If necessary, the drill rig will be pressure-washed to remove contamination prior to use onsite. No grease will be used on drill pipe joints or other downhole equipment; however, PTFE tape or PTFE paste may be substituted.

To accommodate the cleaning of the drill rig and downhole drilling equipment, a decontamination pad will be constructed to collect decontamination wastewater. The pad will be temporary and at a minimum consist of a permeable gravel pad that is lined underneath with a minimum of two layers of 6-mil polyethylene sheeting. The edges will be folded upward to contain water and the bottom will be sloped toward a collection sump. Decontamination wastewater will be pumped from the sump into DOT 17E, closed-top 55-gallon drums for storage.

All hollow-stem augers, drill bits and rods, and tremie pipes will be decontaminated between borings at the decontamination pad. This equipment and the drill rig itself will be decontaminated using a high-pressure hot water washer as determined by the site geologist or geotechnical engineer as well as upon entry and exit to the site. Decontaminated equipment will be stored on plastic sheeting, sawhorses, or on decontaminated auger racks on the drill rig.

All split-barrel soil samplers will be decontaminated prior to collection of each sample using the following procedure:

- Clean any soil residue off by scraping or brushing,
- Scrub in an Alconox detergent and potable wash water using a brush,
- Rinse with potable water,
- Rinse with distilled, and
- Store split-barrel samplers in plastic or aluminum foil when not in use. Samplers may be placed on plastic sheeting or a clean rack prior to use.

The water rinses may be accomplished by either pouring water directly on the equipment or by dispensing the water through all-polyethylene garden sprayers. All waste water from cleaning of equipment will be containerized in DOT 17E, closed-top 55-gallon drums.

As a further protection against sample cross-contamination, the soil samplers will ensure that their gloves are clean prior to handling each sample. If non-disposable type gloves are worn, they will be cleaned in a manner identical to the sampling equipment. If disposable gloves are worn, they shall be changed prior to handling each new sample.

2.2 Well Casing Decontamination

In order to prevent aquifer contamination during well installation, only new PVC casings and screens will be installed. If not packaged in plastic from the manufacturer, all well casing and screen material will be decontaminated prior to installation. Casing, screens and caps will be cleaned with a high-pressure hot water washer followed by rinsing with distilled water. When necessary to provide a water-tight connection, only PVC tape will be allowed for use on the threaded joints. Items will be placed on clean plastic sheeting or racks during assembly and while awaiting installation

2.3 Sampling Equipment Decontamination

Split-barrel soil samplers and other sampling equipment requiring decontamination including well development and purging pumps, stainless-steel bowls and hand tools, and other containers or tools used in collection of samples.

Equipment requiring decontamination for groundwater sampling will include groundwater level indicators and bailers. Prior to sampling, the water level in each well will be measured using a water level indicator decontaminated by rinsing the probe with ASTM Type II, water and wiping the tape with a ASTM Type II water moistened paper towel as the probe is lowered in the well. As the probe and tape are removed, the tape will be wiped off once again and the probe rinsed off again.

This well will not have dedicated sampling equipment, therefore the well will first be purged using a submersible stainless-steel electric pump. Prior to use, the pump will be cleaned using the following procedure:

- Flush the interior of the pump and hosing out by submerging the pump in a container of potable water and running water through it. Pump all remaining water out of the hosing.
- Clean exterior of the pump motor assembly, hosing and cable with Alconox detergent and potable water,

- Rinse the interior and exterior surfaces of the pump with potable water until all traces of detergent are gone;
- Rinse all washed surfaces with ASTM Type II reagent-water prior to use, and
- Store the decontaminated pump in a clean plastic bag between uses.

Once the well is adequately purged, the well will be sampled using decontaminated PVC bailers. Disposable, pre-cleaned PVC bailers may also be used for sampling. Prior to use, all non-dedicated, non-disposable bailers will be cleaned using the following procedure:

- Unscrew one end of bailer if possible and scrub interior and exterior with a bailer brush and Alconox detergent and potable water. If the bailer cannot be disassembled, clean by placing detergent water inside and agitating water back and forth with hands placed over ends of bailer. Scrub exterior with a brush.
- Thoroughly rinse off traces of detergent with potable water.
- Rinse interior and exterior of bailer thoroughly with ASTM Type II reagent water.
- Place decontaminated bailer in a clean storage container or plastic bag during periods of nonuse. Bailer will not be allowed to come in contact with a contaminated surface prior to use.
- Rinse bailer with ASTM Type II water prior to use whether freshly cleaned or stored prior to use.
- All other hand tools, bowls, containers etc. used during soil and sediment sampling will be decontaminated according to the following procedure after each use:
- Scrape or brush off all excess soil or contamination,
- Scrub in Alconox detergent and potable water wash using a brush,
- Rinse thoroughly with potable water to remove detergent,
- Rinse thoroughly with distilled water, and
- Place item on plastic sheeting until use or store in clean plastic bag.

3.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

Several waste streams will be produced during this investigation. These wastes include drill fluids and cuttings, well development water, well purge water, and decontamination wastewater. In order to protect human health and the environment, these wastes will be considered hazardous and managed as such until analysis of the waste proves otherwise. To minimize waste generation, the following guidelines will be followed:

- Removal of as much soil and other contamination from sampling equipment as possible before washing to minimize the quantity of wastewater generated.
- Avoid excessive travel through areas of known contamination to reduce the need for personal and/or vehicle decontamination.
- Avoid excessive well development or purging of monitoring wells.

3.1 Drill Cuttings and Soil Management

A significant quantity of drill fluids cuttings will be generated at the monitoring well locations, and cuttings at each borehole location. Cuttings from each boring will be placed on surface on top of double-lined 6 mil or greater polyethylene plastic and staged at each of the soil boring and well location. All cuttings from the well installation and soil borings will be consolidated in one area or container for sampling and disposal. An adhesive backed label will be used to identify cuttings with the following information: soil boring/monitoring well identification number, contents of the container, and accumulation start date.

3.2 Development and Purge Water Management

Development water from the newly installed well will be containerized in DOT 17E, closed-top 55-gallon drums. An adhesive backed label will be used to label the drum exterior with the monitoring well number, contents of drum, and accumulation start date.

3.3 Decontamination Wastewater

The cleaning of drill rigs, drilling equipment and sampling equipment will generate quantities of decontamination water. Washing of boots at personnel decontamination stations may also generate additional water. All wastewater will be containerized in DOT 17E, closed-top 55-gallon drums. An adhesive backed label will be used to label the drums with the following information: drum contents, accumulation start date, and monitoring well identification number.

3.4 Storage, Testing and Disposal of Wastes

A plastic-lined (2 layers, 6-mil polyethylene) roll-off box containing drill fluids and cutting will be staged at the new monitoring well location. Drums containing cuttings will be staged at each of the new borehole locations. Drums containing development water, purge water, and decontamination wastewater will be staged in the general vicinity of the waste source location (decontamination pad, monitoring well, etc.). Following completion of field activities all IDW will be removed from the LC-38 site.

In order to determine the proper handling, storage and disposal requirements for IDW, a RCRA hazardous waste determination must be made. RCRA regulations define hazardous waste as possessing characteristic for ignitability, corrosivity, reactivity, or toxicity; or listed under 40 CFR Part 261.

The IDW generated during this investigation will be composed largely of soil cuttings, drilling mud and decontamination wastewater, and is not ignitable, corrosive, or reactive. However, the IDW may contain constituents that exhibit constituent concentrations exceeding toxicity characteristic (TC) levels.

To determine whether the IDW contains constituents that exceed the TC levels, the toxicity characteristic leaching procedure (TCLP, EPA Method 1311) will be run on the auger cuttings and purge water. Composite samples will be collected from each waste container and analyzed for UDMH, NDMA and DMN and TCLP metals. If analytical results indicate auger wastes constituents in excess of EPA Land Disposal Standards, the White Sands Missile Range WS-ES TI will be notified to arrange for proper disposal. If analytical results indicate detected constituents in concentrations below EPA Land Disposal Standards, the wastes will be disposed as non-hazardous, at a location approved by the WS-ES TI.

Composite samples will be collected from drums containing purge water from each well site, development water, and decontamination wastewater and analyzed for UDMH, NDMA and DMN, and TCLP metals. If analytical results indicate levels of UDMH, NDMA and DMN or TCLP metals at concentrations above EPA land disposal Standards, the WS-ES TI will be notified to arrange for proper disposal. If analytical results indicate detected contaminants in concentrations below EPA Land Disposal Standards, the water will be disposed as non-hazardous, at a location approved by the WS-ES TI.

A letter report will be submitted to the WS-ES TI that outlines the analytical results of wastes generated during field investigation activities. Characterized wastes include auger cuttings, well development and purge water, and wastewater generated during decontamination activities. The total quantity of materials will be presented along with recommendations for proper disposal. Following disposal, records such as trip reports and manifests will be prepared and submitted to the WS-ES TI for documentation

APPENDIX F

STANDARD OPERATING PROCEDURES

NOTE:These MEVATEC Standard Operating Procedures may be superceded by any of the current project planning documents.

MEVATEC Corporation
STANDARD OPERATING PROCEDURES

MSOP # Title — Page

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 1.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
QUALITY CONTROL PROGRAM

1 PURPOSE

This Standard Operating Procedure (SOP) describes the Quality Control Program developed to implement the quality requirements applicable to the activities at the various sites at White Sands Missile Range, New Mexico.

2 REFERENCES

None.

3 RESPONSIBILITIES

3.1 The Project Manager is responsible for the overall implementation of the Work Assignment Orders. He/she should establish and cultivate principles and practices that integrate quality requirements into the daily work and provide individuals performing the work with proper information, tools, support, and encouragement to properly perform their assigned work. He/she will coordinate the preparation of project specific Quality Control Project Plans (QCPPs) (i.e., Sampling and Analysis Plans, Field Sampling Plans, etc.).

3.2 The Project Technical Manager, Technical Coordinator, and Project Chemist are responsible for assisting the Program Manager to assure that the project's goals and objectives are clearly stated and communicated to participating personnel. Each will provide direct oversight and coordination of operations in order to assure that they are suitably controlled, including acting on the behalf of the Program Manager in his/her absence. Each will prepare portions of project specific Quality Control Project Plans appropriate to his/her background and experience.

3.3 The Quality Assurance Officer is responsible for preparing the programmatic documents and applicable SOPs that describe the implementation of the requirements of the Work Authorization Orders for QC activities. He/she will assign project specific Quality Assurance Officers as appropriate, and provide oversight and assistance in the implementation of the SOPs.

4 DEFINITIONS/MATERIALS

4.1 Quality Control Project Plans

MSOP NO. 1.0
REVISION NO. 0
October 2001

5 PROCEDURE

5.1 The SOPs are designed to implement the quality requirements applicable to the program/project specific activities.

5.2 The SOPs will be reviewed and approved by responsible management prior to their implementation.

5.3 Quality affecting SOPs prepared to perform work assignment orders are prepared and revised by technical personnel under the direction of the Project Environmental Engineer or Project Geologist and are reviewed and approved by the Program Manager, Quality Assurance Officer and as applicable by the Health and Safety Manager.

5.4 The current revision of SOPs required to implement the work assignment orders is maintained in the "Projects" folder on the MEVATEC computer server.

6 REQUIRED FORMS

None

MSOP NO. 1.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
CHAIN OF CUSTODY

1 PURPOSE

This Standard Operating Procedure (SOP) establishes the method and responsibilities associated with the maintenance and custody of samples that are to be used to provide data that form a basis for making project related decisions. It outlines the general procedures for maintaining and documenting sample chain of custody from the time of sample collection through sample disposition.

2 REFERENCES

USEPA, Test Methods for Evaluating Hazardous Waste, (SW-846), current revision.

3 RESPONSIBILITIES

3.1 The Project Technical Manager or Technical Coordinator is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Project Chemist is responsible for assuring that the proper chain of custody is initiated at the time the sample(s) are collected and maintained throughout the handling and subsequent transportation of the sample(s) to the designated laboratory. Additionally, the Project Chemist is the project authority for determining the disposition and fate of sample(s) that have identified deficiencies (e.g., missed holding times, elevated temperature at receipt, etc.).

3.3 The Quality Assurance Officer is responsible for periodic review of Chain of Custody records generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

3.4 The Sampling Team Leader is responsible for properly documenting and maintaining the Chain of Custody from the time of sample collection until the sample is delivered to the laboratory.

3.5 Laboratory Personnel are responsible for receipt and entry of samples into the laboratory that have been submitted to the laboratory under a Chain of Custody document. Additionally, samples received will be entered into the laboratory Chain of Custody procedures by properly documenting and maintaining chain of custody from the moment

MSOP NO. 1.1
REVISION NO. 0
October 2001

that they take custody of the sample at the laboratory until the sample is disposed of or returned to the client.

4 DEFINITIONS/MATERIALS

4.1 Chain of Custody

The Chain of Custody document sometimes called the "cradle to grave" record is the written record that traces the sample possession from the time each sample is collected until its final disposition. Chain of Custody is maintained by compliance with one of the following criteria:

- The sample is in the individual's physical possession.
- The sample is maintained in the individual's physical view after being in his/her possession.
- The sample is transferred to a designated secure area restricted to authorized personnel.
- The sample is sealed and maintained under lock and key to prevent tampering, after having been in physical possession.

4.2 Waybill

A waybill is a document that contains a list of the goods and shipping instructions relative to a shipment.

4.3 Common Carrier

For the purpose of this procedure, the common carrier is any commercial carrier utilized for the transportation of the sample(s) from the field to the laboratory.

5 PROCEDURE

5.1 General

5.1.1 The ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration is important. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal must be documented to accomplish this. Documentation will be accomplished through a Chain of Custody Record that lists each sample and the individuals performing the sample collection, shipment, and receipt.

5.1.2 The Chain of Custody document is a preprinted form. The original will accompany the samples to the laboratory and a copy will be retained in the field project file.

MSOP NO. 1.1
REVISION NO. 0
October 2001

5.2 Field Sample Custody

5.2.1 Sampling personnel, upon collection of samples for analysis, will properly complete a Chain of Custody record form. The Chain of Custody document will be the controlling document to assure that sample maintenance and custody are maintained; thereby assuring the sample(s) are representative of the environment from which they were collected. At a minimum, the following information will be recorded on the Chain of Custody document:

- The unique identification number assigned to each sample.
- A brief description of the sampling location and a physical description of the sample type.
- The date and time of the sample collection.
- Container type (e.g., glass, poly, brass sleeve, etc.).
- Sample volume and number of containers (e.g., 2 x 40 ml, 3 x 1 liter)
- Sample preservation (e.g., HNO_3, H_2SO_4, $4^{o}C$).
- Requested analyses.
- Special instructions to the laboratory including handling requirements, quality assurance/quality control, health and safety, and sample disposition.
- The project name and number.
- The date the analytical report is due.
- The names of all sampling personnel.
- The name and telephone number of the project contact.
- The name and telephone number of the laboratory contact.
- The name of the courier and the waybill number (if applicable).
- A unique document reference number.

5.2.1.1.1 The Chain of Custody document will be initiated in the field by the person collecting the sample and signed by each individual who has the samples in their possession. Each time that sample custody is transferred, the former custodian must sign over the Chain of Custody as "Relinquished By," and the new custodian must sign on to the Chain of Custody as "Received By." The date, time, and the name of their project or company affiliation must accompany each signature.

5.2.1.2 Transferring of Chain of Custody from sampling personnel to the analytical laboratory will be performed in accordance with the requirements stated below.

5.2.1.2.1 If the sampling personnel deliver the samples to the laboratory, transfer of Chain of Custody occurs as follows:

The sampler delivers the samples to the laboratory and relinquishes the sample directly to a laboratory representative.

MSOP NO. 1.1
REVISION NO. 0
October 2001

- The collector signs the Chain of Custody listing his/her name, affiliation, the date, and time. Any person involved in the collection of the sample may act as the sample custodian.

- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time of the Chain of Custody Record. The laboratory representative may decline to take receipt of the samples if the Chain of Custody Record is not properly completed or if the samples are not properly packaged. All designated laboratory personnel may act as the sample custodian.

5.2.1.2.2 If the sampling personnel transfer sample(s) to the laboratory utilizing a common carrier, sampling personnel will retain Chain of Custody responsibility and the common carrier is not responsible for maintaining sample custody. The samplers are responsible for packaging the samples in a manner that meets the Chain of Custody definition criteria, that is, the samples are sealed to prevent tampering. When transferring samples to the courier for transport, Chain of Custody procedures are maintained as follows:

- The sampler lists the courier affiliation and waybill number on the Chain of Custody Record.
- The sampler relinquishes custody by signing their name, affiliation, date, and time. The collector keeps a copy of the relinquished Chain of Custody Record for the project file.
- The relinquished original Chain of Custody Record is sealed in a watertight plastic bag and taped to the inside of the lid of the transport container.
- The transportation container is sealed to prevent tampering and given to the courier for delivery to the laboratory.
- The sampler obtains a copy of the waybill from the courier for the project file.
- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time on the Chain of Custody Record. This copy is maintained with the samples at the laboratory.
- The laboratory representative obtains a copy of the waybill from the courier for the project file.

5.3 Analytical Laboratory Custody

5.3.1 Upon receipt at the analytical laboratory, the field generated Chain of Custody document will be signed, dated, time marked, temperature marked, and laboratory identification will be provided in the appropriate spaces.

5.3.2 Laboratory receipt personnel will enter the samples into the laboratory by implementing the sample custody procedures addressed within their approved Program Plan.

MSOP NO. 1.1
REVISION NO. 0
October 2001

5.3.3 After completion of analytical testing, sample remnants not consumed during testing may be kept for six months beyond the completion of analysis, unless otherwise specified by a notation on the Chain of Custody record that samples are to be returned to the project site for disposal. Once this time period has elapsed, the samples will be disposed of and the disposal record number will be recorded on the laboratory record copy of the Chain of Custody Record.

6 REQUIRED FORMS (ATTACHED)

6.1 Chain of Custody Record

MSOP NO. 1.1
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 1.2
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
FIELD ACTIVITY DOCUMENTATION

1 PURPOSE

This Standard Operating Procedure (SOP) defines the minimum requirements for documenting field activities in the field logbooks. Field logbooks provide a detailed daily handwritten record, kept in real time, of field activities performed at an investigation site. Logbooks are permanently bound by glue or thread into a hard cover, and should be waterproof. Field logbooks may be assigned to specific activities, positions, or areas within the site. Field logbook covers must be sequentially numbered and indicate the position, task, activity, or area assigned to the logbook.

2 REFERENCES

None.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities and geotechnical measurements are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problem occur.

3.3 The Sampling Team Leader is responsible for ensuring that field logbooks are completed daily in accordance with this procedure.

3.4 The Sampling Team Members are responsible for making timely and complete entries in the field logbook and for reporting daily activities to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer, as appropriate.

4 DEFINITIONS/MATERIALS

4.1 Field Logbook

The field logbook is a surveyor's book or record book, bound and ruled/gridded, with sequentially numbered and water proof pages.

4.2 Waterproof black ink pens.

5 PROCEDURE

5.1 Field Logbook Cover

Label the front cover of the field logbook with the project name and number, subcontractor name, client name, the start date and, when complete, the finish date. The field logbooks must be sequentially numbered.

5.2 Field Logbook

The following steps must be followed when making entries in the field logbook:

1. Enter the day and date; time the task started; weather conditions; and the names, titles, and organizations of personnel performing the task.

2. Record the name, title and organization, time of arrival, and time of departure of all visitors to the task area.

3. Describe all site activities in specific detail or indicate the forms used to record such information (e.g., soil boring log or well completion log). A partial data list is given below:

   - Monitoring wells: complete the Monitoring Well Construction Details form (attached)
   - Monitoring well development: complete the Monitoring Well Development Record (attached)
   - Monitoring well purging and sampling: complete the Groundwater Monitoring Well Sampling Data Summary Form (attached)
   - Surface water and sediment/sludge sampling: complete the Drilling Log form (attached), annotating as necessary.
   - Subsurface soil sampling:

     - Soil borings: complete the Drilling Log and include borehole size, depth, sample equipment, method, and sample collected. Detailed lithologic data will be recorded on the boring log.
     - Trenches, and test pits: record the excavation dimensions, sampling equipment or method(s), and samples collected. Detailed lithologic data will be recorded in the Field Logbook.
     - Soil gas and geophysical surveys: grid or line dimensions, probe or sensor spacing, depths, survey and recording equipment type and serial or identification number, and location of resulting data (e.g., strip chart, analog

data record, computer file, and file name). Sketches are valuable additions to field notes and should be used where possible.

4. Describe in specific detail any field tests that were conducted and instruments used. Reference any forms that were used, other data records, and the procedures followed in conducting the test. If the final results of any field activity are obtained in the field, these data should be annotated in the field logbook.

5. Changes in procedures or sample locations and reasons for change.

6. Describe in specific detail any samples collected and whether splits, duplicates, matrix spikes or blanks were prepared.

7. Upgrades or downgrades of personal protective equipment and the rationale for such action, and health and safety information such as level of personal protective equipment (PPE) used.

8. List the time, equipment type, and the procedure followed for all decontamination actions carried out. Reference the page number(s) in the decontamination log (if any) where detailed information is recorded; if not referenced, detailed information shall appear in the field logbook.

9. List all instrument calibrations, person(s) performing calibration, and the page number of the calibration log that provided specific information on calibration procedures and results when the calibrations occur in the field.

10. Record all photographs by number and includes a description of the subject, the direction the photographer is facing, and the photographer's initials. If the event photographed is the collection of a sample, record the sample ID number.

11. List any equipment failures or breakdowns that occurred, together with a brief description of repairs or replacements.

12. No pages may be removed from the site or field logbooks for any reason. Blank pages must be marked with a diagonal, corner to corner line and/or the phrase "This page intentionally left blank".

13. Mistakes must be crossed out with a single line, initialed, and dated. Only persons authorized by the Project Technical Manager or Technical Coordinator may make entries in the logbook.

14. The Project Technical Manager, Technical Coordinator, or Sampling Team Leader must sign the field logbook at the bottom of each page.

MSOP NO. 1.2
REVISION NO. 0
October 2001

6 REQUIRED FORMS

6.1 Monitoring Well Construction Details form

6.2 Monitoring Well Development Record

6.3 Groundwater Monitoring Well Sampling Data Summary Form

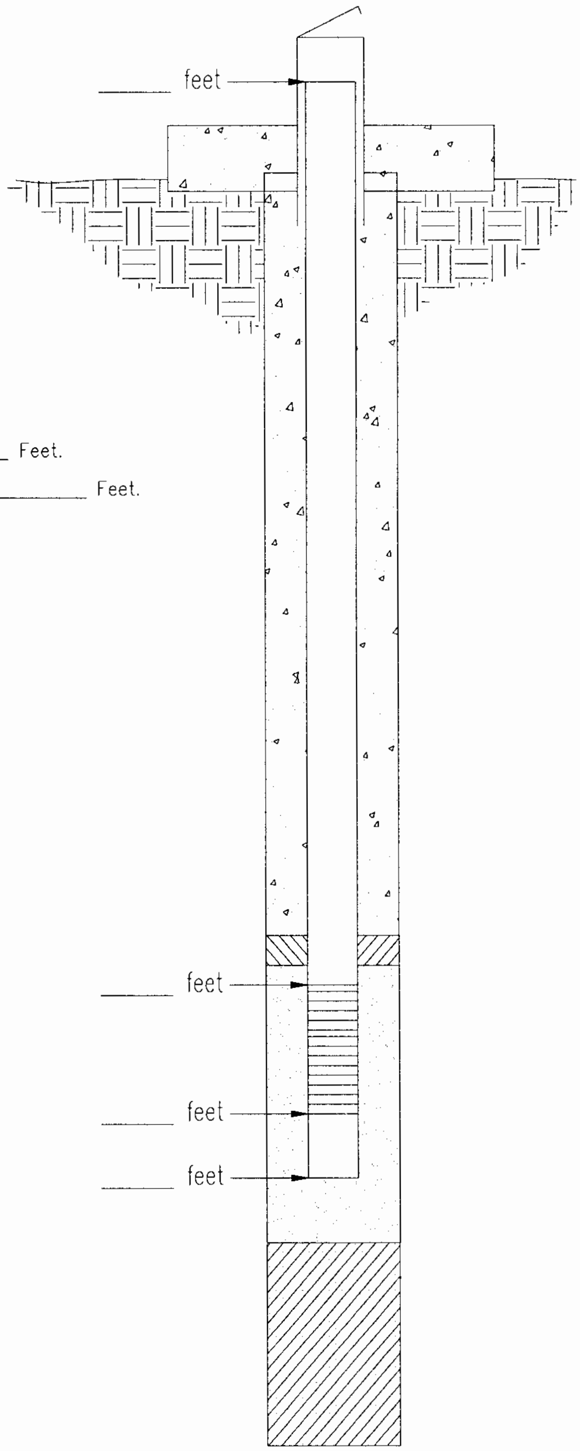
6.4 Drilling Log

MSOP NO. 1.2
REVISION NO. 0
October 2001

MONITORING WELL CONSTRUCTION DETAILS

WELL NUMBER: ______________________

WELL NAME: ______________________



KEYED NOTES:

1. CONCRETE PAD W/ EMBEDDED BRASS MARKER
   ELEVATION__________ FEET (NAVD 1988).
   LAT. ______________________
   LONG. ______________________
2. TOP OF WELL CASING ELEVATION __________ Feet.
3. TOTAL DEPTH (feet below top of casing) __________ Feet.
4. CASING DIAMETER __________ Inches.
5. SCREEN INTERVAL (feet below top of casing):
   __________ Feet to __________ Feet.

GENERAL NOTES:

1. DRAWING NOT TO SCALE.

500bb046

MSOP NO. 1.2
REVISION NO. 0
October 2001

MONITORING WELL DEVELOPMENT RECORD

INSTALLATION	WELL ID		DATE	TIME
PERFORMED BY	WATER LEVEL		TOTAL DEPTH	
	INITIAL	FINAL	INITIAL	FINAL
DEVELOPMENT METHOD		SURGE TECHNIQUE		
FIELD MEASUREMENTS				

Time	Cum. Volume (gal)	Water Quality				Comments
		Temp	pH	Cond	Turbidity	

TOTAL VOLUME REMOVED DEVELOPMENT TIME	COMMENTS

MSOP NO. 1.2
REVISION NO. 0
October 2001

GROUNDWATER MONITORING WELL SAMPLING DATA SUMMARY FORM Page 1 of 2

DATE:______________ SWMU# ________________________

WELL ID:______________________ Personnel:______________________

AIR TEMP:_____ ^{0}F RELATIVE HUMIDITY:________%

WEATHER CONDITIONS ____

WELL PURGE AND SAMPLE

A. Equipment & Supplies

1. Pump # ____________________ 4. HyDac Meter # _________________
2. Bailer (size/type)______________ 5. Water Level Indicator # ___________
3. Drums (number)_______________ 6. Other _________________________

B. Calculations and Measurements

1. DEPTH TO WATER (D.T.W.) (feet below top of casing): _________________________
2. T.D. Well T.D. (feet below ground surface, from well fact sheet): ____________________
3. Top of Casing elevation - Brass Marker Elevation (from well fact sheet): _______________
4. _________T.D. (ft. bgs) ________D.T.W. (ft. bgs) _______ Water Column (h, in feet)
5. COLUMN VOLUME = __________ft. x Gal/ft. (from table below)
6. PURGE VOLUME = ________Column Volume x 3
7. Sample Parameters (at time of collection):

   CONDUCTIVITY_________________ pH__________

   CONDUCTIVITY SCALE__________ WATER TEMP ^{0}F__________

8. SAMPLE TIME: __________________(24 hr. clock) SAMPLE DATE:____________
9. SAMPLE ID:______________________(prim)____________________________(QC)

   ______________________(QC)_________________________(MS/MSD)

For a well with diameter of casing = (inches)	Multiply the water column (h) by:	If casing diameter differs from those given in the table, use the formula below to calculate the well volume:
2	0.163	D2 * h * 0.041
3	0.367	where:
4	0.653	D2 = casing diameter (in inches), squared
5	1.020	h = height (in ft.) = W.C.
6	1.469	
8	2.611	

To calculate the well volume

MSOP NO. 1.2
REVISION NO. 0
October 2001

GROUNDWATER MONITORING WELL SAMPLING DATA SUMMARY FORM Page 2 of 2

Sample Date:__________________Personnel:__________________**WELL ID:**______________

FIELD PARAMETERS

Time 24-hr clock	Volume (gal)	Temp ^{0}F	pH	Conductivity (μS/CM) (Scale:_______)	Comments (clarity, sediment, etc.)

Time (24-hr. clock)	**Notes (problems, observations, deviations from protocol, etc.)**

MSOP NO. 1.2
REVISION NO. 0
October 2001

DRILLING LOG	DIVISION	INSTALLATION	HOLE No.	SHEET No. OF

1. PROJECT	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
2. LOCATION (Coordinates or Station)	12. MANUFACTURER'S DESIGNATION OF DRILL
3. DRILLING AGENCY	13. TOTAL No. OF OVERBURDEN SAMPLES TAKEN / DISTURBED / UNDISTURBED
4. HOLE No. (As shown on drawing title and file number)	14. TOTAL NUMBER CORE BOXES
5. NAME OF DRILLER	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ Vertical ☐ Inclined ______ Degrees from Vertical	16. DATE HOLE / STARTED / COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING
9. TOTAL DEPTH OF HOLE / 10. SIZE AND TYPE OF BIT	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (description) d	% CORE RECOVERY e	BOX OR SAMPLE NUMBER f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g

MSOP NO. 1.2
REVISION NO. 0
October 2001

DRILLING LOG (Continuation Sheet)			INSTALLATION		HOLE No.	SHEET No. OF
1. PROJECT			11. ELEVATION OF TOP HOLE			
ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (description) d	% CORE RECOVERY e	BOX OR SAMPLE NUMBER f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significent) g

MSOP NO. 2.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SAMPLE HANDLING, PACKAGING, AND SHIPPING

1 PURPOSE

This Standard Operating Procedure (SOP) outlines the methods and responsibilities for field personnel to use in the packaging and shipping of environmental samples for chemical and physical analysis. This SOP only applies to the packaging and shipping of limited quantity, low concentration environmental samples. This procedure does not apply to those samples considered hazardous materials, hazardous waste, mixed waste, radioactive waste, and/or dangerous goods. Those requirements are specified in the Department of Transportation (DOT) 49 CFR 114-327 and the International Air Transport Association (IATA) procedures. The details within this SOP are only applicable to the general requirements for sample packaging and shipping and should only be used as a guide for developing more job-specific work plans.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER directive 9355.3-01.

2.3 Code of Federal Regulations, DOT 49 CFR parts 100 to 177, revised October 1, 1992.

2.4 Dangerous Goods Regulations, IATA, January 1, 1994.

3 RESPONSIBILITIES

3.2 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.3 The Project Chemist is responsible for the development and review of site-specific work plans that address the specific sample handling, packaging, and shipping requirements for the project. Review the project specific documentation forms to ensure they are appropriate for the field activities. The Project Chemist is also responsible for seeing that field personnel receive proper training and maintain quality assurance/quality control (QA/QC). If problems arise, the Project Chemist is responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, issuing nonconformances, etc.).

MSOP NO. 2.0
REVISION NO. 0
October 2001

3.4 The Quality Assurance Officer is responsible for periodic review of documentation generated during sample handling, packaging, and shipping and the periodic review and audit of field personnel as they perform the work.

3.5 The Sampling Team Leader(s) is responsible for ensuring that samples are handled, packed and shipped in accordance with this procedure.

4 DEFINITIONS/MATERIALS

4.2 Environmental Sample

A limited quantity, low concentration sample that does not require DOT or IATA hazardous waste labeling as a hazardous waste or material.

4.3 Hazardous Waste Sample

Medium or high concentration sample requiring either DOT or IATA labeling as a hazardous waste or material.

4.4 Hazardous Waste

Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) that would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous material is defined and regulated by the U.S. Environmental Protection Agency (USEPA).

4.5 Hazardous Material

A substance or material in a quantity or form that may pose an unreasonable risk to health, safety, and/or property when transported in commerce. Hazardous material is defined and regulated by DOT (49 CFR 173.2 and 172.101) and IATA (Section 4.2).

4.6 Sample

Physical evidence collected from a facility or the environment that is representative of conditions at the point and time at which the sample is collected.

5 PROCEDURE

5.2 Sample Handling

5.2.1 Inspect the sampling containers (obtained from the analytical laboratory prior to the sampling event) to ensure that they are appropriate for the samples being collected, correctly preserved, and undamaged.

5.2.2 When collecting a sample always use approved/site specific personal protective equipment (e.g., gloves, etc.) to prevent cross-contamination from sample to sample but also as a health and safety requirement.

5.3 Field Packaging

5.3.1 Collect the samples in accordance with the site-specific work plans and applicable SOPs.

5.3.2 As soon as possible after sample collection, tightly seal the container, and place a piece of custody tape over or around the cap. The custody tape should be placed over the cap so that any attempt to remove the cap will cause the tape to be broken. Do not place custody tape over a volatile organic analysis (VOA) vial septum.

5.3.3 Place each container in a separate, appropriately sized, airtight, seam-sealing polyethylene bag (e.g., Ziploc™ or equivalent). Seal the bag, removing any excess air.

5.3.4 Place the bagged container inside an insulating shipping container, "cooler". This cooler should have frozen blue ice or airtight, seam-sealing polyethylene bags of ice inside to assure samples remain cool, 4°C ± 2°C, during transit from field to the packaging location.

5.3.5 Because blue ice does not maintain 4°C standard required for sample shipping, it should only be used while in the field collecting samples.

5.3.6 Maintain the samples under chain of custody in accordance with the site-specific work plans and appropriate SOPs.

5.4 Sample Packaging

5.4.1 Inspect the integrity of the shipping container. The container is generally a "cooler" constructed of heavy plastic or metal with appropriate insulating properties so that variation in temperature during shipping is minimized. Also make sure that the drain plug has been sealed with nylon reinforced strapping tape or mailing tape.

5.4.2 Place two or four inches of absorbent packaging material (e.g., Styrofoam bubbles, Vermiculite™ etc.) in the bottom of the shipping container.

5.4.3 Carefully check the chain of custody record against the collected sample labels and containers to ensure that the sample numbers, sample description, date and time of collection, container type and volume, preservative, and the required analytical methods are correct and in agreement.

MSOP NO. 2.0
REVISION NO. 0
October 2001

5.4.4 Place the samples in the shipping container, allowing sufficient room between the samples to place ice and/or packing material.

5.4.5 Double bag and seal crushed or cubed ice in heavy-duty polyethylene bags (Ziplock™ or equivalent). Place these bags of ice on top of and between samples. Blue ice should not be used for sample shipping; it does not maintain the 4°C temperature necessary for regulatory compliance. Include a VOA vial of tap water clearly labeled "temperature blank" so that the laboratory can verify the temperature of the samples upon receipt. The remaining space will be filled with packing material.

5.4.6 All samples requiring temperature preservation stated at 4°C will be acceptable "as is" within the range of 4°C ± 2°C. The laboratory should record the temperature of receipt upon the chain of custody report. For all samples received at less than 2°C (note not frozen), or at greater than 6°C, the sample(s) and temperature (in 1°C increments) will be identified on the chain of custody and the Project Chemist notified in order to provide a determination and written authorization to proceed to analysis.

5.5 Sample Shipping

5.5.1 The laboratory will be contacted two weeks prior to sample shipments. Delivery on weekends and holidays will be confirmed in one week in advance, and one day prior to shipment. The person in charge of sample custody will time, date, and sign over relinquishment of custody on the Chain of Custody. When a common carrier is to be used for sample shipment, also record the air/waybill number (tracking number) and the name of the carrier on the Chain of Custody record. Place the original copy of the Chain of Custody record and a copy of the task specific analyte list in a sealed, clear plastic envelop or bag and tape the envelope to the inside lid of the shipping container. Retain a copy of the Chain of Custody record for tracking purposes.

5.5.2 Using nylon reinforced strapping tape or mailing tap, seal the shipping container.

5.5.3 Place custody tape over opposite ends of the lid.

5.5.4 Apply a label stating the name and address of the shipper and the receiving laboratory on the outside of the cooler.

5.5.5 If QA split samples are shipped. The Project Chemist shall notify the QA Laboratory by telephone at least two weeks in advance of sample shipment (for large numbers of samples, greater than 20) and again on the day that samples are forwarded to the QA laboratory.

NOTE: The courier or carrier is not responsible for sample custody and is not required to sign the Chain of Custody record.

MSOP NO. 2.0
REVISION NO. 0
October 2001

5.5.6 Contact the appropriate laboratory personnel to advise them of the sample shipment.

5.5.7 Review the chain of Custody and sample collection forms for completeness and turn them over to site or project management.

6 REQUIRED FORMS (ATTACHED)

6.1 Chain of Custody Record

MSOP NO. 2.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 2.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SAMPLE LABELING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample labeling. Sample labeling is required to identify, track and trace samples from the time of collection until the time of disposal. Additional specific procedures and requirements will be provided in the project work plans.

2 REFERENCES

2.1 EPA, September 1987, <u>Compendium of Superfund Field Operations Methods</u>, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, <u>EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA</u>, Interim Final OSWER directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection and labeling activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this sample labeling SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample labeling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to sampling and sample labeling activities are responsible for completing their tasks to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Sample Label

Sample labels include all forms of sample identification (labels and tags) that are physically attached to samples collected and provide, at a minimum, the information required by this SOP and project work plans.

MSOP NO. 2.1
REVISION NO. 0
October 2001

5 PROCEDURE

This section contains the procedures involved with sample labeling. Sample labeling is required to identify, track and trace samples from the time of collection until the time of disposal. The details within this SOP should be used in conjunction with the project work plans. The project work plans will commonly provide the following information:

- Sample collection objectives.
- Number, types and locations of samples to be collected.
- Any additional sample labeling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 Sample Labeling

5.1.1 Document all the information necessary on the sample label and ensure that the label is physically attached to each respective sample. Each sample label must contain at a minimum the following information:

- Project name
- Project number
- Date and time of collection
- Sample location
- Sample identification number
- Collector's name
- Preservative used (if any)

Additional information may also be required per the project work plans and must accordingly be included on all sample labels.

5.1.2 Indelible ink should be used in filling out all sample labels.

5.1.3 Ensure that each sample collected has a sample label.

5.1.4 Ensure that the information documented on the sample label corresponds with the information documented on the Field Logbook and Chain of Custody Record.

6 REQUIRED FORMS (ATTACHED)

6.1 Sample Labels

6.2 Chain of Custody Record

MSOP NO. 2.2
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SAMPLE NUMBERING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample numbering. Sample numbering is required to identify, track and trace samples from the time of collection until the time of disposal. Additional specific procedures and requirements will be provided in the project work plans.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection and numbering activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this sample numbering SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to sampling and sample-numbering activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Sample Number

A sample number is a unique alphanumeric identification assigned to each and all physical samples collected as part of any given project.

MSOP NO. 2.2
REVISION NO. 0
October 2001

5 PROCEDURE

This section contains the procedures involved with sample numbering. Sample numbering is required to identify, track and trace samples from the time of collection until the time of disposal. The details within this SOP should be used in conjunction with the project work plans. The project work plans will commonly provide the following information:

- Sample collection objectives.
- Number, types and locations of samples to be collected.
- Project-specific character string to be used for the sample numbering.
- Person responsible for issuing sample numbers to field personnel conducting sampling activities.
- Any additional sample numbering requirements or procedures beyond those covered in this SOP, as necessary.

5.1 Sample Numbering

5.1.1 The alphanumeric character string will be determined on a project-specific basis and stated in the project work plans. The sample numbers should be as simple and preferably as short as possible; however, they should also be compatible with the laboratory analytical tracking system and the data management system to be used for the project sample data. The number will include the site identifier, the sample location identifier, the depth of soil sample, the date (month and year) and other identifiers as appropriate.

5.1.2 A unique sample number will be assigned in the field to each sample to be submitted for analysis.

5.1.3 The sample numbers will be assigned sequentially (e.g., SB-1000, SB-1001) as the samples are collected. Both environmental (soil, sediment, groundwater, air, etc.) and QC samples will be assigned sequential numbers with the same prefix so that the laboratory will be unable to distinguish between QC and non-QC samples.

5.1.4 The sample number will be recorded, using indelible ink, directly on the sample label attached to each sample per MSOP 2.1.

5.1.5 The sample number must also be recorded on the Field Logbook and Chain of Custody Record.

5.1.6 It is recommended that one person (either the Sampling Team Leader or other designee) be responsible for issuing sample numbers to field sampling personnel and ensuring that the sample sequence numbers are applied to samples in the sequence in which they are collected.

MSOP NO. 2.2
REVISION NO. 0
October 2001

6 REQUIRED FORMS (ATTACHED)

6.1 Sample Collection Log

6.2 Chain of Custody Record

MSOP NO. 2.2
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 2.3
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
ON-SITE SAMPLE STORAGE

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for on-site sample storage. On-site sample storage may be required for samples collected during a given project. Additional on-site sample storage procedures and requirements will be provided in the project work plans.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all on-site sample storage activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field-generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to sample storage activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Field Sample

A sample that has been collected at a project site, during the execution phase of the project, and for the purposes of the project, as defined in the project work plans.

MSOP NO. 2.3
REVISION NO. 0
October 2001

4.2 On-site

For purposes of this SOP, "on-site" is defined as any area within the project site.

4.3 On-site sample storage

For purposes of this SOP, "on-site sample storage" applies to samples stored within the project site for a temporary period of time. Typically, samples may be stored on-site if they are in transit between the project site and a designated laboratory.

5 PROCEDURE

This section contains the requirements pertaining to on-site sample storage. Proper storage is essential to maintain in the quality and integrity of samples collected during a field project. The details within this SOP should be used in conjunction with project work plans. At a minimum, the project work plans will provide the following information:

- Sample collection objectives.
- Number, types and locations of samples to be collected.
- Any additional sample numbering requirements or procedures beyond those covered in this SOP, as necessary.

5.1 On-Site Sample Storage

5.1.1 Samples of all types of media may require being stored on-site. The manner in which these samples are stored will be appropriate for individual samples and each sample type.

5.1.2 Samples collected for chemical analysis are typically required to be stored at approximately 4° Centigrade (°C). Therefore, such samples should either be preserved in a "cooler" using water ice, or a "Sample-Only" refrigerator until received by the assigned laboratory. Blue ice is not recommended for on-site sample storage as is does not maintain the 4°C temperature necessary for regulatory compliance. If a refrigerator is used to store samples at the project site, this refrigerator will be dedicated for the sole use of samples; no food, drinks, or other personal items will be allowed in this refrigerator.

5.1.3 Samples that do not require refrigeration (e.g., air samples and samples for geotechnical or radionuclide analysis) should be stored on-site in a designated, marked area.

5.1.4 Samples that are stored on-site must be stored in appropriate containers per the project-specific work plans and be maintained under custody per MSOP No. 1.1.

5.1.5 Samples that are stored on-site must not be stored in a manner in which they may threaten the integrity of other samples in the holding location.

MSOP NO. 2.3
REVISION NO. 0
October 2001

5.1.6 All samples that are stored on-site must be labeled per MSOP No. 2.1, numbered per MSOP 2.2, and appropriately handled per MSOP 2.0.

5.1.7 It is recommended the Sampling Team Leader or other designee is responsible for maintaining a master sample log listing sample numbers and a brief description of samples collected. The master log should be reviewed on a daily basis for samples that are under storage on site. The samples should then be appropriately shipped, following procedures per MSOP No. 2.1, to ensure that holding time is not missed.

6 REQUIRED FORMS

None.

MSOP NO. 2.3
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 3.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface (0 to 6-inch depth) and shallow subsurface (6-inch to 6-feet in depth) soil samples for physical and chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface and shallow subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to surface and shallow subsurface soils sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

4 DEFINITIONS/MATERIALS

4.1 Surface Soil Sample

Soil collected from the surface to a depth of no more than 6 inches.

MSOP NO. 3.0
REVISION NO. 0
October 2001

4.2 Shallow Subsurface Soil Sample

Soil collected from a depth of 6 inches to 6 feet.

4.3 Subsurface Soil Sample

Soil collected at any depth interval greater than 6 inches.

4.4 Disturbed Soil Sample

Soil sample whose in situ physical structure and fabric has been disturbed as the direct result of sample collection.

4.5 Undisturbed Soil Sample.

Soil sample whose in situ physical structure and fabric has not been disturbed as the result of sample collection.

4.6 Grab Samples

Representative disturbed soil sample that is collected by using such devices as a shovel, stainless steel spoon, etc.

5 PROCEDURE

This section contains both the responsibilities and procedures involved with surface and shallow subsurface soil sampling. Proper surface and shallow soil sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives.
- Locations and depths of soil samples to be collected.
- Number and volumes of samples to be collected.
- Types of analyses to be conducted for the samples.
- Specific quality control (QC) procedures and sampling required.
- Any additional surface or shallow subsurface soil sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined below for surface and shallow subsurface soil sampling will be followed.

MSOP NO. 3.0
REVISION NO. 0
October 2001

5.1 Surface Soil Sampling Equipment

A number of devices are available for the collection of surface soil samples. These include, but are not limited to, core samplers, hand augers, spoons, scoops, trowels and, shovels. These devices are constructed of a number of materials including, but not limited to, stainless steel, brass, glass and, Teflon™.

The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface soil sampling equipment to use.

At present, the method commonly used for the collection of surface samples and shallow subsurface samples, both disturbed and undisturbed, is with a core sampler. The core sampler is usually a hollow, stainless steel cylinder, tapered at the leading end. A sample sleeve (brass, stainless steel, lexan, etc.) is inserted into the trailing end. The trailing end is then connected to a piston-type drive hammer. The core is driven into the soil by a hammer so that a relatively undisturbed sample is collected in the sleeve. The sample is then handled and shipped in the sample sleeve.

When a core sample is not feasible or planned, such devices as a stainless steel shovel, hand auger, trowel and, spoon, can be used to collect a sample. The soil is transferred from the collection device into decontaminated sample containers (commonly glass jars). The project work plans will specify the type of sampling equipment containers to be used; the sample to be used will be specified in the project work plans.

5.2 Surface Soil Sample Collection

5.2.1 Prior to sampling and between sampling locations, decontaminate the sample equipment according to MSOP 6.0 and procedures outlined in the project work plans.

5.2.2 Ensure that all surface and shallow subsurface soil sampling locations have been appropriately cleared of all underground utilities and buried objects per the project work plans. Review all forms and diagrams documenting the location of the cleared sampling locations, as well as that of any underground utilities or lines, or other buried objects.

5.2.3 As required, calibrate any health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

5.2.4 Don appropriate personal protection equipment as specified in the project work plans.

5.2.5 Using equipment that will not be used for sample collection clear the area to be sampled of surface debris and vegetation.

MSOP NO. 3.0
REVISION NO. 0
October 2001

5.2.6 If using the coring device, place the sleeve into the device and drive the assembly into the soil using the drive hammer. Drive the device into the soil until the trailing end of the sleeve is at the soil surface.

5.2.7 Retrieve the device; check to see that soil recovery is adequate in the sample sleeve. If there is sufficient recovery, mark or note the leading end of the sample sleeve.

5.2.8 If using a different sample collection device (other than the coring device), use the other device to scoop or collect soil and directly transfer the soil into the sample container (e.g., glass jar, brass sample sleeve, etc.). Fill the sample container such that little to no headspace exists.

5.2.9 If using sample sleeves, place Teflon™ squares over each end of the sleeve and seal each end with plastic end caps. With a permanent marker, write a "T" for top on the trailing end and a "B" for bottom on the leading end.

5.2.10 Appropriately label and number the sample containers per MSOP 2.1 and 2.2, respectively, and the project work plans. The label will be filled out with waterproof ink and will contain, at a minimum, the following information:

- Project number
- Sample number
- Sample location
- Sample depth
- Sample type
- Date and time of collection
- Parameters for analysis
- Sampler's initials.

5.2.11 Document the sampling event on the Field Logbook or an equivalent form as specified in the project work plans. Note any pertinent field observations, conditions or problems on the Field Logbook. Any encountered problems or unusual conditions should also be immediately brought to the attention of the field geologist.

5.2.12 Appropriately preserve, handle, package, and ship the samples per MSOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per MSOP No. 1.1.

5.2.13 Fill and abandon the sample hole as required by the project work plans.

5.3 Subsurface Soil Sample Collection

5.3.1 The common method to collect shallow subsurface soil samples is to use a hand auger to bore to the desired sampling depth and then retrieve the sample with a core sampler. The hand auger might also be used to recover the sample for direct transfer into glass jars. The exact methodology to be used will be specified in the project work plans.

For subsurface soil samples of less than 18 inches in depth, successive drives of the core sampler may potentially be used to recover shallow subsurface soil samples. In all methods cited above, borehole stability should be maintained to prevent the recovery of slough in the samples. If sloughing cannot be controlled, than another sampling methodology may have to be considered.

5.3.2 As with surface soil samples, shallow subsurface soil sampling follows the same sample collection procedures specified in Section 5.2.1 through 5.2.13.

6 REQUIRED FORMS (ATTACHED)

6.1 Chain of Custody

MSOP NO. 3.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 3.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SUBSURFACE SOIL SAMPLING WHILE DRILLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for subsurface soil sampling while drilling. Proper collection procedures are necessary to assure the quality and integrity of all subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2 REFERENCES

2.1 American Society for Testing Materials (ASTM), 1989, Standard Method for Penetration Test and Split-Barrel Sampling of Soils, Method D-1586-84, Philadelphia. PA.

2.2 American Society for Testing Materials (ASTM), 1986, Standard Practice for Thin-Walled Tube Sampling of Soils, Method D-1587-83, Philadelphia. PA, pp. 304-307.

2.3 American Society for Testing Materials (ASTM), 1986, Standard Practice for Ring-Lined Barrel Sampling of Soils, Method D-3550-84, Philadelphia. PA, pp. 560-563.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to subsurface soils sampling activities during drilling is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

MSOP NO. 3.1
REVISION NO. 0
October 2001

4 DEFINITIONS/MATERIALS

4.1 Borehole

Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing a monitor well.

4.2 Split-Spoon Sampler

A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (semiconsolidated) materials using a drive weight or drilling jars mounted in the drilling rig. A standard split-spoon sampler (used for performing standard penetration tests) is 2 inches in outside diameter and 1 ⅜ inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Six-inch long sleeves (tubes) of brass, stainless steel, or plastic are commonly placed inside the sampler to collect and retain soil samples. A five-foot long split-spoon sampler is also available. A California modified split-spoon sampler is also commonly used. The design is similar to the standard split-spoon except the outside diameter is 2 ½ inches and the inside diameter is 2 inches.

4.3 Shelby Tube Sampler

A thin-walled metal tube used to recover relatively undisturbed samples. These tubes are available in various sizes, ranging from 2 to 5 inches in outside diameter and 18 to 54 inches in length. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

5 PROCEDURE

This section contains both the responsibilities and procedures involved with subsurface soil sampling while drilling. Proper subsurface soil sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives.
- Locations of soil boreholes and target horizons or depths of soil samples to be collected.
- Number and volumes of samples to be collected.
- Types of chemical analyses to be conducted for the samples.
- Specific quality control (QC) procedures and sampling required.
- Any additional subsurface soil boring sampling requirements or procedures beyond those covered in this SOP, as necessary.

There are many different methods that may be used for subsurface soil sample collection during drilling. This SOP focuses on the two most common methods of soil sample collection: split-spoon sampling and Shelby tube sampling. At a minimum, the procedure outlined below for these two subsurface soil-sampling methods will be followed. If other subsurface soil sampling methods are deemed necessary to meet project objectives, the procedures for these methods will be updated in this SOP or included in the project work plans.

5.1 General Sampling Considerations

The two subsurface soil sampling methods covered in this SOP, split-spoon and Shelby tube, are commonly used in conjunction with hollow stem auger, air rotary, and dual tube percussion drilling methods. Split-spoon or Shelby tube sampling may be conducted when drilling with mud rotary methods. However, when using this drilling method the samples are not generally useful for chemical analyses. This is because the samples may become invaded or chemically altered when they are tripped through the drilling mud during sample retrieval. In addition, loose unconsolidated soils may also literally wash out of the samplers when they are tripped through the mud column.

The procedures described in the SOP must be used in conjunction with the SOP proscribed for the specific drilling method used at the site. These also include, but are not limited to, site clearance, site preparation, and health and safety requirements. Consequently, the SOP for the specific drilling method to be used at the site, the project work plans, and this SOP must be reviewed together before the initiation of drilling and sampling.

5.2 Split-Spoon Sampling

Split-spoon samples for chemical analysis will be obtained in brass, plastic, or stainless steel sleeves. The types, dimensions and number of sleeves to be used, along with the length and type of sampler, will be stated in the project work plans. The split-spoon sampler, lined with the brass, plastic, or stainless steel sleeves, is connected to the drill rod string or a wireline sampling string. The procedure for collecting samples from the split-spoon sampler will be outlined in the project work plans. The standard procedure is described below.

5.2.1 Calibrate all field analytical and health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

5.2.2 Wear the appropriate personal protection equipment as specified in the project work plans and the applicable drilling method SOP. Personnel protection will typically include a hard hat, safety glasses, gloves, steel-toed boots, hearing protection, and coveralls.

5.2.3 Between each sampling location and prior to each sampling run, decontaminate the sampler, sleeves, and other sampling equipment as described in MSOP No. 6.0.

MSOP NO. 3.1
REVISION NO. 0
October 2001

5.2.4 Advance the borehole to the desired depth or target horizon where the sampling run is to begin. During drilling, monitor vapors in the breathing zone according to the project work plans, and drilling method SOP.

5.2.5 Insert the sleeves into the split-spoon sampler, connect the halves, and screw together the rear threaded collar and front drive shoe. Attach the split-spoon sampler to the bottom end of the drill rod string or wireline sampling string. Set up and attach the specified weight, if used.

5.2.6 Drive the sampler into the soil at the bottom of the borehole. Record the type of sampler assembly and hammer weight on the Visual Classification of Soils form and/or other appropriate form(s), as specified in the project work plans. To minimize off gassing of the volatiles, the sampler should not be driven until the sampling team is ready to process the sample.

5.2.7 When conducting penetration testing, observe and record on the Visual Classification of Soils form the number of hammer blows as described in MSOP No. 10.0.

5.2.8 Pull the drill rod or wireline sampling string up from the bottom of the borehole and remove the sampler.

5.2.9 Remove the drive shoe and rear collar from the sampler and open the split barrel.

5.2.10 Remove the sleeves one at a time, starting with the sleeve adjoining the drive shoe. Observe and record the amount of sample recovery on the Visual Classification of Soils form per MSOP No. 10.0. Any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery should be noted on the Visual Classification of Soils form. Clean area or stand (table) between samples.

5.2.11 Select sleeve(s) to be submitted for laboratory analysis. Sample sleeve selection should be based on four factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The project work plans will specify the sample sleeve to be submitted for specific analyses and confirm the selection criteria.

5.2.12 Place Teflon™ film over each end of sleeves to be submitted for chemical analysis and seal each end with plastic end caps. Place custody tape over each end cap so that any attempt to remove the cap will break the tape.

5.2.13 Appropriately label and number each sleeve to be submitted for analysis per MSOP No. 2.1 and 2.2, respectively. The label will be filled out using waterproof ink and will contain, at a minimum, the follow information:

MSOP NO. 3.1
REVISION NO. 0
October 2001

- Project number
- Boring number
- Sample number
- Bottom depth of sleeve
- Date and time of sample collection
- Parameters for analysis
- Sampler's initials.

5.2.14 Document the sampling event on the Field Logbook or an equivalent form as specified in the project work plans. At a minimum, this log will contain:

- Project name and number
- Date and time of the sampling event
- Drilling and sampling methods
- Sample number
- Sample location
- Boring number
- Sample depth
- Sample description
- Weather conditions
- Unusual events
- Signature or initials of the sampler.

5.2.15 Appropriately preserve, package, handle, and ship the sample in accordance with the procedures outlined in MSOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per MSOP No 1.1. Samples stored on-site will be subject to the provisions of MSOP No. 2.3.

5.2.16 One of the sample sleeves shall be utilized for lithologic logging per MSOP No. 10.0. This sleeve may not then be retained for chemical analysis, as soil must be removed from the sleeve to effectively describe the soils/lithology and compile the lithologic log.

5.2.17 When VOCs or petroleum hydrocarbons are of concern, remove the soil from one of the remaining sleeves and place in a glass mason jar (fill to one half volume of jar) and seal for organic vapor screening. Place the jar in a warm water bath or in the sunlight (warm) for at least five minutes, shake vigorously for one minute, then using an organic vapor probe (e.g., portable photoionization detector, flame ionization detector, or other appropriate instrument), monitor the soil for organic vapors. Record the reading on the Visual Classification of Soils form, the Field Logbook, and any other form(s) specified in the project work plans.

MSOP NO. 3.1
REVISION NO. 0
October 2001

5.2.18 Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample is collected.

5.3 Thin-walled or Shelby Tube Sampling

A thin-walled tube, or Shelby tube sampler may be used to collect relatively undisturbed soil samples. The procedure for collecting soil samples using a Shelby tube sampler should be outlined in the project work plans. The standard procedure is described below.

5.3.1 Calibrate all field analytical and health and safety monitoring equipment as discussed in Section 5.2.1.

5.3.2 Wear the appropriate personal protective equipment as described in Section 5.2.2.

5.3.3 Between each sampling location and prior to each sampling run, decontaminate the sampler and other sampling equipment as described in MSOP No. 6.0.

5.3.4 Advance the borehole to the desired depth or target horizon where the sampling run is to begin. While drilling, monitor the breathing zone according to the project work plans and applicable drilling method SOP.

5.3.5 Connect the sampling tube to the drill rod string and advance the tube to the bottom of the boring. The tube is then pushed about 2 to 2.5 feet into the soil with a continuous, rapid motion without impact or twisting.

5.3.6 Pull the drill rod strip up from the bottom of the borehole and remove the sampling tube from the string. Observe and record the amount of sample recovery and any associated problems as discussed in Section 5.2.11.

5.3.7 Place Teflon™ film over each end of the tube if it is to be submitted for chemical analysis and seal the ends with plastic end caps. Place custody tape over each end cap so that any attempt to remove the cap will break the tape. With a waterproof marker, write a "T" for top on the trailing end and a "B" for bottom on the leading end of the tube.

5.3.8 Appropriately label and number the tube as described in Section 5.2.14.

5.3.9 Document the sampling event on the Field Logbook as discussed in Section 5.2.15.

5.3.10 Appropriately preserve, package, handle, and ship the sample in accordance with the procedures outlined in MSOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per MSOP No. 1.1. Samples stored on-site will be subject to the provisions of MSOP 2.3.

MSOP NO. 3.1
REVISION NO. 0
October 2001

5.3.11 Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample is collected.

6 REQUIRED FORMS (ATTACHED)

6.1 Visual Classification of Soils Form

6.2 Chain of Custody

MSOP NO. 3.1
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 3.2
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
COMPOSITE SAMPLE PREPARATION

1 PURPOSE

This Standard Operating Procedure (SOP) describes the requirements for compositing techniques. Composite samples, regardless of the media, consist of two or more subsamples taken from a specific media and site at different depth intervals. The subsamples are collected and mixed. A single average sample is taken from the mixture.

The composite sampling will be used at sites where hand augered borings are to be performed. Composite samples are useful in estimating the overall contamination properties of a specific site. They are less expensive than non-composite samples because one sample for analysis represents many subsample locations. Composite samples do not provide detailed information of contamination variability as a function of the location.

2 REFERENCES

None.

3 DEFINITIONS/MATERIALS

The equipment required to obtain a composite sample is identical to that for primary media sampling.

4 RESPONSIBILITIES

4.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all composite sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.2 The Quality Assurance Officer is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of composite samples meet the requirements of the project Sample and Analysis Plan.

4.3 The Sampling Team Leader(s) assigned to composite soil sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

MSOP NO. 3.2
REVISION NO. 0
October 2001

5 PROCEDURE

5.1 Preparation

Site preparation for the purpose of composite sampling is not different from that required for any of the media/waste sampling activities.

5.2 Surface Soil Compositing

The following steps must be followed when compositing surface soil samples:

- Determine where composite sample(s) will be obtained as indicated in the site-specific sampling plan.
- Volatile organic compound (VOC) and, in some cases, semivolatile organic compound (SVOC) samples of solids (e.g., soils, sludge) must be collected and contained immediately as stand-alone samples and, therefore, <u>cannot</u> be composited.
- Collect a minimum of three equal-volume samples from the specific sample location. The volume of each sample must be at least the amount required for a single sample.
- Place the samples on an appropriate mixing tray. Thoroughly homogenize the pooled samples using the appropriate equipment.
- Transfer subsamples of the composite sample into the appropriate sample containers. Seal, decontaminate, and label sample containers. Use the same care in handling these samples as that used for other samples from the site.
- Document activities.
- Decontaminate sampling equipment.

5.3 Subsurface Soil Compositing

Compositing of subsurface soils refers to a single borehole in which several consecutively sampled depths are combined for a single sample. This is done to allow sufficient sample volume for the required analysis.

The following steps must be followed when compositing subsurface soil samples:

1. Determine where composite sample(s) will be obtained as indicated in the site-specific sampling plan.

2. Obtain samples by the methods:

    - For split-spoon or Shelby tube cores from a specified depth or range of depths:

MSOP NO. 3.2
REVISION NO. 0
October 2001

- Extract or extrude the sample from the split-spoon or Shelby tube onto an appropriate mixing tray, peel sample, and discard ends.
- Continue with the four-quarters mixing method.
- Document activities.
- Decontaminate sampling equipment.
- For hand auger samples:
- The sample is acquired directly from the withdrawn auger.
- Extract or extrude the sample from the bucket to an appropriate mixing tray.
- Continue with the four-quarters mixing method.
- Document activities.
- Decontaminate sampling equipment.

5.4 Surface Water Compositing

The following steps must be followed when compositing surface water samples:

- Determine where composite sample(s) will be obtained as detailed in the site-specific sampling plan.
- VOC and, in some cases, SVOC samples must be collected and contained immediately as stand-alone samples and, therefore, cannot be composited.
- Collect a minimum of three equal volume samples from the specified sample location. The volume of each sample must be at least the amount required for a single sample.
- Place the samples in the appropriate mixing container. Thoroughly homogenize the pooled samples using the appropriate equipment.
- Transfer aliquots of the composited sample into the appropriate sample containers. Seal, wipe clean, and label sample container. Handle with the same care as that used for other samples from the site.
- Document activities.
- Decontaminate sampling equipment.

5.5 Collection of Replicate Samples

The following steps must be followed when compositing ground water samples:

- Determine the well that a composite sample(s) will be obtained as detailed in the site-specific sampling plan.
- VOC and, in some cases, SVOC samples must be collected and contained immediately as stand-alone samples and, therefore, cannot be composited.
- Collect a minimum of three equal volume samples from the specified sample location. The volume of each sample must be at least the amount required for a single sample.

MSOP NO. 3.2
REVISION NO. 0
October 2001

- Place the samples in the appropriate mixing container. Thoroughly homogenize the pooled samples using the appropriate equipment.

- Transfer aliquots of the composited sample into the appropriate sample containers. Seal, wipe clean, and label sample container. Handle with the same care as that used for other samples from the site.
- Document activities.
- Decontaminate sampling equipment.

6 REQUIRED FORMS

None.

MSOP NO. 3.3
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
DUPLICATE, SPLIT, AND CO-LOCATED SAMPLE PREPARATION

1 PURPOSE

This Standard Operating Procedure (SOP) describes the requirements for the collection and preparation of duplicate, split, and/or co-located samples.
Duplicate, split, and co-located samples are typically obtained for either of two purposes: (1) as a means of quality control (QC) from the point of sample collection through all analytical processes (if the initial and duplicate samples are not within specification, the reasons for the discrepancy must be found and corrected, if possible), or (2) for later laboratory analyses, if needed. For MEVATEC Corporation projects, co-located or duplicate samples will be collected to provide information on the variability of the contaminants in the field.

Duplicate or co-located samples are samples collected from a location as close to the primary sample location as possible. They are collected to provide a means of assessing the reliability of field sampling methods and analytic data resulting from field samples.
Split samples are normally obtained for the express purpose of submitting identical samples to different laboratories for comparative analytical results. Duplicate, split, and co-located samples may be collected as composite or grab samples from most media or waste types.

The same equipment and techniques will be required when obtaining duplicate and/or split samples as for primary samples. Briefly, the sampling requirements are: (1) grab samples will be collected for surface soil, surface water, ground water, sediment, and sludge, destined for volatile organic compound (VOC) analysis, and, (2) composite or grab sampling techniques can be used for non-VOCs and for subsurface soils.

Comparative analyses between laboratories can also be obtained for semivolatile organic compounds and/or metals. Duplicate samples can also be obtained for VOC and non-VOC contaminated media by careful grab samples. For most duplicate, split, or co-locate sampling for non-VOC parameters, in all media, compositing is recommended.

2 REFERENCES

None.

3 DEFINITIONS/MATERIALS

The equipment necessary to obtain a duplicate, split, and/or co-located sample is identical to that for primary media sampling.

MSOP NO. 3.3
REVISION NO. 0
October 2001

4 RESPONSIBILITIES

4.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all duplicate, split, and co-located sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

4.2 The Quality Assurance Officer is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of duplicate and split samples meet the requirements of the project Quality Assurance Project Plan.

4.3 The Sampling Team Leader(s) assigned to duplicate, split, or co-located sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

5 PROCEDURE

5.1 Duplicate or Co-located Samples

The following steps must be followed when collecting duplicate or co-located samples:

1. Determine the frequency of obtaining duplicate samples as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point that a duplicate or co-located sample is required.
3. The duplicate or co-located sample is a sample taken at the same time, as close as possible, and under the exact conditions as those required for the primary sample. Note: any sample or portion of a sample that is to be analyzed for VOCs shall be collected and contained immediately. Do not stir, mix, or agitate samples for VOC analysis before containment.
4. Follow the specific media-sampling plan. The preparation and disposition of the duplicates will be the same as those for the primary samples.
5. Obtain VOC samples first (without mixing or compositing), then proceed to Step 6. Samples for VOCs must be collected and contained immediately. Agitation by mixing, stirring, or shaking will cause vaporization of the volatile fraction to a significant degree. Resample if agitation has occurred. Mix all non-VOC duplicate samples or when taking duplicates of surface water or ground water samples. Mixing may be accomplished by pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full.

6. Place the sample(s) in the appropriate sample container. Duplicate and co-located samples will be labeled or tagged according to their intended use as detailed in the site-specific sampling plan. If the sampling plan duplicates are to be held for possible later analyses, they may be labeled as "sample XXX duplicate", where the number "XXX" refers to the primary sample. If the duplicates are intended for QC measures, they may be given discrete sample numbers. Duplicate and co-located samples must be properly identified in the field logbook.
7. Seal, pack, and transport duplicate and co-located samples in the same manner as that used for other samples from the sampling site.
8. Decontaminate all equipment. Place all disposable liquids and solids in the appropriate receptacles.
9. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
10. Document activities.

5.2 Split Samples for Surface Soils, Sediments, and Sludges

The following steps must be followed when collecting split samples of surface soils, sediments, and sludges:

1. Determine the number and frequency of required sample splits as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media sampling procedure.

NOTE: Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Section 5.1 of the SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Section 5.1 of this SOP.

4. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
5. Composite these samples.
6. Split the composite sample equally and place the required volumes into the sample containers.
7. Seal and decontaminate the outside surfaces of the containers.
8. Label split samples as specified in the site-sampling plan. Record all pertinent information in the field logbook.
9. Split samples will have a separate chain of custody record.
10. Split samples will be sealed, packed, and transported in an identical manner as that specified for other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.

MSOP NO. 3.3
REVISION NO. 0
October 2001

11. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
12. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
13. Document activities.

5.3 Split, Duplicate, or Co-located Volatile Organic Compound Sampling of Subsurface Soils with Split-Spoons or Shelby Tubes

The following steps must be followed when sampling subsurface soils with split-spoons or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.

NOTE: Most split-spoon sampling in the field is accomplished with 2-inch outside diameter (OD) split-spoons. When split, duplicate, or co-located samples are required, a 2-inch OD split-spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the American Society for Testing Materials (ASTM) D-1584 modified method of split-spoon sampling and a 3-inch OD split-spoon. If blow counts are not required for engineering purposes, and the site soils permit, attempts may be made to drive the 3-inch split-spoon by the 140-lb. weight. This deviation will ensure collection of enough sample volume.

4. Upon retrieval of the split-spoon, the sample should be peeled and the ends discarded. Divide the sample into four sections (A, B, C, and D). Sample A should be immediately containerized and becomes the original sample for VOC analysis. Sample B is also immediately containerized and becomes the duplicate sample for VOC analyses. Section C and D can be composited for all other non-VOC analyses.
5. Decontaminate the outside of the sample container after sealing.
6. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
7. Split samples will have a separate chain of custody record.
8. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
9. Decontaminate all equipment. Place all disposables in the appropriate receptacles.

MSOP NO. 3.3
REVISION NO. 0
October 2001

10. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.

11. Document activities.

5.4 Split, Duplicate, or Co-located Non-Volatile Organic Compounds Sampling of Subsurface Soils with Split-Spoon or Shelby Tubs

The following steps must be followed when sampling subsurface soils with split-spoon or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.
4. Peel the sample and composite the sample.

NOTE: Most split-spoon sampling in the field is accomplished with 2-inch outside diameter (OD) split-spoons. When split, duplicate, or co-located samples are required, a 2-inch OD split-spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the American Society for Testing Materials (ASTM) D-1584 modified method of split-spoon sampling and to use a 3-inch OD split-spoon. If blow counts are not required for engineering purposes, and the site soils permit, attempts may be made to drive the 3-inch split-spoon by the 140-lb. weight. This deviation will ensure collection of enough sample volume.

5. Seal sample containers and wipe outside surfaces.
6. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
7. Split samples will have a separate chain of custody record.
8. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
9. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
10. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
11. Document activities.

MSOP NO. 3.3
REVISION NO. 0
October 2001

5.5 Split Samples for Surface Water and Ground Water

The following steps must be followed when collecting split samples for surface water and ground water:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.
4. Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Section 5.1 of this SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Section 5.1 of this SOP.
5. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
6. Obtain VOC samples first (without mixing or compositing). Samples for VOCs must be collected and contained immediately. Agitation by mixing, stirring, or shaking will cause vaporization of the volatile fraction to a significant degree. Resample if agitation has occurred. Mix all non-VOC duplicate samples or when taking duplicates of surface water of ground water samples. Pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full will accomplish mixing.
7. Split the composited sample by placing the required volumes in the sample containers, including those for split samples.
8. Seal sample containers and wipe outside surfaces.
9. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
10. Split samples will have a separate chain of custody record.
11. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
12. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
13. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
14. Document activities.

6 Required Forms (Attached)

6.1 Chain of Custody Record

MSOP NO. 4.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
CALIBRATION AND MAINTENANCE OF MEASURING AND TEST EQUIPMENT

1 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities associated with the calibration, control, and maintenance of measuring and test equipment (M&TE). It applies to all tools, gauges, instruments, and other test equipment where the manufacturer requires or recommends equipment accuracy to be checked periodically. In the case of commercial devices such as rulers, tape measures, and levels calibration controls will not be required.

2 REFERENCES

None

3 RESPONSIBILITIES

3.1 The Quality Assurance Officer or his/her designee is responsible for monitoring the effective implementation of this SOP and/or the M&TE manufacturer's recommendations.

3.2 The Project Technical Manager, Technical Coordinator, and Sampling Team Leader(s) are responsible for the selection of M&TE to be used in the field activity and to assure it is of the proper type, range, accuracy and tolerance required to meet project objectives. Additionally, they are responsible for storage and protection of M&TE.

3.3 The field personnel performing tests are responsible for assuring that all M&TE is properly calibrated prior to and during use, and for documenting the calibration or deficiencies of equipment.

4 DEFINITIONS

4.1 M&TE

Measuring and test equipment used to obtain data during the performance of tests or inspections.

4.2 Calibration

The comparison of a measurement standard or instrument of a known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the items being compared within allowable deviations.

MSOP NO. 4.0
REVISION NO. 0
October 2001

4.3 Reference Standard

An item of known and verifiable value that is used to check or establish the basis for tests or inspections.

5 PROCEDURE

5.1 Equipment Identification and Control

5.1.1 M&TE that requires calibration will be uniquely identified by the manufacturer's serial number, or other suitable assigned number. If this should prove to be impractical, an identification label will be affixed using materials and methods that provide a clear and legible identification and do not detrimentally affect the function or service life of the M&TE. This identification will be replaced as needed to provide clear identification of the M&TE.

5.1.2 All M&TE and reference standards shall be stored between uses in a manner that will minimize damage or deterioration.

5.2 Calibration

5.2.1 Written and approved procedures will be used for calibration of M&TE. Calibration procedures that have been previously established and approved by the M&TE manufacturer or a nationally recognized authority (i.e., ASTM, EPA) will be used when available. If no preexisting procedure is available, procedures will be developed by qualified personnel familiar with the M&TE and approved by the Project Technical Manager and the Quality Assurance Officer. Development of procedures will take into consideration the intended use and objective of the resulting data, equipment characteristics, required accuracy and precision of data, location of examination, effects of climate or any other parameter that would adversely influence the calibration. The procedures will include, as applicable:

- Name/type of equipment to be calibrated
- Reference standards to be used
- Calibration method and sequential actions
- Acceptance criteria
- Frequency of calibrations/checks
- Data recording form/format
- Data processing methodology
- Any special instructions
- Operator training and qualification requirements.

MSOP NO. 4.0
REVISION NO. 0
October 2001

5.2.2 Field M&TE will be calibrated prior to use. Calibrations of M&TE will be performed by trained and qualified personnel, approved external agencies or by the equipment manufacturer.

5.2.3 The following types of calibrations and checks will be performed by qualified personnel:

- Periodic calibrations - are performed at prescribed intervals established for the M&TE to assure that the equipment is operating within its designed range and accuracy. These are usually performed by outside agencies or the M&TE manufacturer. A calibration certificate will be provided documenting the operational and functional acceptance of the M&TE.
- Specific calibrations - are performed for specific measurements or tests and vary from instrument to instrument and from procedure to procedure. Specific calibrations are performed prior to start of each work shift.

5.3 Calibration Frequency

5.3.1 M&TE will be calibrated at prescribed intervals and before each specific use. The frequency of periodic calibrations will be based on manufacturer's recommendations, national standards of practice, equipment type and characteristics, and past experience.

5.3.2 A scheduled calibration of M&TE does not relieve the user of the responsibility for selecting the appropriate and properly functioning equipment.

5.3.3 In the event that the calibration has expired, the M&TE will be removed from service and tagged as "out-of-service" in order to prevent inadvertent use until it has been appropriately recalibrated.

5.4 Reference Standards and Equipment

5.4.1 Calibration reference standards and equipment will have known relationships to the National Institute of Standards and Technology (NIST) or other nationally recognized standards. If a national standard does not exist, the basis for calibration will be fully documented by the Project Technical Manager and approved by the Quality Assurance Officer.

5.4.2 Physical and chemical standards will have certifications traceable to NIST, EPA or other recognized agencies. Standards that are repackaged or split will also have traceable lot or batch numbers transferred onto the new container.

5.4.3 It is the responsibility of the user to select, verify and use the correct standard in accordance with an approved procedure or established practice.

5.5 Calibration Failure

MSOP NO. 4.0
REVISION NO. 0
October 2001

5.5.1 Each individual user of M&TE is responsible for checking the calibration status of equipment to be used and confirming the acceptable calibration status prior to use. Equipment for which the periodic calibration period has expired, equipment that fails calibration, or equipment that becomes inoperable during use will be removed from service and tagged as out-of-service.

5.5.2 Out-of-service M&TE will be segregated from operational M&TE when practical. The specific reason for removal from service and the date of removal will also be stated on the out-of-service tag. The M&TE will then be repaired and/or recalibrated by the appropriate vendor or manufacturer as deemed necessary by the Project Technical Manager. M&TE that cannot be repaired will be replaced, as necessary, to provide support to the project. Any M&TE consistently found to be out-of-calibration would be replaced.

5.5.3 The Project Technical Manager and the Quality Assurance Officer will evaluate results of activities performed using equipment that has failed recalibration. If the activity results are adversely affected, the results of the evaluation will be documented as a nonconformance.

5.6 Calibration Documentation

5.6.1 Specific calibration records will be prepared and documented for each calibrated M&TE used. Periodic calibration certificates will be maintained and available for review at the field office. Calibration data will be recorded on the Field Logbook or other suitable form. The Project Technical Manager will be responsible for reviewing the calibration data for appropriateness, accuracy, readability, and completeness.

5.6.2 Calibration records will include, as applicable, the following information:

- Equipment identification number
- Calibration procedure used
- Date/time of calibration
- Time of calibration checks (if required)
- Identification of reference standard(s) used
- Applicable responses or readings of calibration
- Name of individual performing calibration
- Item(s) that are being tested or inspected.

5.7 Preventive Maintenance

5.7.1 Preventive maintenance of M&TE will be performed in accordance with the manufacturers' recommendations to maintain proper M&TE performance, minimize equipment failure and to increase measurement reliability.

MSOP NO. 4.0
REVISION NO. 0
October 2001

6 REQUIRED FORMS

6.1 None

MSOP NO. 4.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 4.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
FIELD INSTRUMENT QA/QC

1 PURPOSE

This Standard Operating Procedure (SOP) defines field requirements for quality assurance/quality control (QA/QC), for equipment and instrument calibration, inspection, and maintenance. Instruments and equipment used to gather, generate, or measure environmental data must be calibrated to ensure that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Equipment, instruments, tools, gauges, and other items requiring preventive maintenance must be serviced according to the manufacturer's specifications. Raw data from the field measurements and sample collection activities must be recorded in the appropriate logbook or field form, and standard reporting units must be used for comparability and consistency.

2 REFERENCES

2.1 EPA, September 1987, <u>EPA Compendium of Superfund Field Operations Methods</u>, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, <u>EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA</u>, Interim Final OSWER Directive 9355.3-01

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the calibration of field instrumentation. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requesting corrective actions.

3.3 The Health and Safety Officer is responsible for ensuring that calibration is completed daily in accordance with this procedure, that equipment and instrument inspection and maintenance is conducted, that measurements are taken to the specified accuracy. The Health and Safety Officer is also responsible for validation of field data by:

- Conducting routine checks during the processing of data (e.g. errors in identification codes);

MSOP NO. 4.1
REVISION NO. 0
October 2001

- Checking the consistency with parallel data sets obtained presumably from the same population (e.g., from the same portion of the aquifer or volume of soil).

3.4 The Sampling Team Leader(s) is responsible for calibrating, inspecting, and maintaining instruments, and for taking measurements to the specified precision.

4 DEFINITIONS/MATERIALS

3.5 Instruments (to be calibrated, and manufacturer's operating manual)

- pH Meter
- Conductivity meter
- Turbidity meter
- Photoionization detector
- Thermometer
- Water level measurement device
- Magnetometer
- Gas chromatograph, equipped with FID and PID (for soil sampling)

3.6 Other:

- Maintenance schedule.
- Field logbook.
- Indelible black ink pens.

5 PROCEDURE

5.2 Equipment and Instrument Calibration

The frequency of calibration for field instruments will be performed at the intervals specified by the manufacturer or more frequently as conditions dictate, but daily as a minimum. Field instruments will include a pH meter, thermometer, conductivity meter, organic vapor photoionization detector (PID), magnetometer, and a radioactivity meter. Calibration will be documented on the Field Logbook.

The manufacturer's guide will be followed when calibrating the pH meter, thermometer, conductivity meter, organic vapor photoionization detector (PID), magnetometer, and radioactivity meter

To ensure comparability between sample data of similar samples and sample conditions, standard solutions and material traceable to the National Institute of Standards and Technology or EPA-published standards/protocols will be used to calibrate the field instruments.

MSOP NO. 4.1
REVISION NO. 0
October 2001

5.2.1 Equipment and Instrument Inspection and Maintenance

5.2.2 Equipment and Instrument Inspection

Equipment to be used during field sampling will be examined to ensure that it is in proper operating condition. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes for previous sampling trips will be reviewed so that the notations on any prior equipment problem are not overlooked and all necessary repairs to equipment have been carried out.

5.2.3 Equipment and Instrument Maintenance

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's recommendations. Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to the maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, gauges, etc. will be performed by qualified personnel. In the absence of any manufacturer's recommended maintenance criteria, the operator based upon experience and previous use of the equipment, will develop a maintenance procedure.

5.3 Field Measurement Precision

For the pH meter and the conductivity meter, precision will be tested by multiple readings in the medium of concern. Consecutive readings should agree within ±0.1 standard units pH and ±0.01 ohms/cm conductivity. The thermometer will be visually inspected prior to each use. The photoionization detector probe will be exposed to a volatile organic compound source prior to field use in order to determine if the instrument is working. Water level indicator readings will be precise within ±0.01 feet for duplicate measurements.

The following standard reporting units will be used during all phases of the project:

- Water levels measured in wells will be reported to the nearest 0.01-foot.
- Soil sampling depths will be reported to the nearest 0.1-foot.
- Soil gas results will be reported to two significant figures.

6 REQUIRED FORMS

6.2 Field Logbook

MSOP NO. 4.1
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 5.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
WATER LEVEL MEASUREMENTS IN MONITORING WELLS

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for personnel to use in determining the depth to water in monitoring wells.

2 REFERENCES

2.1 EPA, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Government Printing Office, Washington, D.C.

2.2 EPA, 1991, Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual, Region IV, Environmental Services Division, Athens, Georgia, U.S. Government Printing Office, Washington, D.C.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for the periodic review of documentation generated as a result of this SOP and the periodic review and audit of field personnel as they perform the work. If problems arise, the Quality Assurance Officer is also responsible for verifying implementation of corrective action(s) (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, and issuing nonconformances) and assuring through monitoring the continued implementation of stated corrective actions.

3.3 The Sampling Team Leader(s) is responsible for ensuring that monitoring well water level measurements are properly collected and documented.

4 DEFINITIONS/MATERIALS

A number of devices are available for the determination of water level measurements in monitoring wells. Those most commonly used and covered in this SOP includes steel tapes, electric sounders, and petroleum product probes. The equipment must be capable of recording a measurement to the accuracy required by the project plans.

MSOP NO. 5.0
REVISION NO. 0
October 2001

5 PROCEDURE

Water level measurements are commonly taken in each monitoring well immediately prior to, during, and following well development, and both before and after well purging and sampling. Water level measurements may also be taken where no development or purging is being conducted, strictly to monitor or generate water table or piezometric surfaces. When such measurements are made to monitor water table or piezometric surfaces, water levels in all wells at a given site should be measured within a 24-hour maximum period whenever possible. When measuring wells for water for water table or potentiometric surface analysis, and if the contaminant history is known for each of the wells, it is advisable to monitor water levels beginning with the least contaminated wells first and progressing to the most contaminated wells last.

5.1 Equipment Selection

Project data quality objectives and site characteristics must be taken into account when determining the water level measurement equipment to use. The total number of wells to be measured, weather, tidal influences, pumping, and construction can all affect water level measurements. The project-specific work plans will identify the specific equipment to be used.

5.2 Determining Water Level Measurements in Monitoring Wells

The standard procedure for determining depth to water is described below.

5.2.1 Calibrate all measuring devices according to the manufacturer's specifications. Measuring tapes should be checked a minimum of every six months against a surveyor's tape to determine if shrinking or stretching has occurred.

5.2.2 Prior to taking a water level measurement at each well, decontaminate the measuring device according to the procedures outlined in MSOP 6.0. During decontamination, all measuring tapes should be inspected for kinks, cracks, or tears and, if present, repaired or replaced with undamaged equipment.

5.2.3 Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the well head should be noted on the Field Logbook and the site superintendent notified for repair or replacement of the equipment.

5.2.4 Uncap the well and monitor the air space immediately above the open casing per the project-specific Health and Safety Plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Field Logbook. Lower the electric sounder or equivalent (product probe or steel tape) into the well until the water surface is encountered. If air is observed to be entering flowing out of the casing, the sounder should not be placed inside the well until the air flow stops and pressure equalizes.

MSOP NO. 5.0
REVISION NO. 0
October 2001

5.2.5 Measure the distance from the water surface to the permanent reference point. For above ground "stickup" completions, the reference point is usually a groove cut into the north side of the casing. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the Field Logbook. For flush mount completions, such as street boxes, the water level measurement should be referenced to a steel rate placed across the rim of the street box and over the casing. Any aboveground completions without permanent reference points or marks should be brought to the attention of the appropriate supervisory personnel per the project-specific work plans.

5.2.6 Collect measurements until two consecutive measurements are identical or within the specified tolerance of the project-specific work plan (usually 0.01 ft). Record all appropriate information on the Field Logbook. At a minimum, the following information must be recorded:

- project name and number;
- unique well identification number;
- date and time of measurement collection;
- depth to water to the specified tolerance;
- weather conditions; and
- any problems encountered.

5.2.7 If product or other nonaqueous liquid is encountered, follow the procedures outlined in MSOP 5.1.

5.2.8 Cap and relock the well.

6 REQUIRED FORMS

6.1 Field Logbook

MSOP NO. 5.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 5.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
NONAQUEOUS PHASE LIQUID MEASUREMENTS IN MONITORING WELLS

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for field personnel to use in determining the thickness of nonaqueous phase liquid in monitoring wells. The details within this SOP should also be used in conjunction with project work plans.

2 REFERENCES

2.1 EPA, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Government Printing Office, Washington, D.C.

2.2 EPA, 1991, Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual, Region IV, Environmental Services Division, Athens, Georgia, U.S. Government Printing Office, Washington, D.C.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all nonaqueous phase liquid in monitoring wells is properly measured and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for the periodic review of documentation associated with this SOP and the periodic review and audit of field personnel as they perform the work. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformance and requests for corrective action.

3.3 The Sampling Team Leader(s) is responsible for the proper measurement and documentation of the nonaqueous phase liquid measurement in monitoring wells.

4 DEFINITIONS/MATERIALS

4.1 Product

For the purposes of this procedure, product refers to liquid that is petroleum based (e.g., gasoline, diesel, or petroleum byproducts) or chlorinated hydrocarbon based (e.g., trichloroethene, tetrachloroethene, etc.).

MSOP NO. 5.1
REVISION NO. 0
October 2001

4.2 Two types of equipment used to measure nonaqueous phase liquids (NAPLs) in monitoring wells: product probes and clear bailers. The type of equipment used will be determined on a project specific basis and identified in the Field Sampling Plan.

5 PROCEDURE

5.1 Equipment Selection

5.1.1 This procedure addresses the operation of two types of equipment used to measure nonaqueous phase liquids (NAPLs) in monitoring wells: product probes and clear bailers. Clear bailers include both single- and double-check valve bailers. Single check valve bailers can only be used for measuring light nonaqueous phase liquids (LNAPLs) or floating products. Double check valve bailers can be used for measuring both LNAPLs and dense nonaqueous phase liquids (DNAPLs) or sinking product. The equipment must be capable of recording a measurement to an accuracy of 0.01 foot.

5.1.2 Several problems can arise in measuring product thickness with either product probes or clear bailers. Product probes can malfunction, particularly when measuring degraded or weathered product that sticks to the probe sensors. When the thickness of the product layer in a well is greater than the length of the bailer, the product layer cannot be accurately measured with the bailer. Consequently, it is recommended that both methods be used (one to check the other) to measure product thicknesses in wells. The project work plans will identify the specific equipment to be used.

5.2 Product Probe Procedure

5.2.1 The product probe, sometimes called an immiscible layer probe, is a device that can detect the presence of both LNAPLs and DNAPLs (both "floating" and "sinking" layers) in water wells. The device detects the difference in conductivity or specific gravity between the aqueous and nonaqueous phases in the well. The device is generally a probe connected to a measuring tape with a reel. The device contains a receiver with an audio and/or visual signal that indicates when phase changes occur. The standard procedure for using a petroleum product probe is described below.

5.2.2 Check the accuracy of the measuring tape of the petroleum product probe according to the manufacturer's specifications. Measuring tapes should be checked at least every six months against a surveyor's tape to determine if shrinking or stretching has occurred.

5.2.3 Prior to taking a measurement and between wells, decontaminate the probe and tape measure according to the procedures outlined in MSOP 6.0. It is extremely important to conduct thorough decontamination to prevent cross-contamination between wells. During decontamination, all measuring tapes should be inspected for kinks, cracks, or tears and, if present, repaired or replaced with undamaged equipment.

MSOP NO. 5.1
REVISION NO. 0
October 2001

5.2.4 Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the wellhead should be noted on the Field Activity Daily Log and notify the site superintendent per the project work plans.

5.2.5 Uncap the well and monitor the air space immediately above the open casing per the Project Health and Safety Plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Field Logbook. If air is observed to be flowing into or out of the casing, the probe should not be placed inside the well until the airflow stops and pressure equalizes. Lower the probe into the well until the liquid surface is encountered. Continue lowering the probe, recording the depths at which any audio or visual changes in the device indicate a phase change. When measuring for DNAPL, continue lowering the probe to the bottom of the well. When measuring for LNAPL, there is no need to lower the probe further once the product/water interface is encountered and measured.

5.2.6 While lowering the probe, measure the distances to the encountered phase/phases from the permanent reference point. For aboveground "stick-up" completions, the reference point is usually a groove cut into the north side of the casing. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the Field Logbook and the appropriate form on which the water level is recorded.

5.2.7 For flush mount completions, such as street boxes, the water level measurement should be referenced to a steel rule placed across the rim of the street box and over the casing. Any aboveground completions without permanent reference points or marks should be brought to the attention of the site supervisor per the project work plans.

5.2.8 Collect measurements until two consecutive measurements are identical or within tolerances specified in the project work plans. Record all appropriate information on the field Logbook. At a minimum, the following information must be recorded:

- project name and number;
- well identification number;
- date and time of measurement collection;
- depth to water to the specified tolerance;
- depth to and description of any nonaqueous phase liquid encountered;
- weather conditions; and
- comments, including any problems encountered.

5.2.9 Cap and relock the well.

5.3 Bailer Procedure

MSOP NO. 5.1
REVISION NO. 0
October 2001

5.3.1 A single check-valve bailer is a cylindrical tube, open at the top and containing a floating ball at the bottom. Lowering the bailer into liquid allows the bottom ball to float allowing floating product or water to enter the bailer. The design of this type of bailer only allows collection of a floating product (LNAPL) sample.

5.3.2 A double check-valve bailer is an enclosed cylindrical tube containing a floating ball at both the top and the bottom. Lowering the bailer into liquid causes both balls to float allowing water or product to enter the cylinder. Raising the bailer through the water causes both balls to settle, effectively trapping a discrete section of the water so that it can be brought to the surface. Since the double check-valve bailer is capable of collecting a discrete sample at any depth within the well, it can be used on both "floating" and "sinking" nonaqueous liquids.

5.3.3 The bailers must be constructed of clear material so that any product can be visibly measured. Some are also available with graduated markings on the side to allow easier measurement. Bailers are commonly used with a thin nylon line or cord made of similar material. Some are supplied with a connectable measuring tape. The standard procedure for using bailers to measure nonaqueous phase liquids in monitoring wells is described below.

5.3.4 Check the accuracy of the measuring tape to be used with the bailer according to the manufacturer's specifications. Measuring tapes should be checked a minimum of every six months against a surveyor's tape to determine if shrinking or stretching has occurred.

5.3.5 Prior to taking a measurement and between wells, decontaminate the bailer and tape measure according to the procedures outlined in MSOP 6.0, Sampling Equipment and Well Material Decontamination. If a bailer line is used, it is advised to slip, cut, and dispose of any line that was used inside a previous well and then decontaminate the remaining line. Bailers used for product sampling should never be used for purging or collecting water samples.

5.3.6 If product probe measurements are to be used in conjunction with a bailer, the probe measurements should first be made, recorded, and noted by field personnel taking the measurements.

5.3.7 If bailer measurements are to be taken before or without product probe measurements, visually inspect and document wellhead conditions per Section 5.2.4 above. Uncap the well and monitor and observe the well head per Section 5.2.5 above.

5.3.8 Lower the bailer into the well until the liquid surface is encountered. Use the measuring tape if available to determine the depth to which the bailer should be lowered to recover either the LNAPL or DNAPL product.

If using bailer cord and attempting to recover DNAPL ("sinking") product, a double check-valve bailer may simply be run to the bottom of the well. If attempting to recover LNAPL ("floating") product using bailer cord, it is advisable to first note the depths to product and water made with the product probe and mark the depths on the bailer cord with a rubber band or twine. The bailer (either single or double check-valve) should then be lowered such that the bailer retrieves product layer, thereby retrieving only water. If no product probe measurements are available, the person attempting to retrieve the bailer product sample will then have to "feel" for first contact with the liquid while the bailer is descending inside the well. Once the contact is felt, the bailer descent should be halted. The bailer should then be slowly lowered no more than ¾ of its total length to avoid overtopping. Retrieve the bailer and visually inspect for product. Measure the amount of product contained in the bailer with the measuring tape. Note any appropriate conditions observed in the bailer such as:

- Color and clarity of the product
- Length of product column in bailer compared to overall length of bailer
- Evidence of any problems with the bailer valves
- Evidence of overtopping or complete run through the product column.

5.3.9 Record all appropriate information on the Field Logbook. At a minimum, the following information must be recorded:

- project name and number;
- well identification number;
- date and time of measurement collection;
- depth to water if available to the appropriate tolerance specified in the project work plans;
- measurement and description of any nonaqueous phase liquid encountered;
- any observations made in 5.2.5 above; and
- comments, including any problems encountered.

5.3.10 Cap and relock the well.

6 REQUIRED FORMS

6.1.1 Field Logbook

MSOP NO. 5.1
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 6.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
FIELD EQUIPMENT DECONTAMINATION

1 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures required for decontamination of field equipment. Decontamination of field equipment is necessary to ensure the quality of samples by preventing cross-contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site.

2 REFERENCES

2.1 EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Project Chemist is responsible for ensuring that field personnel are trained in the use of this procedure and that decontamination is conducted in accordance with this procedure.

3.3 The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling and heavy equipment. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform the three phases of inspections and continuous monitoring of the decontamination activities.

3.4 The Sampling Team Leader(s) is responsible for verifying that this procedure is correctly implemented. The Sampling Team Leader may also be required to collect and document rinsate samples to provide quantitative verification that these procedures have been correctly implemented. This SOP and the project work plans should be reviewed before implementing decontamination procedures at the project field area.

MSOP NO. 6.0
REVISION NO. 0
October 2001

4 DEFINITIONS/MATERIALS

4.1 Deionized Analyte-Free Water

Ion-free, analyte-free water produced on site or purchased from a supplier with a deionization chamber equipped with a carbon filter.

4.2 Potable Water

Treated municipal water.

4.3 Laboratory Grade Detergent

A standard brand of laboratory-grade detergent, such as "Liquinox".

4.4 Methanol

Laboratory-grade methyl alcohol, CAS #67-56-1.

4.5 Hexane

Laboratory-grade hexane, CAS #110-54-3.

4.6 HPLC Water

High purity laboratory-grade water.

4.7 Non-sampling Equipment

Non-sampling equipment includes:

- Field logbook.
- Drilling rigs, backhoes, augers, drill pipe, bits, casing, and screen.
- High-pressure pump soap dispenser or steam-spray unit.
- 2- to 5-gal manual-pump sprayer (pump sprayer material must be compatible with the solution used).
- Stiff-bristle brushes.
- Gloves, goggles, boots, and other protective clothing as specified in the site-specific Health and Safety Plan.

4.8 Small Equipment

Small equipment includes:

- Split spoons, bailers, bowls, and filtration equipment
- 5-gal plastic buckets
- Laboratory-grade detergent (phosphate free)
- Stiff-bristle brushes
- Nalgene or Teflon, sprayers or wash bottles or 2- to 5-gal manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes or rags
- Potable water
- Appropriate decontamination solutions
- Gloves, goggles, and other protective clothing as specified in the site-specific Health and Safety Plan

4.9 Pumps and Pump Assemblies

The required pumps and pump assemblies include:

- Three or more empty 30-40 gallon containers
- Plastic sheeting
- 5-gal (or larger) containers of potable water and other required decontamination solutions
- Disposable wipes or rags
- Gloves, goggles, and other protective clothing as specified in the site-specific Health and Safety Plan.

5 PROCEDURES

This section contains responsibilities, requirements, and procedures for sampling equipment and well material decontamination. The decontamination is required in order to maintain proper quality and integrity of collected samples.

The details within this SOP should be used in conjunction with the project work plans. The project work plans will provide the following information:

- Types of equipment requiring decontamination under this SOP;
- Specific materials to be used for the decontamination; and
- Additional decontamination requirements and procedures beyond those covered in this SOP, as necessary.

All field personnel associated with decontamination of sampling equipment or well materials must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all drilling and heavy equipment is provided in MSOP No. 6.1.

MSOP NO. 6.0
REVISION NO. 0
October 2001

5.1 Decontamination Facility

If possible, sampling equipment decontamination will take place in an area designed exclusively for decontamination. This area will ideally be located within the contamination reduction zone on the project site. Well materials may be decontaminated at the facility set up for decontamination of drilling and heavy equipment (see MSOP No. 6.1).

Each decontamination facility will be constructed so that the equipment, as well as all wastes generated during decontamination (e.g.: soil, rinsate, liquid spray, debris, etc.), are fully contained. In addition, chemical products used in the decontamination process must be properly containerized and labeled.

5.2 Decontamination of Non-dedicated Sampling Equipment

Each piece of reusable, small or non-dedicated sampling equipment will be decontaminated before mobilization to each site and before each sampling event. The standard procedure will be performed as described below.

5.2.1 All personnel involved with the task must wear suitable personal protective equipment to reduce personal exposure (specified by the project work plans).

5.2.2 Heavily caked soil and/or other material will be scraped or brushed from equipment. The scrapings will be placed into an appropriate container for disposal. Steam cleaning of equipment may be required to remove material from samplers.

5.2.3 Equipment that will not be damaged by water should be placed into a wash tub containing a laboratory-grade detergent solution and scrubbed with a brush or clean cloth. Rinsing will then be conducted with fresh, potable water, followed by deionized water.

5.2.4 Methanol, hexane, and HPLC water rinses may then follow for some sampler components when specified by the project work plans.

5.2.5 Any equipment that may be damaged by submersion into water will be wiped clean using a sponge and detergent solution. Wiping the equipment with deionized water will follow cleaning.

5.2.6 Air-dry the rinsed equipment. Soil organic vapor sampling equipment should be flushed dry with bottled air of known quality and/or as per the project work plans.

5.2.7 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

MSOP NO. 6.0
REVISION NO. 0
October 2001

5.2.8 Decontamination activities shall be documented on the Field Logbook.

5.3 Decontamination of Dedicated Sampling Equipment

Dedicated sampling equipment, such as submersible pumps, will be decontaminated prior to installation inside monitoring wells. At a minimum, the procedure outlined below must be performed. If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary provided that laboratory certification of decontamination is submitted with the equipment.

5.3.1 All personnel involved in the task will wear suitable personal protective equipment in accordance with the project work plans.

5.3.2 Foot valve and pumping lines will be washed with a laboratory-grade detergent solution.

5.3.3 The equipment will then be rinsed twice with tap water, followed by a rinse with deionized water.

5.3.4 Air dry.

5.3.5 Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

5.3.6 Decontamination activities will be documented on the Field Logbook.

5.4 Decontamination of Well Materials

Well materials including well casing, well screens, centralizers, and end caps will be decontaminated prior to use in constructing monitoring wells. (If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary provided that laboratory decontamination certification is submitted with the equipment.) The standard procedure outlined below must be performed when decontaminating well materials.

5.4.1 All personnel involved in the task will wear appropriate personal protective equipment in accordance with the project work plans.

5.4.2 Materials will be thoroughly sprayed and washed with water using a high-pressure steam cleaner.

5.4.3 Air dry.

MSOP NO. 6.0
REVISION NO. 0
October 2001

5.4.4 Decontaminated materials will be placed on clean metal racks or clean plastic sheeting. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

5.4.5 Decontamination activities will be documented on the Facility Logbook.

5.5 Pump Decontamination

The following steps must be followed when decontaminating pumps:

5.5.1 Set up decontamination area and separate clean storage area using plastic sheeting to cover the ground, tables, and other porous surfaces. Set up three 30-40 gallon containers in a triangle. The two containers at the base of the triangle will be used to contain dilute (non-foaming) soapy water and potable water. The drum at the apex will receive wastewater. Place 5-gal cans of potable water adjacent to the water container on the same side as the potable water container.

5.5.2 Pump should be set up in the same configuration as for sampling. Submerge pump intake (or pump if submersible) and all downhole wetted parts (tubing, piping, foot valve) in soapy water of the first container. Place the discharge outlet in the waste container above the level of wastewater.

Pump soapy water through the pump assembly until it discharges to the waste container.

5.5.3 Move pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.

5.5.4 Decontaminate the discharge outlet by hand following the steps outlined in Section 5.2. part 2 of this SOP.

5.5.5 Remove the decontaminated pump assembly to the clean area and allow to air dry. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.

5.5.6 Record the equipment type and identification, and the date, time, and method of decontamination in the appropriate logbook.

5.6 Waste Disposal

The following steps must be followed when disposing of wastes:

5.6.1 All wash water and rinse water that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste unless other arrangements are approved in advance.

5.6.2 Small quantities of decontamination solutions may be allowed to evaporate.

5.6.3 If large quantities of used decontamination solutions are generated, segregate each type of waste in separate containers. This may permit the disposal of wash water and rinse water in a sanitary sewage treatment plant rather than as a hazardous waste.

5.6.4 Unless required, plastic sheeting and disposable protective clothing may be treated as a solid non-hazardous waste.

6 REQUIRED FORMS

6.1 Field Logbook.

MSOP NO. 6.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 6.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
DRILLING, DEVELOPMENT, AND HEAVY EQUIPMENT DECONTAMINATION

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling and heavy equipment decontamination, and should also be used in conjunction with project work plans.

2 REFERENCES

2.1 EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator have the responsibility for ensuring that the decontamination of drilling and heavy equipment is properly performed through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling and heavy equipment. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform the three phases of inspections and continuous monitoring of the decontamination activities.

3.3 The Sampling Team Leader(s) assigned to drilling, development, trenching, or construction activities are responsible for ensuring that subcontractors or equipment operators properly decontaminate the drilling, development, and heavy equipment associated with those tasks. The project staff are also responsible for documenting the decontamination activities on the Field Logbook.

This SOP and the project work plans should be reviewed before implementing decontamination procedures at the project field area.

MSOP NO. 6.1
REVISION NO. 0
October 2001

4 DEFINITIONS/MATERIALS

4.1 Laboratory Grade Detergent –
A standard brand of laboratory-grade detergent, such as "Liquinox".

4.2 Potable Water –
Water dispensed from a municipal water system.

5 PROCEDURE

5.1 General

5.1.1 This section provides requirements for the set up of a decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The project work plans will provide specific information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;
- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and
- Types of materials and additional details on the procedures to be used in the decontamination process.

5.1.2 All field personnel associated with either the fabrication of the decontamination station or the decontamination of drilling or heavy equipment must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all equipment used specifically for sampling is presented in MSOP 6.0.

5.2 Decontamination Facility

5.2.1 A decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and/or heavy equipment. The location of the decontamination station will be specified in the project work plans. All decontamination of drilling, development, and heavy equipment will be conducted within the station.

5.2.2 At a minimum, the station will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are fully contained and may be collected for appropriate waste management and disposal. The station may be as simple as a bermed, impermeable polyethylene sheeting, of sufficient thickness, with an impermeable sump for collecting rinse water. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements.

MSOP NO. 6.1
REVISION NO. 0
October 2001

These requirements along with specific equipment and construction specifications for the decontamination station will be provided in the project work plans.

5.3 Decontamination of Downhole Equipment

5.3.1 All downhole drilling and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, bailers, etc.) will be thoroughly decontaminated before mobilization onto each site and between borings or wells at each site or as required in the project work plans. The standard procedure will be performed as described below. Decontamination will be performed in accordance with this SOP and the project work plans.

5.3.2 All personnel involved with the task must wear appropriate personal protective equipment to limit personal exposure (as specified in the project work plans).

5.3.3 Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed. The scrapings will be containerized and appropriately disposed.

5.3.4 Equipment will then be sprayed with potable water using a hot water, high-pressure washer.

5.3.5 Washed equipment will then be rinsed with potable water.

5.3.6 Decontaminated downhole equipment (such as drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize airborne contamination.

5.3.7 Decontamination activities will be documented by the Sampling Team Leader, lead geologist, or lead engineer on the Field Logbook.

5.4 Decontamination of Heavy Equipment

5.4.1 Heavy equipment (e.g., drill rigs, development rigs, backhoes, and other earthmoving equipment) will be decontaminated between drilling sites or inside the contaminant reduction area prior to entering and leaving an exclusion zone. Decontamination will be performed in accordance with the project work plans. The standard procedure will be performed as described below.

5.4.1.1 All personnel involved in the task will wear appropriate personal protective equipment in order to limit personal exposure (as specified in the project work plans).

5.4.1.2 Equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed. The scrapings will be containerized and appropriately disposed.

5.4.1.3 Equipment will then be sprayed with potable water using a hot water, high-pressure washer.

5.4.1.4 Clean equipment will then be rinsed with potable water.

5.4.2 During the decontamination effort, fluid systems should be inspected for any leaks or problems that might potentially result in an inadvertent release at the site, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented on the Facility Activity Daily Log. Decontamination should then be completed before moving the equipment onto the site or exclusion zone.

5.4.3 The Sampling Team Leader, lead geologist, or lead engineer will document decontamination activities on the Field Logbook.

5.4.4 Between boreholes at the same site, the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

6 REQUIRED FORMS

6.1 Field Logbook.

MSOP NO. 7.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SURFACE GEOPHYSICS

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for acquiring surface geophysical data. This includes the direct use of surface geophysical equipment by subcontractors conducting surface geophysical surveys. Additional specific surface geophysical procedures and requirements will be provided in the project work plans.

Surface geophysical surveys image into the subsurface using measuring equipment that is placed or located upon or above the ground surface. Common applications of surface geophysics for environmental projects include utility clearance, buried waste delineation, plume delineation, and geologic or hydrologic characterization. The most common surface geophysical techniques used for environmental applications and therefore, covered in this SOP, include electrical resistivity, seismic refraction, electromagnetics (EM), ground penetrating radar (GPR), metal detectors, and magnetometry.

2 REFERENCES

Manufacturer's instructions for the specific instrument utilized shall be consulted for proper operation and preventive maintenance requirements.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all surface geophysical activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field-generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to surface geophysics requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to surface geophysical activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

MSOP NO. 7.0
REVISION NO. 0
October 2001

4 DEFINITIONS/MATERIALS

4.1 Electromagnetic Induction (EM or EMI) –
A method of sending electromagnetic waves into the ground and measuring the responding secondary electromagnetic wave. The secondary wave is generated in the proportion to the conductivity of the earth or objects therein. EM may be used to reveal utility lines, buried waste dumps, former excavations, and in some specific cases, changes in groundwater conductivity.

4.2 Ground Penetrating Radar –
A method utilizing radar waves generated and propagated into the ground surface. The reflected (backscattered) waves are received back as data. GPR is typically used to reveal buried manmade objects, such as tanks, pipes, drums, etc. It may also at times be used to delineate backfilled excavations and waste cells.

4.3 Magnetic Survey –
The process of accurately measuring the earth's magnetic field (on the order of 10/50,000 of the total field). The survey reveals magnetic anomalies that may result from buried metal objects or rock-type differences.

4.4 Metal Detector –
An EM tool with a specialized sensor to detect metallic objects.

4.5 Resistivity Survey –
A geophysical method of determining the resistivity of the earth's layers. The survey is conducted by inducing electrical currents of into the subsurface and measuring electrical potential differences at points of secondary electrical fields generated in the earth in response to the input of electrical current. Resistivity surveys are typically used to provide information on subsurface lithologies and, in certain instances, plume distributions.

4.6 Seismic Methods –
Seismic surveys are conducted by inducing seismic (acoustic) waves into the around and recording the arrival times at varying distances of the refracted waves. They are typically used to reveal buried geologic structures and contacts between rock units.

4.7 Materials

- Any of listed surface geophysical instruments or data collection devices – EM, GPR, magnetometer, earth resistivity, seismic.
- Field logbook
- Indelible black ink pens and markers
- Survey measurement documentation forms or data sheets
- Personal protective equipment and gear

MSOP NO. 7.0
REVISION NO. 0
October 2001

- Appropriate surveying equipment for obtaining field measurements as specified in site-specific sampling plans
- Survey stakes

5 PROCEDURE

This section contains responsibilities, requirements and procedures for conducting surface geophysical surveys. Selection and design of the geophysical surveys to be used on a site must be based upon several factors. These include but are not limited to the following:

- Specific objectives or anticipated use of the survey (e.g., surface clearance, buried object identification, waste cell delineation, etc.)
- Known or expected site-specific conditions
- Targeted parameters and overall surface areas to be evaluated
- Potential site-induced effects that may limit specific survey methods
- Applicability of specific survey methods in meeting above objectives given the site-induced effects.

Consequently these factors must be considered and the tests designed well before generation of the project work plans and implementation in the field. The project work plans will specify all necessary details to complete the geophysical surveys at a particular site. Surface geophysical survey information and specifications to be included in the project work plans will include at a minimum the following:

- Objectives of the surveys
- Type(s) of surveys to be conducted
- Equipment to be used
- Lay-outs of survey grids at each site or location, including sample point spacing
- Type, duration and frequency of measurements to be made
- Additional procedures or requirements beyond those covered in this SOP

Subcontracted geophysical surveys will also be directed by specifications defined in Statements of Work for sub-contractor services, as well as the project work plans.

5.1 General Requirements

The following requirements apply to all surface geophysical surveys and should be performed as required by the project work plans and the conditions present at each survey site.

5.1.1 Inspect all equipment and supplies to ensure that they are in proper working order, using the equipment manuals provided by the equipment manufacturer.

MSOP NO. 7.0
REVISION NO. 0
October 2001

5.1.2 Assure that annual calibration/service by the manufacturer has been conducted as recommended by the manufacturer. Calibration/service records should be maintained in the office where the instrument is stored between investigations. A copy of the calibration records should be kept with the equipment at all times. More frequent calibration/services may be necessary if field measurements indicate possible instrument malfunction.

5.1.3 Prior to mobilization to the site, conduct appropriate decontamination as and if required by the project work plans.

5.1.4 Perform field calibration checks where required by instrument manufacturer or the project work plans. Perform calibration (accuracy and reproducibility) checks in the field by reoccupying base stations at periodic time intervals. Perform the calibration checks in accordance with manufacturer's specifications or the project work plans.

The calibration checks should be entered on a Field Logbook. At a minimum, this document should contain the following information:

- Make and model number of the geophysical instrument.
- Serial number of the instrument.
- The date and time of calibration or instrument check.
- All calibration or instrument-check measurements.
- The name and signature of the person conducting the calibration or instrument check

5.1.5 Establish grid and stake locations or set up traverses for locations of sampling stations.

5.1.6 Make sure all survey and sampling locations are properly staked and the location ID is readily visible on the location stake.

5.1.7 Include a diagram of the measurement locations with the data records on a daily basis. The diagram should include grid alignment, station numbering (if used), and base station location(s).

5.1.8 At the termination of each survey ensure that all equipment is accounted for, and decontaminated as required by project work plans.

5.1.9 Any unusual conditions or problems encountered during the survey must be recorded on the Field Logbook and brought to the attention of the Site Superintendent.

5.1.10 When the activity is completed, or at the end of the day, return the instrument(s) to a secure area. Equipment requiring electrical charging should be placed on charge.

MSOP NO. 7.0
REVISION NO. 0
October 2001

5.1.11 It is recommended that Surface geophysical survey data be stored on diskette for retrieval and management. The following information should be included for each stored data field:

- Site Location
- Location ID (or station)
- Date
- Time

Base station values and calibration measurements do not necessarily need to be recorded on the diskette. However, they must accompany the diskette record in paper copy.

5.2 Surface Geophysical Surveying

5.2.1 Electrical Resistivity

The electrical resistivity method uses an instrument to measure the apparent electrical resistivity of the subsurface. This includes the underlying soil, rock, and groundwater. An electrical current is introduced into the ground through surface electrodes. The resulting potential field (voltage) is measured at the surface between a second pair of electrodes. The procedure below requires the following below in addition to the general requirements listed in Section 4.2.

5.2.1.1 Set up and operate the geophysical electrical resistivity instrument according to manufacturers operating instructions. Record the readings and other pertinent information on the appropriate forms per the project work plans.

5.2.1.2 Calculate apparent resistivities and review plots in the field as a means of quality control. Sounding curves should be relatively smooth. Abrupt changes commonly occur in sounding and profiling data. Near-surface inhomogeneities, electrode contact problems, or changes in hydrogeology may cause unwanted noise. Any changes or noise should be identified. Corrective actions may be taken and the survey re-run if significant improvement to the survey may be attained.

5.2.1.3 Any identified noise problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.2.2 Seismic Refraction

Seismic refraction techniques use instruments to determine the travel time or velocity of seismic waves within layers and interpret the thickness and depth of geologic units and other subsurface features. Other potential applications include the location of the water table and definition of burial pits and trenches. The procedure requires the following elements below in addition to the general requirements listed in Section 4.2.

MSOP NO. 7.0
REVISION NO. 0
October 2001

5.2.2.1 Verify that factory maintenance and calibration has been conducted as recommended by the equipment manufacturer. Manufacturer maintenance should include the electronic calibration of the seismograph timing circuits.

5.2.2.2 Check the seismic signal and noise conditions on the instrument display to verify the proper functioning of the source geophones and trigger cables.

5.2.2.3 If possible, obtain or install boring logs before the survey in order to detect hidden layers or velocity inversions.

5.2.2.4 Set up and operate the geophysical seismic refraction instrument according to operating instructions supplied by the manufacturer. Record the readings and other pertinent information on the appropriate forms.

5.2.2.5 Where possible collect seismic data where known geologic information is available to establish background responses. This information is useful for evaluating complex site conditions.

5.2.2.6 Make a hard copy of the data if the data output is on paper records.

5.2.2.7 In cases where paper records are not produced, plot arrival time picks made from the electronic display on a time/distance graph in the field. Problems with improper picks are often discovered through an early inspection of these plots.

5.2.2.8 Review all output and records of the survey, identifying any potential problems requiring corrective actions.

5.2.2.9 Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.

5.2.2.10 Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.3 Electromagnetics

The EM survey detects lateral and vertical variations of electrical conductivity in the subsurface environment. EM is used for the assessment of hydrogeologic conditions, and identification and mapping of contaminant plumes, trench boundaries, buried conductive wastes, steel drums, and metallic utility lines. The procedure requires the following elements in addition to the general requirements listed in Section 4.2.

5.3.1 Establish a local standard site in the field. This will provide a reference base station to check the instrument's performance and allow correlation between instruments.

MSOP NO. 7.0
REVISION NO. 0
October 2001

5.3.2 Check the signal and noise conditions on the instrument display to verify proper functioning and assure the correct setting of the instrument.

5.3.3 Before conducting the survey, select a temporary site on location for daily base station measurements and calibration checks. Calibration checks should be made twice daily, before and after conducting daily survey operations. Readings will repeat within approximately 10 percent.

Note: Do not make calibration checks in the presence of sources of cultural interference like power lines or buried utilities. Make them on a relatively flat surface outside of topographic lows and away from areas that may include subsurface waste materials.

5.3.4 Operate the EM instrument according to operating instructions supplied by the manufacturer. Record instrument sensitivity settings, readings and all other pertinent information on the appropriate forms. When using an automatic recording device, enter the readings from the first and last stations of each traverse. Compare these data to data from the automatic recorder at the end of each day. Recorded data and field-transcribed data must agree to within ±5 percent to meet acceptability requirements.

5.3.5 The field operating party should check instrument stability when there is local or distant thunderstorm activity. Electromagnetic radiation from thunderstorms can generate noise in the EM system. Operations may have to be postponed during thunderstorms.

5.3.6 Review all output and records of the survey, identifying any potential problems requiring corrective actions.

5.3.7 Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.

5.3.8 Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.4 Ground Penetrating Radar

GPR uses high frequency radio waves to acquire subsurface information. The method produces a continuous cross-sectional image or profile of shallow subsurface conditions. The procedure below requires the following elements in addition to the general requirements listed in Section 4.2.

5.4.1 Calibration and calibration checks of the radar system requires the process described below:

- Accurately determine the total time window (range) set by the operator.

MSOP NO. 7.0
REVISION NO. 0
October 2001

- Determine or estimate the electromagnetic velocity (or travel time) of the local soil/rock condition.
- Calibrate the time window picked for the survey by using a signal calibrator in the field. This device is used to produce a series of time marks on the graphic display measured in nanoseconds. These pulses are counted to determine the total time of the radar unit. A calibration curve can be designed for each radar system.
- If possible, use known trenches, buried pipes, and road culverts to provide a radar target of known depth. The depth of a known target, a radar record taken over the known target, and a time scale provided by the signal calibrator will provide a basic calibration record. From these data, a velocity can be accurately determined at the given target location from the following equation:

$$V = 2d/t$$

The average dielectric constant of the soil is then calculated using

$$Er = c\ 2\ /v\ 2 = 1/v$$

Where:

v_1 = Average electromagnetic wave velocity, feet/nanosecond
t = Two-way travel time, nanoseconds
d = Distance of antenna to the buried object, feet
Er = Average relative dielectric constant of the soil (unitless)
c = Velocity of light in air equal to 1 foot/nanosecond
v_2 = Average electromagnetic wave velocity of the soil, feet/nanosecond

Note: The above assumes a soil with a relative magnetic permeability of 1 (unitless). If significant changes in soil type or moisture content occur with depth, velocity will not be the same throughout the vertical radar profile. Therefore, the vertical radar depth scale will be nonlinear.

This approach will provide calibration at a specific site, however, this assumes that conditions in other areas are the same as the calibration area. Calibration should be repeated at each new site.

5.4.2 Repeat a short GPR traverse twice daily over a known feature before and after conducting daily operations to insure those changing soil conditions, rather than the electronics causes readings.

5.4.3 Conduct the GPR traverse at the sites or locations specified in the project work plans.

5.4.4 Record calibration, instrument settings, measurements and all other pertinent information on the appropriate forms.

5.4.5 Print out and review all hardcopies and records of the survey, identifying any potential problems requiring corrective actions.

5.4.6 Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.

5.4.7 Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.5 Metal Detection

Metal detectors are electromagnetic devices designed to locate metallic objects buried near the surface. In hazardous waste site investigations, metal detectors are invaluable for detecting utility lines, survey markers, steel drums buried at shallow depths, and delineating areas that may potentially include metallic waste materials.

Metal detectors respond to nearby metallic objects in a relative way. For instance, closer or large metallic objects create a greater output level than more distant or smaller ones. An experienced operator can usually make a reasonably accurate estimate of target size and depth. Metal detection survey requirements at a minimum include:

5.5.1 Set up and operate the metal detector according to operating instructions supplied by the manufacturer.

5.5.2 Record the readings and all other pertinent information on the appropriate forms as outlined in the project work plans.

5.5.3 Review all data and records of the survey, identifying any potential problems requiring corrective actions.

5.5.4 Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.

5.5.5 Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.6 Magnetometer

Magnetometer surveys are used to locate metallic objects buried near the surface such as well casings, utility lines, steel drums, and tanks. They may also be used to delineate trenches and landfills. Ferrous metal objects carried by the operator will have a detrimental effect on the accuracy of the magnetometer data. Therefore, the survey team should not wear metal items like rings, watches, belt buckles, coins, and steel-toed boots.

MSOP NO. 7.0
REVISION NO. 0
October 2001

Total field and vertical field measurements may be corrected for the diurnal variation of the earth's magnetic field by employing a reference base station magnetometer. Changes in the earth's field are removed by adding or subtracting variations of fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station because they inherently eliminate time variation in the data. Requirements are as follows:

5.6.1 Conduct a swing sensor test with the proton precision magnetometer before initiating operations at a site and at least once more during the day. Four readings with the sensor oriented 90° to the other readings should be taken with the operator moving with the sensor. Variations greater than one gamma should not be observed. Correct any directional bias by washing the sensor with ordinary soap and water and maintaining an adequate distance between the sensors and battery pack.

5.6.2 Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all possible sources of cultural magnetic fields (e.g., power lines or pipelines). This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.

5.6.3 Take base station readings to remove the effects of the diurnal variation of the earth's magnetic field from the data. Periods of rapid variation may be documented at a permanent base station, set up at the site, where continuous readings are automatically recorded approximately every 10 to 15 minutes. Alternatively, a base station(s) may be reoccupied during the survey at intervals of 45 to 60 minutes.

5.6.4 Collect survey data and record on the appropriate form per the project work plans. Take readings within 10 seconds of each other. Site locations influenced by cultural magnetic fields should be recorded in the logbook. Take three to four sequential readings and record time when recording data manually. In the absence of magnetic storms, the readings should compare within several tenths of a gamma. Repeatability during magnetic storms may degrade to one gamma or more.

5.6.5 The use of automatic recording magnetometers requires recording the magnetometer readings for the first and last station of each traverse in a logbook. Compare the data recorded in the logbook with data from the automatic recording device. Data recorded in the logbook should be within one gamma of the values derived from the recording device.

5.6.6 During cold weather, maintain the battery pack for a fluxgate magnetometer at a relatively warm temperature. This is most easily accomplished by surveying with the battery pack beneath the operator's coat or jacket.

6 REQUIRED FORMS

6.1 Field Logbook

MSOP NO. 8.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
MONITORING WELL INSTALLATION

1 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the installation of monitoring wells using rotary, dual-tube percussion, or hollow-stem auger drilling techniques. Monitoring wells are installed to provide access to groundwater for collecting samples, as well as for obtaining water level and other data. Because monitoring wells are used to collect samples, it is important that construction materials not interfere with sample quality either by contributing contaminants or by sorbing contaminants already present. Further, construction materials must be compatible with (i.e., not degraded by) contaminants present in soils or groundwater.

Monitoring wells are potential contaminant migration routes between aquifers or from the surface to the subsurface. Construction procedures and standards must ensure that neither passive nor active introduction of contaminants can occur. Properly installed hydraulic seals and locking well covers reduce the potential for cross-contamination of monitoring wells. The details within this SOP should be used in conjunction with specific project work plans.

2 REFERENCES

2.1 U.S. Environmental Protection Agency (EPA), Manual of Water Well Construction Practices, U.S. Environmental Protection Agency, Office of Water Supply, U.S. Government Printing Office, Washington D.C.

2.2 U.S. Environmental Protection Agency (EPA), 1986, Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

2.3 U.S. Environmental Protection Agency (EPA), 1987, A Compendium of Superfund Field Operations Methods, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all monitoring well installation activities are conducted and documented in accordance with this and any other appropriate procedures. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

MSOP NO. 8.0
REVISION NO. 0
October 2001

3.2 The Quality Assurance Officer is responsible for periodic review of well installation activities to assure implementation of this SOP. The Quality Assurance Officer is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing nonconformances, etc.) identified during the performance of these activities.

3.3 The Sampling Team Leader(s) assigned to monitoring well installation activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Cuttings

Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

4.2 Borehole

Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing groundwater wells.

4.3 Grout

For the purposes of this SOP, the term "grout" consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry, and once properly set and cured, is capable of restricting movement of water.

4.4 Hollow-Stem Auger Drilling

A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

4.5 Air Rotary Casing Hammer Drilling

A drilling method using a non-rotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

MSOP NO. 8.0
REVISION NO. 0
October 2001

4.6 Mud Rotary Drilling

For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit that is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension to the surface.

4.7 Dual-tube Percussion Drilling

A drilling method using non-rotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced up the center of the inner drill pipe.

4.8 Monitoring Well

A well that provides for the collection of representative groundwater samples, the detection and collection of representative light and dense nonaqueous phase organic liquids, and the measurement of fluid levels.

4.9 Annular Space

The space between:

- Concentric drill pipes;
- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or
- Well screen or casing and the borehole wall.

4.10 Filter Pack

Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

4.11 Well Screen

A perforated, wire wound, continuous wrap or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand.

MSOP NO. 8.0
REVISION NO. 0
October 2001

4.12 Tremie

A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.

5 PROCEDURES

5.1 Well Installation Procedures

This section contains the procedures for monitoring well installation activities. The procedures described herein are applicable as requirements for monitoring well installations using mud rotary, air rotary, air rotary casing hammer, dual tube percussion, or hollow-stem auger drilling techniques. Site-specific factors need to be considered in the selection of well construction and completion materials, specification of well designs, and choosing well drilling methods. These factors will be incorporated in project planning activities and the compilation of specific project work plans. The project work plans will contain the following information related to monitoring well installation:

- Objectives of the monitoring well
- Specific location of the well to be installed
- Zone or depth well is to be installed
- Drilling method(s) to be used
- Well construction materials to be used
- Specification of well design(s) including Well Construction Diagrams.
- Additional procedures or requirements beyond this SOP.

5.1.1 Before mobilization of a rig to the well site, ensure that the monitoring well location has been appropriately cleared of all underground utilities, buried objects, and that drill permits have been issued per the project work plans. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines or other buried objects.

5.1.2 Decontaminate all downhole equipment and well construction materials before monitoring well installation, as described in MSOP 6.0. Decontaminate the drilling rig and all drilling equipment before monitoring well installation per MSOP 6.1.

5.1.3 Clear the work site of all brush and minor obstructions and then mobilize the rig to the monitoring well location. The rig geologist or engineer should then review with the driller the proposed well design and details of the well installation including any anticipated potential drilling or completion problems.

5.1.4 Calibrate health and safety monitoring equipment according to the instrument manufacturer's specifications. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

MSOP NO. 8.0
REVISION NO. 0
October 2001

5.1.5 Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves, steel-toed boots, hearing protection, and coveralls.

5.1.6 Commence drilling and advance the borehole while conducting health and safety monitoring according to the project work plans. Perform readings as often as necessary to ensure the safety of workers. Record all measurements on the Field Logbook. Record all other pertinent information (date, site, well or boring number, and location) on the Field Logbook. Also note and record observed field conditions, any unusual circumstances, and weather conditions. Drilling of the borehole should be conducted in conformance with applicable SOPs, as appropriate.

5.1.7 During drilling, collect representative cutting and soil samples as required by the project work plans. Compile a boring or lithologic log from the cuttings and samples per MSOP 10.0.

5.1.8 At total depth, remove soil cuttings through circulation or rapidly spinning the augers prior to constructing the well. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect the well installation. Condition the hole or take other actions mutually agreed upon by the rig geologist (or engineer), lead technical personnel, and the driller to ensure or aid in the well development.

5.1.9 Remove the drill pipe and bit if using rotary techniques, or remove the center bit boring if using the hollow-stem auger technique. The well construction materials will then be installed inside the open borehole or through the center of the drive casing or augers.

5.1.10 Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not heaved to fill the borehole. If heaving has taken place, options for cleaning, re-drilling, or installation in the open section of the boring should be discussed with lead technical personnel.

5.1.11 In the event that the hole was over-drilled, grout, bentonite pellets, or bentonite chips (as specified in the project work plans) may be added to the bottom of the boring to raise the bottom of the hole to the desired depth. The grout should be pumped through a tremie pipe and fill from the bottom of the boring upward. During grouting, the tremie pipe should be submerged below the top of the grout column in the borehole to prevent free-fall and bridging. If bentonite is used, it should be added gradually to prevent bridging. Grout or bentonite addition will stop when its level has reached no closer than approximately one foot below the desired base of the well string (casing, screen, end plug or sump, etc.). The bentonite plug will be hydrated for at least one hour before installation of a filter pack.

MSOP NO. 8.0
REVISION NO. 0
October 2001

5.1.12 Calculate volumes of filter pack, bentonite pellets/slurry, and grout required, based on borehole and well casing dimensions. If required by the project work plans, determine the filter pack and well screen slot size for the monitoring well.

5.1.13 Place a layer of filter pack (one to two feet, unless otherwise specified in the project-specific work plans) at the bottom of the borehole. The filter pack will be installed through the center of the drive casing/augers. Filter pack will be added slowly while withdrawing the drive casing/augers.

5.1.14 Inspect the casing, screen, and any other well construction materials prior to installation to assure that no damage has occurred during shipment and decontamination activities.

5.1.15 Connect and carefully lower the well string through the open borehole, drive casing, or inside of the augers until the well string is at the desired depth. The well string should be suspended by the installation rig and should not rest on the bottom of the boring. In the event the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement, the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment (drill pipe, hammers, etc.) to prevent the casing from rising. The rig geologist or engineer shall note the amount of rise and then shall consult the lead technical personnel for an appropriate course of action.

5.1.16 Record the following information on the As-Built Well Completion Form and/or other appropriate forms per the project work plans:

- Length of well screen
- Total depth of well boring
- Depth from ground surface to top of grout or bentonite plug in bottom of borehole (if present)
- Depth to base of well string
- Depth to top and bottom of well screen.

5.1.17 When using the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. Clean, potable water may be used to assist with the filter pack tremie operation. For all other drilling techniques, the filter pack may be allowed to free-fall or be tremied per the project work plans. If using drive casing or augers, the drive casing or augers should be pulled slowly during filter pack installation in increments no greater than five feet.

5.1.18 Filter pack settlement should be monitored by initially measuring the sand level (before beginning to withdraw the drive casing/augers). In addition, depth soundings using a weighted tape shall be taken repeatedly to continually monitor the level of the sand. The top of the well casing shall also be monitored to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement.

5.1.19 Filter pack should be added until its height is approximately two feet above the top of the screen (unless otherwise specified in the project work plans), and verification of its placement (by sounding) should be conducted. The filter pack should then be gently surged using a surge block or swab in order to settle the pack material and reduce the possibility of bridging.

5.1.20 The height of the filter pack will then be re-sounded and additional filter pack placed as necessary. Once the placement of the filter pack is completed, the depth to the top of the pack is measured and recorded on the As-Built Well Completion Form or other appropriate forms per the project work plans.

5.1.21 A three-foot thick (unless otherwise specified in the project work plans) bentonite seal is then installed on top of the filter pack. If pellets or chips are used, they should be added gradually to avoid bridging. Repeated depth soundings will be taken using a weighted tape to ascertain the top of the bentonite seal. The seal should be allowed to hydrate for at least one hour before proceeding with the grouting operation.

5.1.22 After hydration of the bentonite seal, grout is then pumped through a tremie pipe and filled from the top of the bentonite seal upward. The bottom of the tremie pipe should be maintained below the top of the grout to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, the drive casing/augers should be raised in incremental intervals, keeping the bottom of the drive casing/augers below the top of the grout. Grouting will cease when the grout level has risen to within approximately one to two feet of the ground surface, depending on the surface completion type (flush mount versus aboveground). Grout levels should be monitored to assure that grout taken into the formation is replaced by additional grout. If settling of the grout occurs, additional topping off of the grout may be necessary.

5.1.23 For aboveground completions, the protective steel casing will be centered on the well casing and inserted into the grouted annulus. Prior to installation, a 2-inch deep temporary spacer shall be placed between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap.

5.1.24 After the protective casing has set, a drainage hole may be drilled into the protective casing if required by the project work plans. The drainage hole is positioned approximately two inches above ground surface. The protective casing will be painted with a rust-preventive colored paint.

MSOP NO. 8.0
REVISION NO. 0
October 2001

5.1.25 The well head will be labeled to identify, at a minimum, the well number.

5.1.26 A minimum of 24 hours after grouting should elapse before installation of the concrete pad and steel guard posts for aboveground completions, or street boxes or vaults for flush mount completions.

5.1.27 For aboveground completions, a concrete pad, usually 3-foot by 3-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete is sloped away from the protective casing to promote surface drainage from the well.

5.1.28 For aboveground completions, where traffic conditions warrant extra protection, three steel bucking posts will be embedded to a depth approximately 1.5 feet below the top of the concrete pad. The posts will be installed in concrete filled postholes spaced equally around the well at a distance of approximately 1.5 feet from the protective steel casing. Where removal of bucking posts is required for well access, mounting sleeves should be imbedded into the concrete.

5.1.29 For flush mount (or subgrade) completions, a street box or vault is set and cemented in position. The top of the street box or vault will be raised slightly above grade and the cement sloped to grade to promote surface drainage away from the well.

5.1.30 Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the project work plans.

6 REQUIRED FORMS

6.1 Well Construction Diagram

6.2 Field Logbook

6.3 Lithologic/Soil Boring Log

6.4 As-Built Well Completion Form

MSOP NO. 8.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
MONITORING WELL DEVELOPMENT

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for specifying, assessing and documenting the well development process. Additional specific well development procedures and requirements will be provided in the project work plans. Monitoring wells are developed to remove skin (i.e., near-well-bore formation damage), well drilling fluids, sediments, and to settle and remove fines from the filter pack. Wells should not be developed within 48 hours after completion when a cement bentonite grout is used to seal the annular space, or within 7 calendar days beyond internal mortar collar placement.

2 REFERENCES

2.1 U.S. Environmental Protection Agency (EPA), August 1988, *Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA*, Interim Final OSWER Directive 9355.3-01.

2.2 U.S. Environmental Protection Agency (EPA), 1987, *A Compendium of Superfund Field Operations Methods*, EPA-540/P-87/001a, U.S. Government Printing Office, Washington D.C.

2.3 ASTM, 1988, *Standards Technology Training Program - Groundwater and Vadose Zone Monitoring*, Nielsen, et al.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that monitoring wells are properly developed and that the development process is properly documented. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with well development. If deviations from project requirements occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requests for corrective action.

3.3 The Sampling Team Leader(s) is responsible for conducting monitoring well development and documentation in accordance with the specifications outlined in this SOP and by the project work plans.

MSOP NO. 8.1
REVISION NO. 0
October 2001

4 DEFINITIONS/MATERIALS

4.1 Well Development –
The act of removing fine grained sediment and drilling fluids from the sand pack and formation in the immediate vicinity of the well, thus increasing the porosity and permeability of the materials surrounding the intake portion of the well.

4.2 Eductor Pipe –
The pipe used to transport well discharge water to the surface.

4.3 Materials

- Submersible pump or bailer.
- Power source (e.g., generator), if required.
- Electronic water level indicator and/or oil/water interface probe.
- Temperature, conductivity, pH, and turbidity meters.
- Personal protective equipment as specified in the project Health and Safety Plan.
- Organic vapor meter (MicroTip, OVM, HNU, etc.).
- Teflon-coated stainless steel cable or acceptable material.
- Monitorin Well Development Record (attached).

5 PROCEDURE

5.1 General

5.1.1 The most common methods used to develop monitoring wells consist of surging and bailing, surging and pumping, or combinations of all these.

5.1.2 The project work plans will identify the specific well development procedure to be followed. The standard procedure for field personnel to use in assessing and documenting well development is described below and is intended only for development methods listed above.

5.2 Well Development

5.2.1 Decontaminate the rig and development equipment in accordance with MSOPs 6.0 and 6.1, respectively.

5.2.2 Calibrate all field analytical test equipment (pH, temperature, conductivity, and turbidity) according to the instrument manufacturer's specifications and MSOP No. 4.0. Specific test equipment to be used should be identified in the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service, tagged with an out of calibration label, and segregated (when possible) from the calibrated equipment area.

An exception to the daily calibration requirements will be made in the case of the water level meters. The tape of these instruments will be checked prior to the beginning of the project and each succeeding six months using a steel surveyor's tape.

5.2.3 Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any observed problems with the well head should be noted in the Field Logbook and reported to the Sampling Team Leader(s).

5.2.4 Unlock the well and obtain a depth to water level measurement according to the procedures outlined in MSOP No. 5.0. Calculate the volume of water in the well (cased well volume) as follows:

$\pi \times (d/2)^2 \times (h_1 - h_2) \times 7.48$ = cased well volume (in gallons)
Where
d = inside diameter of well casing (in feet)
h_1 = depth of well from top of casing (in feet)
h_2 = depth to water from top of casing (in feet)

5.2.5 The depth to the bottom of the well should be sounded and then compared to the completion form or diagram for the well. If sand or sediment is present inside the well, it should first be removed by surging and bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the Site Superintendent and obtain approval to continue or cease well development activities.

5.2.6 Begin development by first gently surging followed by bailing or pumping. This is then continued with alternate surging and bailing or pumping. At no time should the surge block be forced down the well if excessive resistance is encountered. During development, the bailer should not be allowed to free-fall or descend rapidly such that it becomes lodged in the casing or damages the end cap or sediment trap at the bottom of the well.

5.2.7 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Monitoring Well Development Record.

5.2.8 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Monitoring Well Development Record.

MSOP NO. 8.1
REVISION NO. 0
October 2001

5.2.9 While developing, water is also periodically collected directly from the eductor pipe or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. The water color and clarity will be noted and recorded. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans), and a minimum of three well volumes of water have been removed. In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete upon removal of the minimum of three well volumes. In some cases, the project work plans may also specify a maximum turbidity requirement for completion of development.

5.2.10 Obtain a water level and turbidity measurement at the completion of development.

5.2.11 Complete documentation of the well development event on the Monitoring Well Development Record form. At a minimum this record must contain:

- Project name and number
- Well identification number
- Well depth, casing size, and completion date
- Method of development
- Volume of water removed
- Water levels (including the time of measurement)
- Physical description of the water (e.g., discoloration, turbidity, odor, etc.) and solids removed from the well
- Test equipment readings for pH, conductivity, temperature and turbidity (including the time of collection)
- Signature of the well development observer.

5.2.12 Collect and appropriately transport and dispose of water removed from the well in accordance with criteria listed in the project-specific work plans and regulatory requirements.

5.2.13 Allow the well to recover for at least 24 hours prior to sampling.

6 REQUIRED FORMS

6.1 Well Development Record Form

MSOP NO. 8.1
REVISION NO. 0
October 2001

MONITORING WELL DEVELOPMENT RECORD

INSTALLATION	WELL ID		DATE	TIME
PERFORMED BY	WATER LEVEL		TOTAL DEPTH	
	INITIAL	FINAL	INITIAL	FINAL
DEVELOPMENT METHOD		SURGE TECHNIQUE		
FIELD MEASUREMENTS				

Time	Cum. Volume (gal)	Water Quality				Comments
		Temp	pH	Cond	Turbidity	

TOTAL VOLUME REMOVED DEVELOPMENT TIME	COMMENTS

MSOP NO. 8.1
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 9.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
GROUND WATER SAMPLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of ground water samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all ground water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2 REFERENCES

2.1 EPA, September 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01.

2.3 ASTM, 1988, *Standards Technology Training Program - Groundwater and Vadose Zone Monitoring*, Nielsen, et al.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QC/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to ground water sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4 DEFINITIONS/MATERIALS

MSOP NO. 9.1
REVISION NO. 0
October 2001

4.1 Bladder Pump

A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Compressors or cylinders provide gas (air or nitrogen).

4.2 Peristaltic Pump

A peristaltic pump is a self-priming, low volume pump consisting of a rotor and a ball bearing roller. The rotors squeeze tubing placed around the rotor as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet.

4.3 Electric Submersible Pump

An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and pump the groundwater to the surface.

4.4 Bailer

A bailer is an enclosed cylindrical tube containing a ball check-valve at the bottom. Lowering the bailer into water causes the ball to move off of it's seal allowing water to enter the cylinder. Raising the bailer through the water causes the ball to settle, creating a seal so as to trap the water in the bailer so that it can be brought to the surface.

4.5 Dedicated Ground Water Monitoring Equipment

Dedicated ground water monitoring equipment is used to purge and sample only one well. The equipment is installed and remains in the well for the duration of the monitoring program. Dedicated equipment does not need to be decontaminated between sampling events.

4.6 Materials:

- Clean rope or wire line of sufficient length for conditions.
- Appropriate sample containers with labels and preservatives, as required.
- Hard plastic or steel cooler with cold packs (or ice) for samples.
- Temperature, pH, conductivity, and turbidity meters.
- Equipment calibration standards.
- Electronic water level indicator.
- Organic vapor meters.

MSOP NO. 9.1
REVISION NO. 0
October 2001

- Plastic sheeting, if needed.
- 55-gallon drums for purge water.
- Decontamination supplies, as required.
- Personal protective clothing and equipment, if required by the project Health and Safety Plan.
- Field logbook, Groundwater Monitoring Well Sampling Data Summary Form, and Monitoring Well Development Record

5 PROCEDURE

This section contains the procedures involved with groundwater sampling. Proper ground water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives
- Locations of ground water samples to be collected
- Numbers and volumes of samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Any additional groundwater sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined in this SOP for ground water sampling will be followed.

5.1 Ground Water Sampling Requirements

5.1.1 Equipment Selection and Sampling Considerations

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g., Teflon™, stainless steel), with respect to known or anticipated contaminants in the well(s), should be used whenever possible. The project work plans will describe the type of equipment to be used.

If non-dedicated sampling equipment is to be used and the contaminant histories of the wells are known, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated last.

5.2 Ground Water Purging and Sampling with a Bladder Pump

Pre-sample purging and sampling should be conducted in accordance with the project work plans. The standard procedure for purging and sampling using a bladder pump will be conducted as described below.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.2.1 Inspect the equipment to ensure that it is in good working order.

5.2.2 Calibrate all field analytical test equipment (e.g., pH, temperature, and conductivity) according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.

5.2.3 If non-dedicated sampling equipment is being used, decontaminate according to MSOP No. 6.0. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.

5.2.4 Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Logbook and brought to the attention of the Sampling Team Leader.

5.2.5 Uncap the well and monitor the air space immediately above the open casing per the Health and Safety Plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Groundwater Monitoring Well Sampling Data Summary Form (attached).

5.2.6 Obtain a depth to water level measurement according to the procedures outlined in MSOP 5.0. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi \times (d/2)^2 \times (h_1 - h_2) \times 7.48 = \text{cased well volume (in gallons)}$$

Where
d = inside diameter of well casing (in feet)
h_1 = depth of well from top of casing (in feet)
h_2 = depth to water from top of casing (in feet)

Record static water level measurement and calculations on the Groundwater Monitoring Well Sampling Data Summary Form.

5.2.7 If using non-dedicated sampling equipment, lower the pump and associated tubing and/or lines into the well.

5.2.8 Attach the compressor or cylinder to the controller and the controller to the gas supply line, making sure that the compressor is downwind of the monitoring well. Attach the sampling tube to the discharge supply line. Adjust the pressure/discharge cycle on the controller.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.2.9 Begin purging. Collect, transport, and dispose of purge water in accordance with the criteria specified by the project work plans.

5.2.10 Physical parameters (pH, specific conductance, and temperature) of the purge water will be measured when purging begins and then periodically throughout the purging procedure. These measurements will be recorded on the Groundwater Monitoring Well Sampling Data Summary Form. Purging is considered complete when a minimum of three casing volumes have been removed and pH, specific conductivity, and temperature measurements have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans). If stability is not reached within the removal of three well volumes then purging is continued until a maximum of five cased well volumes have been removed.

For slowly recharging wells, the parameters may not stabilize. In this case, purging will be considered complete upon removal a minimum of three well volumes.

5.2.11 Allow the well to recover to at least 80 percent of the initial cased well volume prior to sampling.

5.2.12 Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

5.2.13 Turn on the pump and adjust the pressure/discharge cycle on the pump controller so that the water will flow smoothly and without agitation into the sample containers.

5.2.14 Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analysis should be filled to the base of the bottleneck.

5.2.15 The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples. The volatile samples should be collected during one full discharge cycle. Do not partially fill a volatile sample during one cycle and complete the filling during the next cycle.

5.2.16 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.2.17 Cap the bottle and attach custody tape across the cap so that any attempt to remove the sample or open the sample bottle will be evident. Fill out and attach the sample label to the bottle per MSOP No. 2.1. The sample will be assigned a sample number per MSOP No. 2.2.

5.2.18 Document selected details of the sampling event in the Field Logbook, and record all appropriate sampling data in the Groundwater Monitoring Well Sampling Data Summary Form.

5.2.19 As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziplock™ or equivalent). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

5.2.20 Handle and ship the sample according to the procedures outlined in MSOP No. 2.1, following appropriate custody procedures described in MSOP No. 1.1. Samples stored temporarily on site will be maintained per MSOP No. 2.3.

5.3 Ground Water Purging and Sampling with a Peristaltic Pump

Purging and sampling will be conducted per the project work plans. The standard procedure for ground water purging and sampling using a peristaltic pump will be conducted as described below.

5.3.1 Inspect the equipment to ensure that it is in good working order.

5.3.2 Conduct all field analytical test equipment (pH, temperature, and conductivity) calibration as discussed in Section 5.2.2.

5.3.3 Conduct equipment decontamination as described in Section 5.2.3. However, the old Tygon™ tubing should not be decontaminated. New tubing should be used for each well.

5.3.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.2.4 and 5.2.5.

5.3.5 Obtain a water level measurement and calculate the cased well volume per Section 5.2.6.

5.3.6 Connect new Tygon™ tubing to the rotor head of the pump motor and tighten until snug.

5.3.7 Run a short section of the tubing from the discharge side of the pump head to a collection vessel.

5.3.8 Insert the free end of the influent tubing into the well and lower it to the middle of the well screen.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.3.9 Begin and conduct purging as described in Sections 5.2.9 and 5.2.10.

5.3.10 Purging will be considered complete per Section 5.2.10. Once purging is completed, allow the well to recover to at least 80 percent of the initial cased well volume prior to sampling.

5.3.11 Inspect the sampling bottles to be used per Section 5.2.12.

5.3.12 Turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample bottles.

5.3.13 Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.

5.3.14 The samples should be collected in the order of volatility as described in Section 5.2.15. VOC samples should not be collected with a Peristaltic Pump.

5.3.15 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

5.3.16 Appropriately cap, label, and number the samples as discussed in Section 5.2.17.

5.3.17 Document selected details of the sampling event in the Field Logbook, and record all appropriate sampling data in the Groundwater Monitoring Well Sampling Data Summary Form.

5.3.18 Appropriately seal, store, handle, and ship the samples per Sections 5.2.19 and 5.2.20.

5.4 Ground Water Purging and Sampling with an Electric Submersible Pump

Purging and sampling will be conducted in accordance with the project work plans. The standard procedure for purging and sampling using a submersible pump is described below.

5.4.1 Inspect the equipment to ensure that it is in good working order.

5.4.2 Conduct field analytical test equipment (pH, temperature, and conductivity) calibration as discussed in Section 5.2.2.

5.4.3 Conduct equipment decontamination as described in Section 5.2.3.

5.4.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.2.4 and 5.2.5.

5.4.5 Obtain a water level measurement and calculate the cased well volume per Section 5.2.6.

5.4.6 If using non-dedicated sampling equipment, lower the pump and associated lines into the well.

5.4.7 Place the generator downwind of the well. Start the generator, and then plug the pump into the generator.

5.4.8 Begin and conduct purging as described in Sections 5.2.9 and 5.2.10.

5.4.9 Purging will be considered complete per Section 5.2.10. Once purging is completed, allow the well to recover to at least 80% of the initial cased well volume prior to sampling.

5.4.10 Inspect the sampling bottles to be used per Section 5.2.12.

5.4.11 Turn on and adjust the flow rate of the pump by using the check-valve on the discharge line so that the water will flow smoothly and without agitation into the sample bottles.

5.4.12 Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analyses should be filled to the base of the bottle neck.

5.4.13 The samples should be collected in the order of volatility, as described in Section 5.2.15. An electric submersible pump is not recommended for collecting volatile organic samples.

5.4.14 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

5.4.15 Appropriately cap, label, and number the samples as discussed in Section 5.2.17.

5.4.16 Document the sampling event on the Field Logbook.

5.4.17 Appropriately seal, store, handle and ship the samples per Sections 5.2.19 **and 5.2.20.**

5.5 Ground Water Purging and Sampling with a Bailer

Purging and sampling will be conducted in accordance with the project work plans. The standard procedure for purging and sampling with a bailer is described below.

5.5.1 Inspect the equipment to ensure that it is in good working order.

5.5.2 Conduct field analytical test equipment (pH, temperature, and conductivity) calibration as discussed in Section 5.2.2.

5.5.3 Decontaminate purging and sampling equipment according to MSOP No. 6.0.

5.5.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.2.4 and 5.2.5.

5.5.5 Obtain a water level measurement and calculate the cased well volume per Section 5.2.6.

5.5.6 Attach the bailer to the bailing line.

5.5.7 Begin purging by slowly lowering the bailer into the groundwater. Allow the floating ball valve to seat, and slowly retrieve the bailer. Repeat this procedure to purge the well. Collect, transport, and dispose of purge water in accordance with the criteria specified in the project work plans.

During purging, the descent of the bailer should be controlled to prevent free fall inside the well. In the event the bailer encounters an obstruction inside the well, no attempts may be made to push the bailer beyond the obstruction. If the bailer becomes lodged in the well, the line should not be pulled with such force that it would part from the bailer. Such conditions should also be noted in the Field Logbook or the Groundwater Monitoring Well Sampling Data Summary Form and brought to the immediate attention of the field geologist or engineer.

5.5.8 Purging will be considered complete per Section 5.2.10. Once purging is completed, allow the well to recover to at least 80% of the initial cased well volume prior to sampling.

5.5.9 Inspect the sampling bottles to be used per Section 5.2.12.

5.5.10 Lower the sample collection bailer and submerge into the water column as above. Retrieve the bailer and insert a bottom-emptying device into the bailer so that the water will flow smoothly and without agitation into the sample bottles.

5.5.11 Collect the sample water directly into the provided sample bottles (containers), allowing the discharge to flow gently down the inside of the bottles, minimizing aeration of the sample. Completely fill the bottles. Samples collected for metals and general water chemistry analyses should be filled to the base of the bottleneck.

5.5.12 The samples should be collected in the order of volatility as described in Section 5.2.15.

5.5.13 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

5.5.14 Appropriately cap, label, and number the samples as discussed in Section 5.2.17.

5.5.15 Document selected details of the sampling event in the Field Logbook, and record all appropriate sampling data in the Groundwater Monitoring Well Sampling Data Summary Form.

5.5.16 Appropriately seal, store, handle, and ship the samples per Sections 5.2.19 and 5.2.20.

6 REQUIRED FORMS

6.1 Field Logbook

6.2 Groundwater Monitoring Well Sampling Data Summary Form

MSOP NO. 9.1
REVISION NO. 0
October 2001

GROUNDWATER MONITORING WELL SAMPLING DATA SUMMARY FORM

DATE:______________ SWMU# ______________________

WELL ID:______________________ Personnel:______________________

AIR TEMP:________ ^{0}F RELATIVE HUMIDITY:________%

WEATHER CONDITIONS ____

WELL PURGE AND SAMPLE

A. Equipment & Supplies

1. Pump # ____________________
2. Bailer (size/type)______________
3. Drums (number)______________
4. HyDac Meter # ________________
5. Water Level Indicator # ___________
6. Other ________________________

B. Calculations and Measurements

1. DEPTH TO WATER (D.T.W.) (feet below top of casing): ____________________
2. T.D. Well T.D. (feet below ground surface, from well fact sheet): ________________
3. Top of Casing elevation - Brass Marker Elevation (from well fact sheet): ____________
4. _________T.D. (ft. bgs) ________D.T.W. (ft. bgs) _______ Water Column (h, in feet)
5. COLUMN VOLUME = __________ft. x Gal/ft. (from table below)
6. PURGE VOLUME = ________Column Volume x 3
7. Sample Parameters (at time of collection):

   CONDUCTIVITY________________ pH__________

   CONDUCTIVITY SCALE__________ WATER TEMP ^{0}F___________
8. SAMPLE TIME: __________________(24 hr. clock) SAMPLE DATE:____________
9. SAMPLE ID:______________________(prim)____________________________(QC)

   _________________________(QC)___________________________(MS/MSD)

For a well with diameter of casing = (inches)	Multiply the water column (h) by:	If casing diameter differs from those given in the table, use the formula below to calculate the well volume:
2	0.163	D2 * h * 0.041
3	0.367	where:
4	0.653	D2 = casing diameter (in inches), squared
5	1.020	h = height (in ft.) = W.C.
6	1.469	
8	2.611	

To calculate the well volume

Sample Date:__________________Personnel:__________________**WELL ID:**_____________

MSOP NO. 9.1
REVISION NO. 0
October 2001

FIELD PARAMETERS

Time 24-hr clock	Volume (gal)	Temp ^{0}F	PH	Conductivity (μS/CM) (Scale:_______)	Comments (clarity, sediment, etc.)

Time (24-hr. clock)	**Notes (problems, observations, deviations from protocol, etc.)**

MSOP NO. 9.1
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
CONE PENETRATION TESTING (CPT) AND HYDROPUNCH®
GROUND WATER SAMPLING

1. PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for conducting cone penetration testing (CPT), soil sampling using a CPT rig, and Hydropunch® groundwater sampling. The details within this SOP should also be used in conjunction with project work plans.

2. REFERENCES

2.1. ASTM, 1988, Standard Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil, Designation: D 3441-86, Volume 4.08 Soil and Rock, Building Stones: Geotextiles, pp.409-414.

2.2. Manchon, B., 1992, Introduction to Cone Penetrometer Testing and Groundwater Samplers, Sixth National Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring and Geophysical Methods, May 1992.

3. RESPONSIBILITIES

3.1. The Project Technical Manager and Technical Coordinator are representative is responsible for ensuring that all CPT, soil sampling, and Hydropunch® activities are conducted and documented in accordance with this and any other appropriate procedures. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

3.2. The Quality Assurance Officer is responsible for periodic review of field activities and documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, generation of variances to CPT and sampling requirements, issuing nonconformances, etc.) if problems occur.

3.3. The Sampling Team Leader(s) and sampling personnel assigned to CPT, soil sampling, and Hydropunch® activities are responsible for completing their tasks according to this and other appropriate procedures. All staff members are responsible for reporting deviations from the procedure to the Project Technical Coordinator.

4. Definitions/Materials

4.1. Cone – the cone-shaped point of the penetrometer tip, upon which the end-bearing resistance develops.

MSOP NO. 9.1
REVISION NO. 0
October 2001

4.2. Cone penetrometer –
An instrument in the form of a cylindrical rod with a conical point, designed for penetrating soil and soft rock and for measuring the end-bearing component of penetration resistance.

4.3. Cone resistance or end-bearing resistance –
The resistance to penetration developed by the cone, equal to the vertical force applied to the cone divided by its horizontally projected area.

4.4. Hydropunch® -
A device used to collect groundwater samples using CPT or drill rig technology. Various forms of the Hydropunch® exist; they vary in the method used for sample collection. Hydropunch® I uses the body of the hydropunch to collect and retrieve the sample. Hydropunch® II allows for the collection of water samples using a bailer lowered within the CPT rods or drill stem.

4.5. Sounding –
The entire series of penetration tests performed at one location.

4.6. Friction Ratio –
The ratio of friction resistance to cone resistance, expressed in percent.

4.7. Friction Resistance –
The resistance to penetration developed by the friction sleeve, equal to the vertical force applied to the sleeve divided by its surface area. This resistance consists of the sum of friction and adhesion.

4.8. Differential Pore Pressure Ratio –
A calculated parameter equal to the excess pore pressure measured behind the tip divided by the sum of the tip resistance (corrected for pore pressure effects and the total overburden stress). Used in combination with the end-bearing resistance to infer lithology.

4.9. Pore Pressure –
Water pressure in the formation.

4.10. Push Rods –
The thick-walled tubes, or other suitable rods, used for advancing the penetrometer tip or Hydropunch® to the required test depth.

5. PROCEDURE

Depending on the sampling activities to be performed, CPT/Hydropunch® testing may require multiple runs to complete the desired tests. The first run is generally conducted to generate stratigraphic or hydrogeologic information. The stratigraphic or hydrogeologic data is then evaluated to determine optimum depth intervals to obtain soil and ground water samples that will be collected in subsequent runs.

An experienced contractor under the direction of the prime contractor or their subcontractors will perform CPT soundings, and soil and groundwater sampling. All CPT, soil sampling, and Hydropunch® techniques covered in this SOP will be performed in accordance with the project work plans. The project work plans will identify the following:

- Testing and sampling objectives
- Locations and depths of CPT and sampling points
- Numbers and volumes of soil or groundwater samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Specific procedures to be performed in addition to those covered in this SOP.

At a minimum, the procedures outlined below for CPT, soil sampling, and Hydropunch® groundwater sampling will be followed.

5.1 Preparation Procedures

5.1.1 Prior to commencement of CPT activities ensure that all CPT, soil sampling, and Hydropunch® locations have been appropriately cleared of all underground utilities and buried objects per the project work plans. Review all forms and diagrams documenting the location of the cleared sampling and CPT locations, as well as that of any underground utility lines or other buried objects.

5.1.2 Perform a specific calibration of air monitoring equipment required for air space monitoring according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that can not be calibrated according to the manufacturer's specifications will be removed from service and tagged.

5.1.3 Don the appropriate personal protection equipment specified in the project-specific work plans.

5.2 Cone Penetration Testing

In general, the CPT is the first run to be conducted. The CPT rig is normally truck-mounted and contains a hydraulic push system (20 ton is typical). The depth of investigation will typically be less than 100 feet below ground surface (bgs). Lighter weight rigs can be utilized for shallow surveys up to approximately 15 feet bgs.

MSOP NO. 9.1
REVISION NO. 0
October 2001

Some CPT rigs are equipped with an automatic decontamination system featuring an enclosed chamber that may be mounted beneath the CPT rig (project-specific decontamination requirements are specified in the project work plans). This chamber contains scrubbers and spray nozzles for pressure washing of the CPT probe as it is retrieved from the ground. In this type of system, all activities are conducted within the enclosed CPT rig.

The standard procedure for conducting stratigraphic and hydrogeologic investigations is described below.

5.2.1 Obtain specifications on the type and dimensions of the probes and equipment, along with the results of current shop calibrations from the CPT subcontractor.

5.2.2 With the CPT subcontractor, inspect all equipment to ensure that it is in proper working order.

5.2.3 Examine data from adjacent soil borings, if available. Initial correlation of the CPT data with site lithologies will be accomplished by comparison with existing boring logs, geophysical logs, and CPT logs.

5.2.4 Before moving onto the site, decontaminate the outside of the rig per MSOP No. 6.1 and the project work plans. For those rigs that do not have an automatic decontamination system, the CPT probe and rods should also be decontaminated per MSOP No. 6.1.

5.2.5 Calibrate the CPT cones at zero load reading in air and water, shielding the cone from direct sunlight before commencement of testing at each location.

5.2.6 Commence the test and advance the CPT probe into the subsurface at a consistent, controlled rate of 0.03 to 0.07 feet per second (1 to 2 centimeter per second), unless conditions prevent that rate.

5.2.7 Record real-time field plots consisting of depth, cone tip resistance, sleeve friction resistance, and friction ratio. Pore pressure and differential pore pressure ratio may be included in some cases.

5.2.8 Pore pressure dissipation tests may be conducted to determine relative flow rates at specific depths. The CPT probe is held stationary at a given depth and data are recorded for a set time interval. The time interval is dependent on the lithology of the zone being tested.

5.2.9 Once the CPT is pushed to the maximum desired depth, data collection is terminated. The CPT is retracted from the hole and the tip and rods are wiped down during extraction.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.2.10 Upon completion of a test, calibrate the piezocone again to zero load reading and compare this to the initial reading.

5.2.11 Abandon the hole in accordance with the project work plans.

5.2.12 The rig geologist or engineer will record all pertinent information observed during the investigations. Information will be recorded on the Field Logbook. Any and all problems or unusual conditions encountered should also be noted on the above forms and brought to the attention of the site superintendent.

5.3 Soil Samples

If required, soil sampling will follow the CPT analysis run. Soil sampling locations will be placed updip relative to the location of the previous CPT testing run. The standard procedure is described below.

5.3.1 Assemble and check the necessary sampling equipment before soil sampling. Decontaminate all downhole sampling equipment before sampling, as described in MSOP 6.0. The rig should also be decontaminated per MSOP No. 6.1.

5.3.2 Deploy and advance the soil sampling probes with the CPT rods to collect soil samples at the sample intervals specified in the project work plans. The sample intervals may be identified from the adjacent CPT data and any other subsurface data available. The sampling device contains removable liners that fit inside the drive tip mechanism.

5.3.3 Retrieve the sampler and remove the liners containing the soil. Cover the ends of each liner to be submitted for chemical analysis with Teflon™ film and then cap with plastic end caps.

5.3.4 Each liner to be submitted for analysis will be appropriately labeled. The label will be filled out using waterproof ink and will contain, at a minimum, the following information:

- Project number
- Sample point (or boring) number
- Bottom depth of liner
- Date and time of sample collection
- Parameters for analysis
- Sampler's initials.

5.3.5 As soon as possible after sample collection, place the sample in an appropriately sized, airtight, seam-sealing polyethylene bag (e.g., Ziploc ™ or equivalent). Seal the bag, removing any excess air, and tape the bag with custody tape so that any attempt to remove the sample will cause the tape to be broken.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.3.6 Document the sampling event on the Field Logbook.

5.3.7 Handle the sample according to the procedures outlined in MSOP No. 2.1. For samples submitted to a laboratory for analysis, a task-specific Analyte List and Chain-of-Custody Record shall be completed and maintained per MSOP No. 1.1 and the project work plans.

5.3.8 Abandon the hole following the procedure outlined in the project work plans.

5.4 Hydropunch® Ground Water Samples

The Hydropunch® sample locations, if conducted in conjunction with CPT data collection, will be located a few feet in the estimated up gradient direction from the previous CPT location. Hydropunch® sampling will be conducted in accordance with the project work plans. The standard procedure for Hydropunch® sampling is described below.

5.4.1 Decontaminate the Hydropunch® probe and push/drive rods in accordance with MSOP No. 6.0. If the Hydropunch® model is being used with a small diameter bailer, the bailer and associated equipment must also be decontaminated in accordance with MSOP No. 6.0.

5.4.2 Advance the probe to the target depth, which will commonly be a permeable layer as defined from the adjacent CPT or other stratigraphic information. Depth control is maintained by counting the number of whole and partial push or drive rods used. The Hydropunch® is measured at the tip of the tool and zeroed at the ground surface.

5.4.3 To obtain a ground water sample, retract the outer jacket of the Hydropunch® probe to allow ground water inflow into the sample chamber. An optional technique, used to determine when the sample chamber is full as follows:

- Place a surgical glove over the end of the push rod before the outer jacket of the sampler is retracted.
- As water enters the sample chamber and displaces air, the glove will inflate.
- Once the glove stops inflating, water has ceased flowing into the chamber and the sample may be retrieved.
-

The length of time required for the sample chamber to fill is a function of the relative permeability of the formation and the presence or absence of materials which may clog the filter screen, thereby inhibiting the flow of water.

5.4.4 Retract the probe from the hole, disconnect the push rods from the Hydropunch®, and remove the upper valve. Replace the upper valve with a Teflon ™ stopcock valve and a disposable tube (Hydropunch® I). Turn the sampler upside down, open the cock valve and decant the sample into the sample container.

MSOP NO. 9.1
REVISION NO. 0
October 2001

5.4.5 If using the Hydropunch® II model with a small diameter bailer, the water sample is retrieved by lowering the bailer through the inside of the push rod into the sample chamber. The water recovered in the bailer is then decanted directly into the appropriate sample containers.

5.4.6 If collecting samples for analysis of volatile organic compounds (VOCs) first completely fill the VOC sample vials. Each filled, capped vial will be inverted to ensure no air bubbles are present. If an air bubble is present, the vial will be opened and refilled with an additional sample. The vial will be immediately capped and checked again for bubbles. If air bubbles are still present, the VOC sample vial will be discarded and a new vial used. The VOC sample vial filling procedure is then repeated until no air bubbles are present.

5.4.7 If other sample analyses are required, fill the other sample containers after the VOC sample vials are filled. Samples collected for metals and general minerals analysis will be filled to the base of the bottle neck. Care will be taken not to aerate the sample during transfer from the bailer to the sample bottles and not to overfill bottles containing preservatives. All samples shall be appropriately preserved per the project work plans.

5.4.8 Each sample container to be submitted for analysis will be appropriately labeled. The label will be filled out using waterproof ink and will contain, at a minimum, the following information:

- date and time sample was collected
- sample location
- the initials of the individual conducting the sampling
- any additional required information.

5.4.9 Document the sampling event on the Field Logbook.

5.4.10 Place the labeled vials in seam-sealing plastic bags (i.e., Ziplock or equivalent). Seal the bag, removing any excess air, and tape the bag with custody tape so that removal of the sample will cause the tape to be broken.

5.4.11 Conduct a visual inspection of the turbidity of samples and record on the Field Logbook to provide a qualitative record of results.

5.4.12 Handle the samples according to procedures outlined in MSOP No. 2.1. For samples submitted to a laboratory for analysis, a task-specific Analyte List and Chain-of-Custody Record shall be completed and maintained per MSOP No. 1.1 and the project work plans.

5.4.13 After samples are collected, water levels may be measured. For water level measurements using the Hydropunch®, allow enough time for ground water to fill the sample chamber and the push rods. After static water level conditions are achieved, an electric tape is lowered through the push rods and the water level is measured. Document results on the appropriate form, as specified by the project-specific work plans.

5.4.14 Abandon the hole following the procedure outlined in the project work plans.

5.5 Reporting

The CPT contractor should provide a field survey report of the test data before demobilizing from each location. The CPT contractor should record on the survey report the operator's name, date of the survey, and the CPT location number. The report should include the following:

- descriptions of the various probes and equipment, and the results of calibrations performed;
- profiles of cone tip resistance, sleeve friction resistance, friction ratio, inclination, pore pressures, and differential pore pressure ratio versus depth; and
- a list of the derived geotechnical parameters related to the subsurface conditions, including soil types, standard penetration test blow counts, relative density, and shear strengths.

The report should then be reviewed, approved, and signed by the Project Geologist as identified in the project work plans.

6 REQUIRED FORMS

6.1 Field Logbook

6.2 Task-Specific Analyte List

6.3 Chain-of-Custody Record

MSOP NO. 9.2
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SURFACE WATER SAMPLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface water samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QC/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to surface water sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Materials:

- Appropriate sample containers with labels and preservatives, as required.
- Hard plastic or steel cooler with cold packs (or ice) for samples.
- Temperature, pH, conductivity, and turbidity meters.

MSOP NO. 9.2
REVISION NO. 0
October 2001

- Equipment calibration standards.
- Organic vapor meters.
- Plastic sheeting, if needed.
- Decontamination supplies, as required.
- Personal protective clothing and equipment, if required by the project Health and Safety Plan.
- Field logbook and sample forms

5 PROCEDURE

This section contains the procedures involved with surface water sampling. Proper sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives
- Locations of samples to be collected
- Numbers and volumes of samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined in this SOP for surface water sampling will be followed.

5.1 Surface Water Sampling Requirements

5.1.1 Equipment Selection and Sampling Considerations

Sampling equipment is constructed from a variety of materials. The most inert material (e.g., Teflon, stainless steel), with respect to known or anticipated contaminants, should be used whenever possible. The project work plans will describe the type of equipment to be used. If non-dedicated sampling is to be used and the contaminant histories of the sites are known, it is advisable to establish a sampling order starting with the least contaminated site and progressing to the most contaminated last.

5.1.2 Sampling with a Bailer or Dipper

Sampling should be conducted in accordance with the project work plans. The standard procedure for sampling using a bailer or dipper will be conducted as described below.

5.1.2.1 Inspect the equipment to ensure that it is in good working order.

5.1.2.2 Calibrate all field analytical test equipment (e.g., pH, temperature, and conductivity) according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

5.1.2.3 If non-dedicated sampling equipment is being used, decontaminate according to MSOP No. 6.0. During decontamination, the equipment should again be inspected for damage and, if damage is present, the equipment should be repaired or replaced with undamaged equipment.

5.1.2.4 Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

5.1.2.5 Using the bailer or dipper, collect water directly from the surface water body being monitored. Care should be taken to avoid disturbing the sample surroundings, e.g., stirring up sediment form the bottom of a stream or pond.

5.1.2.6 Collect the sample directly into the provided sample bottle (container), minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analysis should be filled to the base of the bottle neck.

5.1.2.7 The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples.

5.1.2.8 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

5.1.2.9 Cap the bottle and attach custody tape across the cap so that any attempt to remove the sample or open the sample bottle will be evident. Fill out and attach the sample label to the bottle per MSOP No. 2.1. The sample will be assigned a sample number per MSOP No. 2.2.

5.1.2.10 Document the sampling event on the Field Logbook.

MSOP NO. 9.2
REVISION NO. 0
October 2001

5.1.2.11 As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziplock™ or equivalent). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

5.1.2.12 Handle and ship the sample according to the procedures outlined in MSOP No. 2.1, following appropriate custody procedures described in MSOP No. 1.1. Samples stored temporarily on site will be maintained per MSOP No. 2.3.

5.1.3 Sampling with a Peristaltic Pump

Sampling will be conducted per the project work plans. The standard procedure for surface water sampling using a peristaltic pump will be conducted as described below.

5.1.3.1 Inspect the equipment to ensure that it is in good working order.

5.1.3.2 Conduct all field analytical test equipment (pH, temperature, and conductivity) calibration as discussed in Section 5.1.2.2.

5.1.3.3 Conduct equipment decontamination as described in Section 5.1.2.3. However, the old Tygon™ tubing should not be decontaminated. New tubing should be used for each site.

5.1.3.4 Connect new Tygon™ tubing to the rotor head of the pump motor and tighten until snug.

5.1.3.5 Run a short section of the tubing from the discharge side of the pump head to a collection vessel.

5.1.3.6 Insert the free end of the influent tubing into the surface water site and lower it to the middle of the water column.

5.1.3.7 Inspect the sampling bottles to be used per Section 5.1.2.4.

5.1.3.8 Turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample bottles.

5.1.3.9 Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottle neck.

MSOP NO. 9.2
REVISION NO. 0
October 2001

5.1.3.10 The samples should be collected in the order of volatility as described in Section 5.1.2.7. VOC samples should not be collected with a Peristaltic Pump.

5.1.3.11 Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

5.1.3.12 Appropriately cap, label, and number the samples as discussed in Section 5.1.2.9.

5.1.3.13 Document the sampling event in the Field Logbook.

5.1.3.14 Appropriately seal, store, handle, and ship the samples per Sections 5.1.2.11 and 5.1.2.12.

6 REQUIRED FORMS

6.1 Field Logbook

MSOP NO. 9.2
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 10.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
LITHOLOGIC LOGGING

1 PURPOSE

The purpose of this procedure is to define the requirements necessary for borehole and sample logging. The major objective of this procedure is to provide a uniform set of guidelines that will aid in developing consistency among sample descriptions and sample techniques. The importance of accurate, complete, clear, and concise logs cannot be overemphasized.

2 BACKGROUND

Borehole logging is used to determine the geologic relationships of subsurface soil and rock formations. The relationship of geologic formations and features is important in describing groundwater flow and in determining probable contaminant migration pathways.

3 RESPONSIBILITIES

3.1 The Field Geologist is responsible for on-site monitoring of drilling and soil sampling operations, for recording (logging) pertinent information regarding the geologic materials penetrated during the operations, and for ensuring that the well and sample numbering system is consistent with the site specific sampling and analysis plan.

4 EQUIPMENT

4.1 Required Equipment

1. Clipboard
2. Drilling log forms
3. Portable organic vapor detector
4. Field logbook, straight edge and black permanent ink
5. Weighted engineer's tape
6. Folding rule or tape measure
7. Sand gauge
8. Color chart
9. Acid bottle
10. Water level indicator
11. Site map
12. Copy of drilling contract
13. Waterproof marking pen
14. Sample jars or bags

MSOP NO. 10.0
REVISION NO. 0
October 2001

4.2 Optional Equipment

1. Hand lens
2. Brunton or equivalent compass
3. Pocket penetrometer
4. Equipment pouch
5. Flagging tape
6. Cooler and water bottles
7. Flashlight
8. Rock hammer

5 PROCEDURE FOR FILLING OUT DRILLING/WELL LOG

This form is intended for use in the field during the drilling, sampling, and logging process for soil borings and wells. Most of the items can be neatly and legibly included in the field; however, some items, such as the graphic log column, may be reserved for completion in the office. The purpose of the log is to clearly document the events and findings of the drilling activity. All pertinent data related to boring/drilling operations must be concisely recorded as objectively as possible. The geologist or engineer has the option to resubmit this form in a deliverable as a completely redrafted/typed form, or as a combination of information applied in the field and in the office. Regardless, the original field log should be retained in the permanent file. Any alterations or changes between the office copy and the original should be justified. To complete the boring or well logs:

- Fill out information on header of the log noting either boring or well number, if well is to be installed. Use the sampling site identification number.
- Note number under "Location".
- Note start and end date of boring or well installation under "Date", use MM/DD/YY format.
- Briefly describe wind direction, speed, and temperature under "Weather".
- The logging geologist or engineer should include his name under "Logged by", include three initials.
- The driller's name and drilling company should be included under "Drilled by", include three initials for the driller's name.
- "Drilling method" should contain information such as hollow-stem auger and auger inside diameter. If using rotary methods, include size of bit and rotary method used.
- "Sampling method" should be described as length of sampler and type, i.e., 2.5′ split spoon. The sampling method should be described such that it is easily translatable to one of the following codes at time of data entry:
  - B Bail
  - C Composite grab
  - G Single grab

MSOP NO. 10.0
REVISION NO. 0
October 2001

- P   Pump
- S   Split-spoon core sampling
- T   Shelby tube core sampling
- U   Soil auger
- X   Composite core sample
- Z   Scraping from physical surface
- 1   Magnetometer (UXO survey)
- 2   Well sampler
- 9   Trip and rinse blanks

- "Gravel pack" should include the depth interval of gravel pack installation, sieve filter size, and type, e.g., 50′-39′, 20-40 Colorado silica.
- "Seal" The seal should describe the depth interval of seal above the gravel pack and type. The seal should also describe the depth interval of grout slurry, e.g., 39′ - 34′ - Bentonite pellets, 34′ - 0′ - Bentonite/grout slurry

Under the header of casing, the casing description will require the following:

- "Type" Schedule 40 polyvinyl chloride (PVC), stainless steel etc.
- "Diameter" The information supplied here will be reported in inches (usually 4 inch).
- "Length" The length of casing or riser should include stick-up at the surface.

Under the heading of screen, the well screen will require the following information:

- "Type" Schedule 40 polyvinyl chloride (PVC), stainless steel etc.
- "Slot" The screen slot size. For silts and fine-grained sands, the slot size will be 0.01 inch. For sands medium to coarse grained, the slot size will be 0.02 inch.
- "Diameter" The diameter for well screens reported in inches (usually will be 4 inch).
- "Length" The length of the well screen in reported feet.
- "Hole Diameter" The diameter of hole cut by either a rotating bit or auger cutting head. Reported in inches.
- "Total Depth" The total depth drilled (in feet). If sampled deeper than depth drilled, this should be noted at the bottom of the log.
- "Location Map" A sketch of the boring location should be constructed in this corner.
- Topographical setting will be one of the following:

  - DEPR   Local depression
  - DTCH   Drainage ditch
  - DUNE   Dunes (mound, ridge, or hill of windblown sand; bare or

MSOP NO. 10.0
REVISION NO. 0
October 2001

covered with vegetation)

- FLAT Flat surface
- HLSD Hillside slope
- HLTP Hilltop
- PDMT Pediment (broad, gently sloping erosion surface)
- TRCH Trench (a long, narrow excavation, natural or artificial)
- VALY Valley - flat valleys of all sizes

- "Surface cover" will be bare, wooded, or grassy.

Below the header are lithology/remarks and sample classifications. The following sample classifications should be described as follows:

- "Moisture Content" (Clays and Sands)

  - Dry
  - Damp
  - Moist (compactable)
  - Wet (not compactable)
  - Saturated
  - "Sorting" (Sands only)
  - Very well
  - Well
  - Moderately
  - Poorly
  - Very poorly

- "Density" or consistency (CONSS) (Sands and Clay) Density is described by the number of drops required by a 140 lb. hammer over 30 inches to drive a 2-inch outside diameter, 1 3/8 inch inside diameter, split-spoon 6 inches. The following is a description of soil consistency (density):

Sand or Gravel	**Blows per Foot**	**Silt or Clay**	**Blows per Foot**	**Thumb Penetration**
VL (Very Loose)	0-4	VSO (Very Soft)	0-2	Very easy-inches
L (Loose)	4-10	SO (Soft)	2-4	Easily inches
MD (Medium Dense)	10-30	M (Medium Soft)	4-8	Moderate effort-inches
D (Dense)	30-50	ST (Stiff)	8-15	Indented easily
VD (Very Dense	> 50	VST (Very Stiff)	15-30	Indented by nail
		H (Hard)	> 30	Difficult by nail

MSOP NO. 10.0
REVISION NO. 0
October 2001

- Other descriptions may include:

  - NC (Non-cemented)
  - PC (Poorly cemented)

- "Plasticity" Plasticity refers to the case in which cohesive soils are molded. The following describes the plasticity terms.
  - EXTREMELY HARD, resistant to pressure, not broken by hand
  - NONPLASTIC, not wire formable
  - SLIGHTLY PLASTIC, wire formable but soil remains easily deformed
  - PLASTIC, wire formable, moderate pressure required
  - VERY PLASTIC, wire formable, much pressure required

- "Sample Number" In this column, record the number order that the sample was taken.
- "TIP Reading" Refers to "Total Ionizables Present". Record the headspace reading here and the type of instrument used, i.e., HNU, OVM, etc.
- "Sample Recovery" After obtaining a split-spoon sample or Shelby sample, measure the length of recovered sample to the nearest 0.01′ and record level.
- "Penetration Resistance" The blow counts for every 6 inches of driving the sample are to be recorded under this heading.
- "Color" The Munsell soil color or Geological Society of America soil color codes (COLOR) are a combination of the hues, values, and colors listed below:

  - Hue: 2Y, 2YR, 5B, 5BG, 5G, 5GY, 5P, 5PB, 5R, 5RP, 5Y, 5YR, 7R, 7YR, 10G, 10GY, 10R, 10Y, 10YR, N
  - Value: 0 - 9
  - Color: 0 - 8 (not used when hue is "N"). A Munsell color chart will be available for color determination.

- "USCS Classification/Lithology/Grain Size, Modifications/Remarks". The predominant lithology or lithologies should be identified first in capital letters, followed by qualifying adjectives that define grain size, color (using a Munsell chart), mineralogy, structural/textural features, bedding and laminations. For mixed lithologies within a common interval, provide relative percentages of the two or more lithologies within parenthesis following the lithologic name. For example, Sand (fine-medium [60%]) brownish yellow (10 yr. 6/6), and Gravel coarse (40%) very pale brown (10 yr. 7/3). Any obvious features related to evidence for contamination, such as odor or staining, should be documented. Drilling comments and occurrences should also be noted under this section. The acceptable codes, based on Unified Soil Classification System (USCS) augmented by lithology and special codes, are identified in Table 1. Codes for grain size (soil) are listed below:

MSOP NO. 10.0
REVISION NO. 0
October 2001

Action or Measurement		**Acceptable Entries**	
Code	**Description**	**Code**	**Description**
GRAIN	Grain size (soil)	For soils:	
		C	Coarse
		CF	Coarse to fine
		F	Fine
		FM	Fine to medium
		LG	Large
		vM	Medium
		MC	Medium to coarse
		SMALL	Small
		VC	Very coarse
		VF	Very fine

Rock texture codes are available, but have not been included here since they are not expected.

Table 1 Soil Classification and Lithology.

Action or Measurement		**Acceptable Entries**	
Code	**Description**	**Code**	**Description**
USCS	Unified Soil Classification System augmented by lithology and special codes		Separate dual USCS codes by a hyphen.
		USCS Codes:	
		CH	Fat clay, inorganic clay of high plasticity
		CL	Lean clay, sandy clay, silty clay, or low to medium plasticity
		GC	Clayey gravel, gravel-sand-clay mixtures
		GM	Silty gravel, gravel-sand-silt mixtures
		GP	Gravel, poorly graded, gravel-sand mixtures, little or no fines
		GW	Well graded gravel-sand mixture, little or no fines
		MH	Silt, fine sandy or silty soil with high plasticity
		ML	Silty and very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
		OH	Organic clays of medium to high plasticity, organic silts
		OL	Organic silts and organic silty clays of low plasticity

MSOP NO. 10.0
REVISION NO. 0
October 2001

Action or Measurement		**Acceptable Entries**	
Code	**Description**	**Code**	**Description**
		PT	Peat or other highly organic soil
		SC	Clayey sand, sand-clay mixtures
		SI	Shells
		SM	Silty-sand, sand-silt mixtures
		SP	Sand, poorly-graded, gravelly sands
		SW	Sand, well-graded, gravelly sands
		WD	Wood
		Special:	
		ASH	Ash
		ASPHLT	Asphalt (road material
		CONC	Concrete
		CRLMSN	Crushed limestone
		FILL	Unknown man-made landfill material
		LC	LC Lost core
		NR	NR No recovery
		NTLOGD	Not logged
		RUBBLE	Construction debris rubble or demolition fill
		VOID	Void or cavity
WSTAT	Final status of the well	CB	Well filled with grout: cement-bentonite
		FB	Well filled with bentonite
		FC	Well filled with concrete
		FG	Well filled with gravel
		FS	Well filled with soil
		NC	Well filled with grout: neat cement
		O	Open well
		OP	Open well with piezometer or observation well installed
		WD	Well damaged
MODIF	Lithology modifications	B	Boulders
		BDWX	Badly weathered
		CAL	Calcareous
		CARB	Carbonaceous
		CC	Concretions
		CEM	Cemented
		CHE	With chemicals (based on headspace reading)
		CL	Clayey
		CS	Clay strata or lenses
		DCOLOR	Discolored
		FAULT	Faulted
		FECC	Iron concentrations
		FILL	Disturbed soil

MSOP NO. 10.0
REVISION NO. 0
October 2001

Action or Measurement		Acceptable Entries	
Code	**Description**	**Code**	**Description**
		FRACT	Fractured
		FRIA	Friable
		G	Gravelly
		HPL	Highly plastic
		IRNST	Ironstained
		LIG	Lignite fragments
		MICA	Micaceous
		ML	Silty
		MOT	Mottled
		O	Organic matter
		ODOR	Odiferous
		OX	Oxidized
MODIF	Lithology modifications	PL	Plastic
(continued)		ROUND	Rounded
		RT	Rootlets
		S	Sandy
		SDL	Sandstone lenses
		SDS	Sandstone fragments
		SH	Shale fragments
		SHLN	Shale lenses
		SHLY	Shaly
		SIS	Silt strata or lenses
		SL	Slickensides
		SLF	Shell fragments
		SLWX	Slightly weathered
		SO	Solid
		THSK	Thin streaks
		TR	Trace
		TRCL	Trace of clay
		TRG	Trace of gravel
		TRML	Trace of silt
		TRMN	Trace of manganese
		TRS	Trace of sand
		WCL	With clay
		WFE	With iron oxide
		WG	With gravel
		WGML	With gravel and silt
		WLAM	With laminations
		WML	With silt
		WS	With sand
		WX	Weathered

6 REQUIRED FORMS

6.1 Drilling Log Forms

MSOP NO. 11.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
SOIL STOCKPILING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for stockpiling of excavated soils. The details within this SOP should be used in conjunction with project work plans. The work plans may present additional project-specific requirements and procedures for soil stockpiling.

2 REFERENCES

None.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for assigning project staff to complete soil stockpiling activities, and for ensuring that this and any other appropriate procedures are implemented by project personnel. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for the periodic review of field generated documentation associated with soil stockpiling. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformance and requests for corrective action.

3.3 The Sampling Team Leader(s) assigned to this task is responsible for performing the task according to this SOP and other appropriate procedures identified in the project work plans. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

4 DEFINITIONS/MATERIALS

None.

5 PROCEDURE

5.1 General

5.1.1 Stockpiling of soils is overseen by various regulatory agencies. Prior to initiating excavation activities, ensure that the procedures and requirements for compliance with applicable federal, state, and local regulations regarding stockpiling of soils have been

MSOP NO. 11.0
REVISION NO. 0
October 2001

reviewed and understood. The standard procedures for short-term and long-term stockpiling are described below. The project work plans will also present the following information pertaining to soil stockpiling:

- Any additional requirements or procedures to be followed
- Equipment to be used
- Stockpile locations.

5.2 Short-term Stockpiling

5.2.1 Upon initiation of excavation activities, soil will be segregated on a site-specific basis. Potentially clean soils will be stored in a separate short-term stockpile at the site. Soil that is suspected or known to be contaminated will be short-term stockpiled at the site separately from the clean soil.

5.2.2 The short-term stockpiles will be placed upon two layers of impermeable sheeting (such as polyvinyl chloride, polyethylene, etc.). For short-term storage, the separated soils may also be placed in bins or drums for subsequent transport to long-term stockpiles, per the project work plans.

5.2.3 Each pile will be covered with impermeable sheeting at the end of each workday. The covering will be secured at both the top and base of the stockpile. Plastic sheeting will be utilized to limit soil aeration and the release of windborne dust and particulates. The cover will also limit access by rainwater, resulting in possible contamination of surface water runoff from the stockpile. If bins or drums are used for short-term storage, impermeable sheeting should be used to cover the bins and the covers to the drums should be secured and seated at the end of each workday.

5.2.4 Short-term stockpiling activities will be documented by the Project Technical Coordinator or field geologist on the Field Logbook.

5.3 Long-term Soil Stockpiling

5.3.1 When space and logistics allow, long-term stockpiles will be constructed on a concrete or asphalt base. Two layers of impermeable sheeting will be placed on top of the concrete or asphalt. All sheeting will be folded at joining edges with a three-foot overlap to prevent seepage.

5.3.2 A berm will be erected around each stockpile. Boards or hay bales can be used to construct the berm. The material used to construct the berm will be placed under the two layers of impermeable sheeting to provide containment of any liquids that might leach from the soil.

MSOP NO. 11.0
REVISION NO. 0
October 2001

5.3.3 Soil will be segregated by contaminant type (i.e., separate stockpiles for storage of soils impacted by gasoline, diesel, halogenated hydrocarbons, metals, etc.).

5.3.4 Each stockpile will be visibly labeled.

5.3.5 Covering of each pile with impermeable sheeting will be completed at the end of each workday. The covering will be secured at both the top and base of the stockpile. The sheeting will be utilized to limit soil aeration and the release of windborne dust and particulates. This cover will also limit access by rainwater, resulting in possible contamination of surface water runoff from the stockpile.

5.3.6 The Project Technical Coordinator or field geologist will document on the Field Logbook long-term stockpiling activities.

6 REQUIRED FORMS

6.1 Field Logbook

MSOP NO. 11.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 12.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
HOLLOW STEM AUGER DRILLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use during the supervision of drilling operations involving hollow stem auger techniques. Additional specific hollow stem auger drilling procedures and requirements will be provided in the project work plans.

2 REFERENCES

None

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all hollow stem auger-drilling activities are conducted and documented in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to hollow stem auger drilling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to hollow stem auger drilling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Hollow Stem Auger Drilling

A drilling method using rotating auger flights (typically in 5-foot joints) with a bit on the bottom of the lead flight (sometimes called the "lead auger"). The flights consist of a hollow pipe and an outer spiral plate, that when rotated, forces soil cuttings upward along the borehole wall to the surface. The auger string is advanced by rotation, with pressure exerted by the rig, forcing the bit to cut the soil at the bottom and direct cuttings to the augers.

A retractable plug with a pilot bit is placed at the bottom of the auger string to prevent cuttings from entering the hollow stem. When the plug is retracted, a sampler may be sent through the hollow center to sample soil at the bottom of the borehole without requiring the augers to be removed. A wireline sampler may also be attached to the inside of the lead auger for coring as the borehole is advanced.

This method is commonly used for drilling and sampling of soil borings, collection of soil gas and screening-level water samples, and installation of some smaller diameter wells. The well casing string may be placed through the hollow stem.

The hollow stem auger drilling method has advantages over other drilling techniques in certain circumstances, and disadvantages in others. This method is highly suitable for unconsolidated and consolidated fine-grained soils. Hollow-stem auger drilling can achieve the most rapid rates of penetration in soft sticky clay-dominated soils. However, coarse and consolidated gravels and hard bedrock may be too dense for adequate drill penetration. Soil cuttings are typically disaggregated and remolded, making bedding, fabric, and soil property determination difficult. The most reliable method for logging of soils during hollow stem auger drilling is by collecting relatively intact samples through the hollow stem. An advantage of the hollow stem auger method is that soil samples can be readily obtained from the bottom of the hole without requiring the removal of the auger string (unlike air or mud rotary methods).

This drilling method may be used to install monitoring wells (limited by diameter) as there is good depth control, and the auger can be progressively pulled as well construction materials are added to the borehole. The methodology may also be used to drill out monitoring wells for abandonment.

Another advantage of the hollow stem auger method is that air or mud is not required as circulating media. Therefore, there is limited to no potential for flushing of soil samples collected for chemical analyses, and a reduction in volumes of investigated derived wastes requiring costly handling and management procedures. Auger-type rigs can be significantly smaller than other types of rigs, making them the most suitable for some jobs with significant space constraints, including overhead clearance.

Disadvantages of the hollow stem auger method include a typical maximum depth of 100 to 200 feet (may be less depending on soil conditions). Hard soil horizons or very coarse gravel (cobbles and boulders) may be impenetrable with this method.

5 PROCEDURE

This section contains procedures and requirements for hollow stem auger drilling. The selection and implementation of hollow stem auger drilling techniques must incorporate site specific conditions and requirements. Consequently, the project work plans will identify the following:

- The purpose of each borehole (e.g., to install monitoring well, soil sampling, well abandonment, etc.)

MSOP NO. 12.0
REVISION NO. 0
October 2001

- Specific methodology for drilling, including equipment and cuttings/fluid containment
- Specific locations, depths, and diameters of boreholes
- Objectives and types of sampling and/or logging of borehole
- Details of mobilization/demobilization and decontamination of equipment
- Appropriate health and safety guidelines and personnel protective equipment
- Additional procedures or requirements beyond those covered in this SOP

5.1 Drilling Site Mobilization

5.1.1 Rig Decontamination and Preparation

5.1.1.1 All drilling and sampling equipment should be decontaminated before drilling as per MSOP Nos. 6.0 and 6.1, and the project work plans.

5.1.1.2 The driller and rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination prior to each time the rig is mobilized to a site. All clutches, brakes and drive heads should be in proper working order. All cables and hydraulic hoses should be in good condition. All auger joints and bits should also be in good condition (e.g., no cracked or bent blades, bits are not excessively worn, etc.).

5.1.1.3 Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to mobilize.

5.1.2 Site Preparation

5.1.2.1 The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

5.1.2.2 Before mobilization, the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (slip/trip/fall, overhead power lines, etc.), and determine how drilling operations may impact the environment (dust, debris, and noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, as per the project work plans.

5.1.2.3 The Project Technical Coordinator or appropriate designee should ensure that all identifiable underground utilities around the drilling location have been marked and the borehole location appropriately cleared per the project work plans. At a minimum, copies of the site clearance documents should be kept on-site.

5.1.3 Mobilization and Set-Up

MSOP NO. 12.0
REVISION NO. 0
October 2001

5.1.3.1 Once the site is prepared, the rig is mobilized to the site and located over the borehole location. The rig is leveled with a set of hydraulic pads attached to the front and rear of the rig. The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig, and avoiding obstructions or hazards.

5.1.3.2 Appropriate barriers and markers should be in place prior to drilling, as per the site Health and Safety Plan. Visqueen (plastic, 6-mil thickness minimum) will be placed beneath the rig to contain any leakage of hydraulic fluids.

5.1.3.3 Appropriate cuttings and other investigation-derived waste containment should be set on site prior to commencement of drilling.

5.1.4 Health and Safety Requirements

5.1.4.1 Tailgate Safety Meetings should be held in the manner and frequency stated in the Health and Safety Plan. All personnel at the site should have appropriate training and qualifications as per the Health and Safety Plan.

5.1.4.2 During drilling all personnel within the exclusion zone should pay close attention to rig operations. The rotating auger blades can snag or catch loose clothing and literally screw someone into the ground.

5.1.4.3 Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the rig geologist/engineer of any unforeseen hazard or when anyone is approaching the exclusion zone.

5.2 Drilling Procedures

5.2.1 Breaking Ground

5.2.1.1 Prior to the commencement of drilling, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

5.2.1.2 The Field Geologist should inform the driller of the appropriate equipment (e.g., cookie cutter, etc.) to be used for penetration of the surface cover (e.g., asphalt, concrete, cement, etc.). In the event of breaking ground where a shallow subsurface hazard may exist (unidentifiable utility, trapped vapors, etc.), the driller should be informed of the potential hazard and drilling should commence slowly to allow continuous visual inspection and/or monitoring and, if necessary, to stop for probing.

MSOP NO. 12.0
REVISION NO. 0
October 2001

5.2.2 Borehole Drilling

During drilling operations, and as the borehole is advanced, the rig geologist/engineer will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;
- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare soil, soil vapor, and groundwater samples.

5.2.2.1 As drilling progresses the rig geologist/engineer should observe and be in frequent communication with the driller regarding drilling conditions. This includes relative rates of penetration (indicative of fast or slow drilling) and chattering or bucking of the rig. These conditions, including the relative drilling rate, should be recorded on the boring log per MSOP No. 10.0. Drilling should not be allowed to progress faster than the rig geologist/engineer could adequately observe conditions, compile boring logs, and supervise safety and sampling activities.

The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as additional auger joints are added to the auger string. Any observed problems, including significant down time, and their causes are recorded on the Field Logbook.

5.2.2.2 Cuttings and fluids containment during drilling should be observed and supervised by the Program Geologist, as per specifications in the project work plans.

5.2.2.3 The Field Geologist will oversee or conduct appropriate health and safety sampling and monitoring. If any potentially unsafe conditions are evident from the above drilling observations and the health and safety sampling and monitoring, the Field Geologist may suspend drilling operations at any time and take appropriate actions as per the Health and Safety Plan. In the event suspension of drilling activities occur:

- The Project Technical Manager must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the Field Logbook.

5.2.2.4 During drilling the rig geologist/engineer will compile a boring log as per MSOP No. 10.0. The log will be compiled preferably from soil samples recovered while drilling. Logs should only be compiled from cuttings if this is the only option. Observations of drilling conditions are also entered on the log as discussed above and in

MSOP No. 10.0. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the Field Logbook.

5.2.2.5 Subsurface soil samples may be collected with a split spoon sampler or Shelby tube during drilling per MSOP No. 3.1. The Field Geologist will supervise the sampling. Soil samples (drive samples) can be readily obtained at discrete intervals with these methods.

5.2.2.6 Soil organic vapor (SOV) sampling may be conducted at discrete intervals during hollow stem auger drilling. This is done by stopping at the desired depth and driving a sample probe through the hollow stem into the soil ahead of the bit and then collecting a vapor sample. The sampling should be supervised by the rig geologist/engineer.

5.2.2.7 Ground water screening (grab) samples can be obtained at discrete intervals during drilling. One method is to auger to the bottom of the selected interval or zone and pull the auger back to the top of the interval, allowing ground water through the open borehole. A water sample is then collected with a bailer run through the inside of the augers. Another method is to stop the augers at a selected interval or zone and advance a hydropunch sampler beyond the lead auger to retrieve a water sample.

5.2.3 Borehole Abandonment

If the borehole is to be abandoned once drilling is completed, the abandonment will follow procedures outlined in the project work plan. The abandonment will be supervised by the rig geologist/engineer.

5.2.4 Monitoring Well Completion

If a monitoring well is to be installed in the borehole, the well completion will follow procedures outlined in MSOP No. 8.1. The rig Field Geologist will supervise the well installation activities.

5.3 Demobilization/Site Restoration

After drilling, sampling, well installation or borehole abandonment is completed the hollow stem rig is rigged down and removed from the borehole location. The rig geologist/engineer or appropriate designee will supervise the demobilization/site restoration.

5.3.1 All debris generated by the drilling operation will be removed and appropriately disposed.

5.3.2 The site should be cleaned (ground washed if necessary) and surface conditions restored as per the project work plans.

5.3.3 All abandoned borings should be topped off and completed as per the project work plans. All monitoring wells will also have their surface completions finished as per the project work plans.

5.3.4 Any remaining hazards as a result of drilling activities will be identified and appropriate barriers and markers put in place, as per the Health and Safety Plan.

5.3.5 All soil cuttings and fluids will be properly contained, clearly labeled, and maintained as per the project work plans.

5.3.6 The Field Geologist or appropriate designee should inspect the site to make sure that post-drilling site conditions are in compliance with the project work plans.

6 REQUIRED FORMS

6.1 Field Logbook

6.2 Boring Log

MSOP NO. 12.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 13.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
FIELD QUALITY CONTROL (QC) SAMPLING

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for conducting field quality control (QC) sampling. Field QC sampling is required to assist in verifying the quality and integrity of samples collected during a given sampling event. Additional specific field QC sampling procedures and requirements will be provided in the project work plans.

2 REFERENCES

2.1 EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

2.2 EPA, August 1988, EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field-generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to environmental and QC sampling activities is responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4 DEFINITIONS/MATERIALS

4.1 Field QC Sample

A field QC sample is a physical sample collected during or for a specific sampling event. The purpose of this sample is to evaluate the quality and integrity of original samples collected during the specific sampling event.

MSOP NO. 13.0
REVISION NO. 0
October 2001

5 PROCEDURE

This section contains the requirements for field QC sampling. Field QC sampling is required to provide data to verify the quality and integrity of environmental samples collected during a given sampling event.

The details within this SOP should be used in conjunction with project plans. These plans will generally provide the following information:

- Sample collection objectives
- Numbers, types and locations of environmental (non-QC) samples to be collected
- Numbers and types of supportive QC samples to be collected
- Any additional QC sampling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 Quality Control Sampling Requirements

5.1.1 Field QC samples may consist of different media. Typical QC samples are as follows:

- Trip blank (TB)
- Equipment rinsate (ER)
- Field blank (FB)
- Field duplicate (FD)

5.1.1.1 Trip blanks are analyte-free water, shipped from and returned unopened to the laboratory in the same shipping containers for volatile organic, and at times gasoline hydrocarbons. The blanks are prepared at the laboratory using ASTM Type II DI Water, sent to the project location, carried with the sampling team(s) during sampling, and shipped to the laboratory for analysis with the environmental samples.

Trip blank samples are commonly collected and analyzed at a rate of one per sample cooler containing samples for volatile organic analyses or the gasoline fraction of petroleum hydrocarbons. The number or rate of trip blanks to be collected and the specific analyses to be conducted for the trip blanks will be provided in the project work plans.

5.1.1.2 Equipment rinsate samples are collected from the final rinse water during decontamination of groundwater, soil, or waste sampling equipment. This type of equipment includes bailers, split-spoon samplers, soil sample sleeves, hand augering equipment, surface soil sampling equipment, purge and sample pumps, etc.

Rinsate samples are generally collected at a rate of one per day per sampling team during the sampling event. Equipment rinsates are usually collected from dedicated sampling equipment only upon installation. The number or rate of equipment rinsate samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the rinsate samples will also be developed and documented in the project work plans.

5.1.1.3 Field blanks are prepared from the water that is used for decontamination. One sample from each sampling event and each water source or lot number is generally collected and analyzed for all parameters of interest for the project. Upon collection, a description of the water source for the field blank sample should be documented in the Field Logbook. The number or rate of field blank samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field blank samples will also be developed and documented in the project work plans.

5.1.1.4 For soils, field duplicate samples are generally collected by co-located sampling (e.g., using successive sample tubes from the same split-spoon sampling run) or by splitting samples. Field duplicate water samples are commonly collected by retaining consecutive samples from the sampling device (e.g., bailer or sample pump discharge line). Field duplicate water samples may also be generated by splitting a collected volume; however, this practice may lead to a loss in volatile organic compounds and is not common practice for volatile analyses.

Field duplicate samples are commonly collected at a rate of 10 percent per media sampled. However, the number or rate of field duplicate samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field duplicates will also be developed and documented in the project work plans.

5.1.2 The type and number of QC samples collected for a particular project is based on specifications provided in project specific documents, i.e., the project work plans. Field QC samples are to be collected at appropriate times during a sampling event.

5.1.3 All field QC samples will be collected in proper containers with appropriate preservation per the project work plans.

5.1.4 The collection of field QC samples consisting of various media (e.g., soil, groundwater, etc.) will follow procedures in sample collection SOPs for the respective media and any other applicable procedures in the project work plans. For example, the collection of a groundwater field duplicate QC sample will follow procedures specified in the groundwater sampling SOP (MSOP No. 9.0). Equipment rinsate samples are collected directly while rinsing the sampling equipment following appropriate procedures in MSOP No. 9.0 and the project work plans. Field blank samples are collected by pouring decontamination water directly into sample containers following appropriate protocol in MSOP No. 9.0 and the project work plans.

5.1.5 Field QC samples will be labeled and numbered as described in MSOP Nos. 2.1 and 2.2 respectively and the project work plans.

5.1.6 The field QC samples will also be maintained under custody per MSOP No. 1.1, and be appropriately stored, handled and shipped per MSOP Nos. 2.0 and 2.3.

6 REQUIRED FORMS

6.1 Field Logbook

6.2 Chain of Custody Form

MSOP NO. 14.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for the proper handling and disposal of investigation-derived waste.

During environmental investigations at White Sands Missile Range, sampling crews may generate potentially contaminated Investigation-Derived Waste, including but not limited to the following types of materials:

- Saturated and unsaturated soil
- Groundwater
- Decontamination water
- Personal Protective Equipment (PPE) and miscellaneous refuse

2 REFERENCES

2.1 EPA, 1992, Guide to Management of Investigation Derived Wastes, EPA Publication Number 9345.3-03FS.

3 RESPONSIBILITIES

3.1 The Project Technical Manager and Technical Coordinator are responsible for ensuring that all investigation-derived waste is managed in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

3.2 The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if problems occur.

3.3 The Sampling Team Leader(s) assigned to environmental and QC sampling activities is responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4 REQUIRED MATERIALS

- Field logbook: surveyor's book or field book, bound and ruled/gridded, record book with sequentially numbered and waterproof pages.

MSOP NO. 14.0
REVISION NO. 0
October 2001

- Indelible black ink pens.
- Paint pens for marking drums
- Drum Tracking Form.

5 PROCEDURES

5.1 Waste Minimization Procedures

To the extent that it is practical, environmental investigations will follow waste minimization procedures. Guidelines for waste minimization are:

- Minimize materials that are introduced into any exclusion zone in an investigation area.
- Combine similar wastes throughout an investigation area in a single container wherever possible.
- Combine decontamination water from multiple sites in one container.
- Use a container of the appropriate size (e.g., use a 5-gallon drum for small amounts of waste unless a 55-gallon drum is needed to hold all the waste).
- Decontaminate and reuse material and equipment whenever practical. Minimize the volume of decontamination water generated.
- With solid environmental media and materials, ensure that waste is tightly packed to minimize the number of containers.
- Use less hazardous substances whenever possible.

5.2 Waste Management Procedures Overview

Management of each IDW type will be discussed separately in Section 5.5. General IDW management procedures for all waste categories are subject to the procedures outlined below.

5.3 Waste Containerization Procedures

Container specifications are discussed in Section 5.5. Drums will not be completely filled. At least 6 inches of space will be left at the top of each drum to allow for expansion of waste due to freezing. All drums will be closed after receiving waste, and properly labeled and numbered as specified in Section 5.6.2.

Container accumulation points are associated with the location of each field activity. Separate container accumulation points will be designated for liquid and solid IDW. When the total IDW volume exceeds 55 gallons, or use of container is determined to be complete, the drum(s) will be sampled, labeled according to Section 5.6.2, and then moved to a Less Than 90-Day Storage Area while awaiting analysis and characterization.

MSOP NO. 14.0
REVISION NO. 0
October 2001

5.4 Waste Characterization

Obtain adequate IDW characterization data within 45 days after transfer of IDW to a Less Than 90-Day Storage Area. This information will be furnished to White Sands Missile Range on or before the 45-day deadline. Data from three sources may be used to characterize an IDW. These sources are:

- *Analytical Data from Environmental Samples Associated with IDW.* This data could identify chemicals associated with a listed hazardous waste. The data would support assigning a listed hazardous waste code to IDW associated with the environmental sample. In certain situations this data could prove useful in determining whether an IDW should have a characteristic hazardous waste code. (Note that this data could also be obtained from total constituent analysis of a sample of IDW.)

- *Analytical Data from RCRA Characteristic Testing on Samples of IDW.* This data can be directly used to identify a characteristic hazardous waste.

- *Historical Knowledge of Processes Which Generated Wastes Disposed in an Investigation Area.* This information identifies possible listed hazardous waste codes that might apply to IDW.

To expedite movement of IDW through the system, all IDW will be considered hazardous and managed as such, pending receipt of initial analytical results. If initial analyses support a non-hazardous designation, it is more time effective to remove a drum from the system than adding a new drum to the system.

5.5 Waste Management Procedures for Specific Types of Investigation Derived Waste

Due to the variable properties and/or regulatory requirements and guidelines for different types of IDW, certain specific procedures are required for each IDW type.

5.6 Unsaturated Soil IDW

Unsaturated soil cuttings will be classified into three categories that are managed separately.

- Unsaturated soils from soil removal areas will be placed in DOT Specification 1A2 open head drums for storage. Containerized IDW will be transferred to a Less Than 90-Day Storage Area in accordance with procedures outline in Section 4.1. Analytical samples will be collected prior to transfer.
- Unsaturated soil cuttings from borings will be returned to the test hole after completion of the boring.
- Unsaturated soil cuttings from monitor wells installed outside the area of investigation will be spread on the ground in the immediate vicinity of the monitoring well.

MSOP NO. 14.0
REVISION NO. 0
October 2001

5.7 Saturated Soil Cuttings

All saturated soil cuttings will be placed in DOT Specification 1A2 open head drums for storage. Containerized IDW will be transferred to a Less Than 90-Day Storage Area in accordance with procedures outlined in Section 4.1. Analytical samples will be collected prior to transfer.

5.8 Purged Groundwater

Any purged groundwater generated during monitoring well development or prior to groundwater sampling will be placed in DOT Specification 1A2 closed head drums, or applicable alternate container designated within the Work Plan, for storage. Containerized IDW will be transferred to a Less Than 90-Day Storage Area in accordance with procedures outlined in Section 4.1. Analytical samples will be collected prior to transfer.

5.9 Decontamination Water

Decontamination water will be placed in DOT Specification 1A2 closed head drums, or applicable alternate container designated within the Work Plan, for storage. Containerized IDW will be transferred to a Less Than 90-Day Storage Area in accordance with procedures outline in Section 4.1. A composite analytical sample will be collected prior to transfer. The container will be labeled as to the investigation area(s) at which the equipment was used. When combining decontamination water from multiple sites into one container, it is important that the container be marked with all the site identification numbers where the decontamination fluids were used.

5.10 Personal Protective Equipment and Miscellaneous Refuse Generated within an Investigation Area

No hazardous waste is expected to be generated from PPE. Any anticipated hazardous IDW PPE would be addressed within the Project Work Plan. Maximum effort will be made to minimize the amount of refuse generated within an investigation area. Arrangement for disposal of refuse will be the responsibility of the Investigation Contractor.

5.11 Drum Management

Drum inventory and tracking will be managed through a three-step process. The process includes proper drum labeling, proper assignment of drum numbers, and accurate documentation on the Field Logbook.

5.12 Drum Labeling

All drums used to store potentially contaminated IDW at White Sands Missile Range will be labeled by the end of each workday. Drums must be covered and sealed daily before field personnel leave the site. No unlabeled drums in use will be left on site. Drums will be labeled on the side and lid using a paint marker. Duplicate drum numbers will be avoided by reviewing the Field Logbook before assigning a number to an IDW drum. Drum labeling will include the following:

- Drum number
- Dates of first use and last use
- Investigation area number
- Site Identification (include SWMU #, sample type, sample No.)
- Waste type (e.g., purge water, unsaturated soil cuttings)
- Level of PPE worn when IDW was generated
- The phrase "Awaiting Analysis"

5.13 Drum Number

All drums of IDW will be numbered to aid in drum management through the Field Logbook. Drum number will comply with the following:

- Drum numbers will be sequential, using an "XX" two-character designation specific for the Investigation Contractor, followed by four numbers.
- Drum numbers will begin with XX0001 and end with the last drum used during the investigation.
- An adequately trained Investigation Contractor field team member will track the drums using the Field Logbook.
- The field team member will return the Field Logbook to the field operations leader responsible for tracking at the end of each workday.

5.14 Field Logbook

The field operations leader will keep all drum inventory information on the Field Logbook. The Field Logbook will contain the following information:

1. Unique drum ID number (as described in Section 5.6.2)
2. Site ID
3. Drum contents
4. Dates:
    - Drum filled
    - Sample collected
    - Drum transfer to Less Than 90-Day Storage Area
    - Analytical results must received by
    - Analytical results actually received

MSOP NO. 14.0
REVISION NO. 0
October 2001

5. Hazardous waste determination decision
6. Date information was entered into HWTS
7. Date Turn-in is complete for acceptance by the White Sands Missile Range
8. Date drum is moved from a Less Than 90-Day Storage Area to approved TSD facility

Drums are moved from the investigation area to a Less Than 90-Day Storage Area with a copy of the Field Logbook.

5.15 Recordkeeping

The Investigation Contractor will maintain completed Field Logbooks and waste characterization data packages that they generate.

6 REQUIRED FORMS

6.1 Field Logbook

MSOP NO. 15.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
PREPARATION, REVISION, AND APPROVAL OF PLANS AND PROCEDURES

1 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities associated with the preparation, revision, and approval of quality-affecting documents.

2 REFERENCES

None.

3 RESPONSIBILITIES

3.1 The Program Manager has the responsibility to assure that standard operating procedures and plans that are required for work assignment orders are prepared by qualified personnel and are reviewed and approved by authorized personnel, prior to the implementation of the work assignment order activities.

3.2 The Quality Assurance Officer is responsible for the preparation and maintenance of SOPs. He/she reviews and approves SOPs. He/she is also a part of the approval cycle for the technical planning documents (e.g., Work Plan, Sampling and Analysis Plan, etc.).

4 DEFINITIONS

4.1 Standard Operation Procedures (SOP)

A set of implementing procedures that prescribe the actions necessary to complete a work operation in accordance with accepted practices for quality and safety.

5 PROCEDURE

5.1 Preparation

5.1.1 The Program Manager determines the need for establishing a procedure describing how to perform quality-affecting activities. He/She also initiates revisions to these documents due to programmatic requirement changes, audit findings, or corrective actions, as applicable.

5.1.2 Procedures, fieldwork variance, and drawings will include appropriate qualitative and quantitative acceptance criteria for determining satisfactory work performance and quality compliance.

5.2 Format

5.2.1 The SOPs will adhere to a consistent format in accordance with the following guidelines.

5.2.2 Revision Block - This area will contain the document identification, section or procedure number, revision number, date, and pages. This information will appear consistently on each page of the document in the upper right-hand corner.

5.2.3 Title Block - This area will contain the title of the SOP and will appear on the first page only.

5.3 Contents

5.3.1 Procedures required to implement work assignment order activities will include the information listed below. When any of these items are not required or are inappropriate to the SOP, they will be noted by the word "none".

1.0 Purpose - Describe the purpose of the SOP. Be as specific as possible; do not generalize.
2.0 References - Identify pertinent documents or procedures that interface with the SOP being prepared. Reference to specific documents that are directly applicable to the SOP (e.g., Chemical Data Quality Management Plan (CDQMP), Sampling and Analysis Plan (SAP), Field Sampling Plan (FSP), Health and Safety Plan (HSP) etc.) is acceptable.
3.0 Responsibilities - Assign responsibility for accomplishing activities, be specific in context. Include appropriate reporting requirements for assuring that important activities have been satisfactorily accomplished.
4.0 Definitions/Materials - Define words and phrases having a special meaning of application within the SOP. List materials and equipment required for the procedure(s) being performed.
5.0 Procedure - Identify the sequence of activities to be followed for accomplishing activities, be specific in context. Incorporate examples of forms or documents that are required to be completed as a result of the procedure implementation.
6.0 Required Forms - List all forms that are required for the successful implementation of the specific SOP.

5.4 Approval

5.4.1 The signature of the Program Manager, Quality Assurance Officer and others as deemed necessary on the Table of Contents/Log of Revisions or cover page will signify the documents and revisions listed are authorized for use. For SOPs, the Program Manager and Quality Assurance Officer will sign the Table of Contents/Log of Revisions Page of the procedure manual indicating their approval.

MSOP NO. 15.0
REVISION NO. 0
October 2001

5.5 Manual Change Requests

5.5.1 Personnel responsible for complying or interfacing with the requirements of the approved plans, SOPs may request revisions to these documents via a Manual Change Request memo. Manual Change Requests are different from fieldwork modifications, as they are used to suggest improvements to existing processes or systems and are not structured to adjust the plans and procedures based on changing site conditions.

5.5.2 Originators of the Manual Change Request are responsible for forwarding a Manual Change Request to the Program Manager for dispositioning.

5.5.3 The Program Manager is responsible for reviewing all Manual Change Requests and either accepting or rejecting them. If a Manual Change Request is accepted, the Program Manager will indicate this acceptance by signing and dating the Manual Change Request. He/she will forward a copy of the signed Manual Change Request to the originator for their files. The Program Manager will maintain a copy of accepted Manual Change Request for logging and revision inclusion.

5.5.4 If a Manual Change Request is not accepted, the Program Manager will indicate this by marking, signing and dating the Manual Change Request. Non-accepted Manual Change Requests will be maintained in the project files.

5.6 Revisions

5.6.1 Revisions to approved plans will be documented and will receive the same level of review, approval, and control as the original document.

5.6.2 The Program Manager using the Fieldwork Variance form will issue fieldwork variances. When twelve (12) months have elapsed for a Field Work Modification Form or six (6) have been issued, whichever comes first, the Program Manager will issue new revisions to the affected documents to incorporate the Field Work Variances.

6 REQUIRED FORMS

6.1 Manual Change Request

MSOP NO. 15.0
REVISION NO. 0
October 2001

THIS PAGE INTENTIONALLY LEFT BLANK

MSOP NO. 16.0
REVISION NO. 0
October 2001

MEVATEC CORPORATION
Standard Operating Procedures
QUALITY INSPECTIONS AND INSPECTION RECORDS

1 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities for the performance and documentation of Quality Control inspection of activities performed during delivery order activities to ensure compliance with established requirements.

2 REFERENCES

None.

3 RESPONSIBILITIES

The Program Manager and the Quality Assurance Officer will select the most qualified individual(s) to perform the QC inspection. This determination will be made based on the nature of QC inspection.

4 DEFINITIONS

4.1 Inspection –
Examination or measurement to verify whether an item or activity conforms to a specified requirement(s).

5 PROCEDURE

5.1 Qualification of Inspectors

5.1.1 Personnel performing inspection activities will have the necessary expertise in the area to be inspected but will be sufficiently independent of the activity performed.

5.1.2 Prior to performance of inspection activities, personnel designated for that responsibility would review and be thoroughly familiar with the procedures, regulations, etc., governing the activities to be inspected.

5.2 Field Inspection Plans and Reports

5.2.1 Activities requiring inspection (i.e., Preparatory Phase, initial Phase and Follow-up Phase) will have a definable features of work matrix prepared for that activity. Inspection(s) will be performed for definable features of work that are identified for each delivery order and will be performed consistent with ongoing delivery order activities.

MSOP NO. 16.0
REVISION NO. 0
October 2001

5.2.1.1 The definable features of work matrix will identify the items and activities to be inspected and will provide or reference the specification section and paragraph which specifies the requirements for each activity or item.

If a Nonconformance Report is required for activities being inspected, a reference will be provided on the Daily QC Report.

5.2.1.2 The Daily QC Reports will be issued identifying inspections performed. The report will be completed by the Quality Assurance Officer (or designee) and will address each inspection performed during the course of the daily activities and submitted to the Program Manager.

5.2.1.3 Items or activities not conforming to inspection acceptance criteria will be resolved and when determined necessary documented on a Nonconformance Report. Daily QC Reports will be logged and sequentially numbered. Each Daily QC Report will be signed by the inspector certifying that the activities listed within the report have been completed in accordance with the project planning documents to the best of his/her knowledge, and submitted for review by the Program Manager.

6 REQUIRED FORMS

6.1 Definable Features of Work Matrix

6.2 Daily QC Report

APPENDIX G

MONITORING WELL DESIGN AND INSTALLATION PLAN

APPENDIX G

MONITORING WELL DESIGN AND INSTALLATION PLAN

1.0 WELL DESIGN AND INSTALLATION

1.1 General Requirements

One groundwater monitoring well will be installed as part of this investigation, downgradient of the release site. The well will be installed to monitor the vadose zone/groundwater interface (estimated to be approximately 225 feet, or 68.6 m).

MEVATEC shall provide all drilling equipment, materials and personnel required to install the wells, as well as a qualified geologist or geotechnical engineer, who will be on site for all drilling, installation, development and testing operations.

Petroleum based lubricants, such as grease or oil, on drill rod joints shall not be permitted. Dispersing agents (such as phosphates) or acids shall not be used. No attempt shall be made to chemically disinfect the well. The drill tools and associated equipment will be decontaminated prior to commencement of drilling at each well and boring location. It is expressly required that toxic and/or contaminating substances shall not be used during any part of the drilling, well installation or well development processes.

1.2 Protection of Water Yielding Zones

All drilling activities and methods shall be performed in a manner intended to reduce the potential for the introduction of contaminants from one water-bearing stratum to another via the well bore or completed well.

1.3 Boring Diameter

The borehole for the monitoring well will be drilled using mud-rotary drilling techniques. Drilling fluid will consist of bentonite and/or biodegradable polymer and water, which will not interfere with the development of the well or introduce contaminants. The borehole widths for the well will not exceed 8 inches (20.32 cm) in diameter.

MEVATEC will have the responsibility of selecting and placing the well screen in the appropriate location in the borehole so that the completed monitoring well functions satisfactorily. The placement will take into consideration the sampling objectives of the well and the site-specific hydrogeologic conditions encountered during boring advancement. The screen interval will be placed so that approximately 5 feet (1.52 m) of the screen is above the water surface to account for any seasonal groundwater level fluctuations.

1.4 Well Installation

One monitoring well will be installed at a depth of approximately 245 ft (74.7 m) with a total screen length of 20-ft (6.1 m) from approximately 220-ft bgs (67.1 m) to 240-ft bgs (73.2 m). The groundwater flow direction is to the southeast. The well will be installed as described in the following sections.

1.5 Well Riser and Screen

The well screen for the groundwater interface monitoring well will consist of 20 foot (6.1 m) length, new, threaded, flush joint, nominal 4-inch diameter ASTM-D1785 Schedule 40 PVC material. This material will be non-contaminating, factory constructed, machine slotted. Field slotted or cut screen will not be used. The slot size for the well screen is No. 10 size (0.010 inch), or finer, to be compatible with the aquifer and gravel pack material.

The well riser will consist of new threaded, flush joint, polyvinyl chloride (PVC) (ASTM-D 1785 Schedule 40) pipe of 4-inch (10.16 cm) nominal diameter. A five-foot sump (sand trap), with a bottom cap, shall be located at the base of the screen. Screen and riser sections will be joined by threaded flush-joint couplings, to form water-tight unions that retain 100% of the strength of the screen. Solvent glues, cements, or adhesive tapes may not be used to join two sections of pipe and screen. Stainless steel centralizers will be placed at the bottom of the well screen, directly above the well screen, and at 50-foot intervals along the length of each well. Figure 1-1 (shown on next page) provides a typical schematic for the groundwater interface monitoring well.

1.6 Filter Pack

Filter pack material will consist of clean, washed, well graded, rounded to subrounded silica sand. Grain size will be selected so as to exclude the majority of the material in the aquifer. (20-40 mesh size with uniformity coefficient in the range of 1.1-1.6).

Filter pack will be placed 5 feet below the base of the sand trap to five feet above the top of the screened interval. To construct the upper seal, bentonite chips or pellets shall be added to at least five feet above the top of the gravel pack.

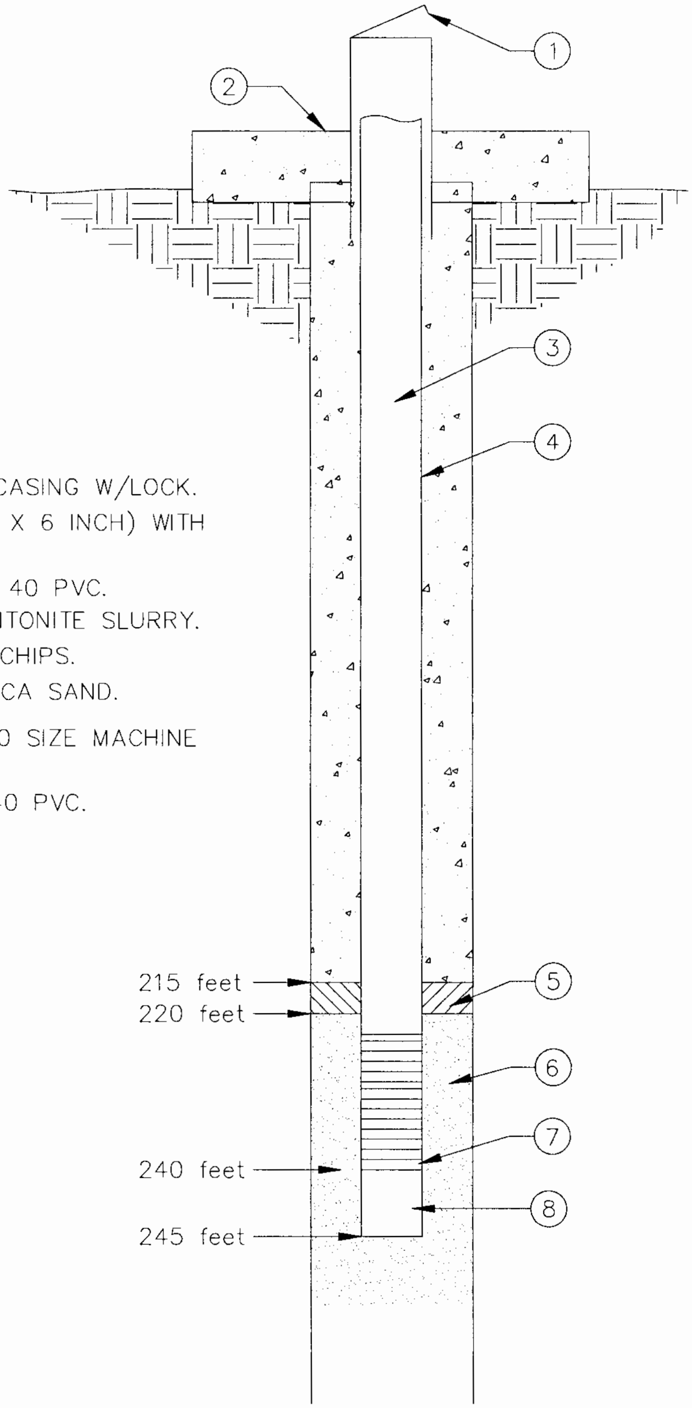
1.7 Bentonite Seal and Grout

A minimum 5-foot (1.5 m) seal, consisting of bentonite pellets or chips, shall be placed into the annular space between the riser and boring wall. The bentonite seal will be installed above the filter pack and if necessary, be hydrated by charging the hole with approved potable water.

To seal the upper borehole annulus, grout will be emplaced with a tremie pipe from the top of the bentonite seal to the land surface. The grout mixture will consist of a mixture of Portland cement (ASTM-C-150), bentonite powder (without additives) and potable water in the proportions of not more than 7 gallons (26.5 liters) of water per 94 pounds (42kg) of Portland cement per 3 pounds (1.3 kg) of bentonite powder. The grout will be prepared by first thoroughly mixing the bentonite and water and then mixing in the Portland cement.

WELL CONSTRUCTION DIAGRAM

WELL NUMBER: TBD
WELL NAME: TBD
GEOLOGIST: Kathy Davis



KEYED NOTES:

1. PROTECTIVE STEEL OUTER SURFACE CASING W/LOCK.
2. CONCRETE PAD (36 INCH X 36 INCH X 6 INCH) WITH EMBEDDED BRASS SURVEY MARKER
3. WELL CASING: 4-INCH DIAM. SCHED. 40 PVC.
4. ANNULUS BACKFILL: CEMENT/5% BENTONITE SLURRY.
5. UPPER SEAL: HYDRATED BENTONITE CHIPS.
6. FILTER PACK: 20-40 MESH SIZE SILICA SAND.
7. WELL SCREEN : 4-INCH DIAM. NO. 10 SIZE MACHINE SLOTTED SCHEDULE 40 PVC.
8. WELL SUMP: 4-INCH DIAM. SCHED. 40 PVC.

GENERAL NOTES:

1. TOTAL BOREHOLE DEPTH: 245 ft.
2. BOREHOLE DIAMETER: 8 INCHES
3. ALL DEPTHS MEASURED FROM GROUND SURFACE.
4. DRAWING NOT TO SCALE.

LC380004

Figure 1-1. Proposed Well Construction Diagram.

2.0 WELL DEVELOPMENT

After the well is constructed, the well shall be developed by pumping and/or surging using such methods as surge block and bailing. Selection of the method used shall be dependent upon the aquifer characteristics; including depth, yield and water quality, and in-situ characteristics; however, air lift methods shall not be used.

Development shall continue until the groundwater removed from the well shows a visual reduction in turbidity (reduced sand and silt content) and temperature, pH and conductance have stabilized. Stability is defined as three consecutive sets of temperature and conductance values within $\pm$ 5 percent of each other, and pH within 0.1 units. The minimum volume of water removed between measurement sets is 5 gallons. If the development parameters have stabilized (by the above definition) and the total volume of water removed is less than five (5) well casing volumes, then development will continue until five (5) well casing volumes of water are removed from the well. Therefore, the minimum volume of water that would ever be developed from a well would be the greater of either 15 gallons or 5 well casing volumes. No water or other liquid may be introduced into the well other than formation water from that well.

The site geologist shall record the following data during well development:

- Date and time well development started,
- Initial static water level
- Volume of water removed
- Color and turbidity
- Temperature, pH and conductance
- Date and time well development finished
- Well development methods and equipment

3.0 WELL ACCEPTANCE

Each well is to be installed using the proper materials and methods, such that it yields samples of the water-bearing strata monitored by the well. The following criteria will be used to evaluate the acceptability of the monitoring well installation

All risers and screens will be set round, plumb and true to line. Monitoring well primary filter packs and screened intervals will not be cemented. Monitoring well casing and screen must not be collapsed, broken, damaged, obstructed or contaminated during drilling. All casings, screens, grout and filter packs will be set to depths as directed by the site geologist, in coordination with the WS-ES Technical Inspector.

3.1 Protection of Well

At all times during the progress of the work, precautions shall be taken to help prevent tampering with the well or the entrance of foreign material into it. Upon completion of the well, a suitable cap will be installed to help prevent material from entering the well. A protective above-grade steel casing with a locking cap will be centered around the well and embedded into the three ft of Portland cement-sand grout (no bentonite) before it has set up. The protective well casing shall rise approximately 3 ft (0.9 m) above ground level. It will be of sufficient size and positioned such that the monitoring well cap can be easily removed. A mark will be made on the top of the riser pipe to provide a standard measuring point for performing groundwater level measurements.

A minimum 3-foot (0.9 m) square, 24-inch (61 cm) thick concrete pad, sloped away from the well, will be constructed around the well casing at the final ground level elevation. A survey marker shall be permanently placed in each pad. Each survey marker shall be marked with the identifying number of the well and the elevation of the survey marker (to the closest 0.1 foot/0.03m). The ground immediately surrounding the top of the well shall be sloped away from the well. There shall be no openings in the protective casing wall below its top.

3.2 Temporary Capping

Any well that is to be temporarily removed from service, or left incomplete due to delay in construction, shall be capped with a watertight cap and equipped with a "vandal proof' cover satisfying applicable state or local regulations or recommendations.

3.3 Field Logs

The site geologist shall maintain suitable field logs detailing augering and well construction practices and any down-hole geophysical surveys. For each soil boring/monitoring well installed, a field-boring log and detailed lithologic log will be completed. The Field Log will include, but not limited to the following:

- Sampling method,
- Sample drive, recovery blow counts, hammer weight and length of fall,
- Sample numbers,
- Depth interval from which each formation sample was taken,
- Field screening results,
- Depth at which hole diameter (bit sizes) change,
- Depth at which groundwater is first observed,
- Depth to the static water level and any noted changes in static water level with well depth,
- Total depth of completed well or soil boring,
- Location of observed fractures, joints, faults, cavities or weathered zones,
- Depth of any grouting or sealing,
- Nominal hole diameters,
- Amount of cement used for grouting or sealing,
- Depth and type of well casing (Description to include length, location, diameter, slot size, material and manufacturer of well screen),
- Static water level upon completion of the well and after development,
- Drilling date or dates,
- Construction details of monitoring well, and
- Type of drill rig and method of drilling.

4.0 LOCATION SURVEYS

Following well installation and surface completions, all wells will be located horizontally and vertically by surveying. A permanent brass survey marker, stamped with the well number, will be embedded into the concrete well pad. Vertical locations for the brass marker and measuring point (mark on the top of the casing) will be surveyed to an accuracy of plus/minus 0.01 feet. Horizontal locations at the brass marker will be provided in latitude/longitude and UTM (Universal Transverse Mercator Coordinate) format. Horizontal position will be based upon North American Datum of 1983. Elevations will be based upon the North American Vertical Datum of 1988. All data will meet or exceed the accuracy requirements of the National Geodetic Survey for a Third Order - Class I Survey. Well location data will be provided on well construction diagrams and in the Site Characterization Report.