SUBJECT: Initiation of Voluntary Corrective Measures at the HELSTF Technical Support Area (TSA) Fuel Spill Site

Dear Ms. Martin:

White Sands Missile Range (WSMR) has been investigating the HELSTF TSA Fuel Spill Site in accordance with the Resource Conservation and Recovery Act (RCRA), as administered by the New Mexico Environment Department (NMED), Hazardous Waste Bureau. This site was first discovered and reported to the NMED Ground Water Bureau in March 2000. Subsequent to that report, the responsibility for the action was transferred to the Hazardous Waste Bureau.

The WSMR believes that this site does not pose a serious or an imminent threat to human health or the environment. However, the site requires investigation, perhaps additional remediation, and closure if we are going to use it in the future to support our military mission. Further, WSMR has funding available to carry the work forward. Accordingly, WSMR intends to carry out the balance of the investigation as a Voluntary Corrective Measure (VCM). Completion of the investigation will facilitate preparation of a risk assessment and a Corrective Measures Study.

We intend to carry out the work as presented in BAE SYSTEMS Work Plan for the RCRA Facility Investigation at the HELSTF Technical Support Area, August 2003, enclosed.

We note that the spill site has yet to be designated as a solid waste management unit (SWMU). Nevertheless, all activities will be carried out in full compliance with the substantive requirements of RCRA. WSMR will provide your office with an appropriate report upon work completion. We remain actively committed to meeting our environmental compliance responsibilities and appreciate your understanding and support on this issue.
Copies of this letter are being provided to Ms. Cheryl Frischkorn, Mr. Glenn von Gonten, and Mr. Steve Pullen, NMED-HWB Mr. James Harris, Mr. Larry King, EPA Region VI; Mr. James Pigg, SJA; and BAE Systems.

Mr. Gene Forsythe remains the overall action officer for this effort and he may be reached at (505) 678-1007 for further discussion on this subject. Mr. William Little of BAE Systems is the assigned technical manager for the project. He may be reached at (505) 678-0263.

Sincerely,

Thomas A. Ladd
Director, Environment and Safety Directorate

Enclosure
FINA L
WORK PLAN FOR THE
RCRA FACILITY INVESTIGATION AT THE
HELSTF TECHNICAL SUPPORT AREA

August 2003

White Sands Missile Range
Environment and Safety Directorate
White Sands Missile Range, New Mexico  88002
## Work Plan for the RCRA Facility Investigation at the High Energy Laser System Test Facility (HELSTF) Technical Support Area (TSA)

### Abstract (Maximum 200 Words)
A leak from piping associated with an above ground storage tank was identified at the HELSTF TSA. An estimated 1,500 gallons of gasoline was released. Preliminary investigations have confirmed the release of gasoline to the subsurface at the site. An interim response measure was completed which recovered a significant portion of the lost fuel. This report presents the work plan for further investigations.

### Subject Terms
- HELSTF
- TSA
- RCRA
- RFI
- TPH
- Soil Borings
- Monitoring Wells
- Petroleum release

### Security Classification of Report
- Unclassified

### Security Classification of Abstract
- Unclassified

### Distribution Availability Statement

---

Leonard Habel, P.E., Sr. Environmental Engineer

BAE SYSTEMS
Box 399
WSMR, NM 88002

Department of the Army
U.S. Army White Sands Missile Range
100 Headquarters Avenue
ATTN: CSTE-DTC-ES-ES-EC (Gene Forsythe)
White Sands Missile Range, NM 88002

---

Report Document Page

---

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.
WORK PLAN FOR THE
RCRA FACILITY INVESTIGATION AT THE HELSTF TSA SITE

Submitted to:

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

August 2003

Submitted by:

BAE SYSTEMS
Building 126
White Sands Missile Range, New Mexico 88002
EXECUTIVE SUMMARY

A release was discovered at the High Energy Laser Systems Test Facility (HELSTF) Technical Support Area (TSA) Petroleum/Oil/Lubricants Station in March 2000. Initial estimates placed the volume of gasoline lost at 1,500 gallons.

A site investigation was immediately initiated to determine the nature and extent of contamination. Shallow soil samples were obtained using a hand auger to quickly characterize the problem. Further characterization was completed in May and June 2000 when soil samples were obtained using a drill rig equipped with split spoons. The drill rig also placed three monitor wells to determine if the groundwater had been impacted by the spill.

The investigation revealed that the release occurred as a result of a poor connection between the dispenser and the underground piping leading from the above ground storage tank. Soil contamination was found to extend from the surface to approximately 30 feet below the ground surface (bgs).

A shallow perched water-bearing zone was encountered at approximately 34 feet bgs. Although, contaminants were detected in aqueous samples collected from this interval, the perched zone was laterally discontinuous and is not considered an aquifer.

The regional aquifer was encountered at approximately 90 feet bgs. The groundwater samples collected from this interval did not contain detectable concentrations of gasoline compounds. The groundwater was also determined to be non-potable due to the presence of naturally occurring high TDS concentrations.

A soil vapor extraction system was installed in October 2000 and temporarily operated at the site for a total of four months as an interim response measure. The operation was highly successful. It is estimated that approximately 1,790 gallons of gasoline were removed from the subsurface, exceeding the initial loss estimate.

This document presents the work plan for the further investigation of the release at the site. It 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 Facility Investigation (RFI).

The RFI will be conducted to determine remaining 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, the installation of two new monitoring wells and the sampling of the new and existing groundwater-monitoring wells.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>ii</td>
</tr>
<tr>
<td>ACRONYMS</td>
<td>vi</td>
</tr>
<tr>
<td>NMED Guidance Cross-Reference</td>
<td>vii</td>
</tr>
<tr>
<td>1.0 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1.1 Objectives and Scope</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Location</td>
<td>1</td>
</tr>
<tr>
<td>1.3 Regulatory Background</td>
<td>1</td>
</tr>
<tr>
<td>2.0 ENVIRONMENTAL SETTING</td>
<td>2</td>
</tr>
<tr>
<td>2.1 Climate</td>
<td>2</td>
</tr>
<tr>
<td>2.2 Regional Geology</td>
<td>2</td>
</tr>
<tr>
<td>2.3 Hydrogeology</td>
<td>4</td>
</tr>
<tr>
<td>2.4 Land Use</td>
<td>4</td>
</tr>
<tr>
<td>3.0 SITE BACKGROUND</td>
<td>5</td>
</tr>
<tr>
<td>3.1 Site History</td>
<td>5</td>
</tr>
<tr>
<td>3.2 Previous Investigations</td>
<td>7</td>
</tr>
<tr>
<td>3.3 Summary of Site Geology and Hydrogeology</td>
<td>11</td>
</tr>
<tr>
<td>3.4 Interim Response Action</td>
<td>12</td>
</tr>
<tr>
<td>4.0 FIELD SAMPLING PLAN</td>
<td>12</td>
</tr>
<tr>
<td>4.1 Basis</td>
<td>12</td>
</tr>
<tr>
<td>4.2 Approach and Implementation</td>
<td>13</td>
</tr>
<tr>
<td>4.3 Soil Borings</td>
<td>13</td>
</tr>
<tr>
<td>4.3.1 Soil Boring Sampling Procedure</td>
<td>13</td>
</tr>
<tr>
<td>4.3.2 Soil Sampling Documentation</td>
<td>14</td>
</tr>
<tr>
<td>4.4 Monitoring Wells</td>
<td>14</td>
</tr>
<tr>
<td>4.5 Ground Water Sampling</td>
<td>16</td>
</tr>
<tr>
<td>4.5.1 Groundwater Level Measurements</td>
<td>16</td>
</tr>
<tr>
<td>4.5.2 Groundwater Sampling Procedure</td>
<td>16</td>
</tr>
<tr>
<td>4.5.3 Groundwater Sampling Documentation</td>
<td>16</td>
</tr>
<tr>
<td>4.6 Quality Control Samples</td>
<td>17</td>
</tr>
<tr>
<td>4.6.1 Trip Blanks</td>
<td>17</td>
</tr>
<tr>
<td>4.6.2 Field Blanks</td>
<td>17</td>
</tr>
<tr>
<td>4.6.3 Rinsate Blank</td>
<td>17</td>
</tr>
<tr>
<td>4.6.4 Replicate Samples</td>
<td>18</td>
</tr>
<tr>
<td>4.7 Sample Integrity and Documentation</td>
<td>18</td>
</tr>
<tr>
<td>4.7.1 Sample Identification</td>
<td>18</td>
</tr>
<tr>
<td>4.7.2 Sample Labeling and Documentation</td>
<td>18</td>
</tr>
<tr>
<td>4.7.3 Sample Containers and Preservation</td>
<td>19</td>
</tr>
<tr>
<td>4.7.4 Custody</td>
<td>19</td>
</tr>
<tr>
<td>4.7.5 Sample Preparation and Shipment</td>
<td>20</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS

4.7.6 Laboratory Receiving ................................................................. 20
4.8 Decontamination ............................................................................ 21
4.9 Location Surveying ......................................................................... 21
4.10 Investigation Derived Waste .......................................................... 21

5.0 QUALITY ASSURANCE PROJECT PLAN ............................................. 22
5.1 Data Quality Objectives Process ....................................................... 22
5.1.1 Accuracy ....................................................................................... 23
5.1.2 Precision ....................................................................................... 23
5.1.3 Completeness ............................................................................... 24
5.1.4 Representativeness ....................................................................... 24
5.1.5 Comparability ............................................................................... 24
5.2 Laboratory Test Methods and Detection Limits .................................... 25
5.2.1 Sensitivity ..................................................................................... 25
5.2.2 Laboratory Blanks and Standards .................................................. 25
5.3 Chemical Data Validation ................................................................. 26
5.4 Field Data and Measurements ......................................................... 26
5.5 Technical Data ................................................................................ 28
5.6 Corrective Action ............................................................................ 28
5.6.1 Field Activities ............................................................................ 28
5.6.2 Field Data .................................................................................... 28
5.6.3 Laboratory ................................................................................... 28
5.6.4 Implementation and Reporting ....................................................... 28

6.0 PROJECT MANAGEMENT .................................................................... 29
6.1 Duties and Responsibilities ............................................................... 29
6.1.1 Technical Inspector ...................................................................... 29
6.1.2 General Manager ......................................................................... 29
6.1.3 QA/QC Manager ......................................................................... 30
6.1.4 Task Manager ............................................................................... 30
6.1.5 Task Coordinator ......................................................................... 31
6.1.6 Site Health and Safety Officer ....................................................... 31
6.1.7 Project Chemist ........................................................................... 31
6.2 Data Management and Reporting .................................................... 32
6.2.1 Work Plan .................................................................................... 32
6.2.2 Site Specific Health and Safety ...................................................... 32
6.2.3 Letter Report of Generated Wastes ............................................... 32
6.2.4 Site Characterization Report ......................................................... 32
6.2.5 Record Keeping ............................................................................ 34

REFERENCES .................................................................................. 35
### TABLE OF CONTENTS

**concluded**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
</table>

#### List of Photographs

Photograph 3-1. AST at HELSTF TSA................................................................. 6
Photograph 3-2. Hand auger beneath dispenser............................................. 7

#### List of Tables

Table 5-1. Test Methodologies, Hold Times, and Preservatives for Soils and Water. .......... 25
Table 5-2. Laboratory reporting limits by analytical method. .......................... 27

#### List of Figures

Figure 1-1. General Location Map ........................................................................... 2
Figure 2-1. Relief Map Showing Mountain Range .................................................. 3
Figure 2-2. Generalized East-West Cross Section of the Southern Part of the Tularosa Basin, North of Highway 70 (USACE, 1989). ........................................ 3
Figure 3-3. Locations of Soil Borings Installed with Hollow-Stem Auger, May 2000........ 9
Figure 3-4. Extent of Soil Contamination Along Section A-A’ ................................ 10
Figure 3-5. Extent of Soil Contamination Along Section B-B’ ................................. 10

APPENDIX A BAE SYSTEMS STANDARD OPERATING PROCEDURES
APPENDIX B SITE HEALTH AND SAFETY PLAN
# ACRONYMS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials</td>
</tr>
<tr>
<td>AST</td>
<td>Above ground storage tank</td>
</tr>
<tr>
<td>bgs</td>
<td>below ground surface</td>
</tr>
<tr>
<td>BTEX</td>
<td>benzene, toluene, ethylbenzene, and xylene</td>
</tr>
<tr>
<td>CMS</td>
<td>Corrective Measures Study</td>
</tr>
<tr>
<td>DQO</td>
<td>data quality objectives</td>
</tr>
<tr>
<td>ft</td>
<td>feet</td>
</tr>
<tr>
<td>GPS</td>
<td>global positioning system</td>
</tr>
<tr>
<td>GRO</td>
<td>gasoline range organics</td>
</tr>
<tr>
<td>HELSTF</td>
<td>High Energy Laser System Test Facility</td>
</tr>
<tr>
<td>mg/kg</td>
<td>milligram(s) per kilogram</td>
</tr>
<tr>
<td>mg/l</td>
<td>milligram(s) per liter</td>
</tr>
<tr>
<td>MSL</td>
<td>mean seal level</td>
</tr>
<tr>
<td>MTBE</td>
<td>methyl tertiary butyl ether</td>
</tr>
<tr>
<td>MW</td>
<td>monitoring well</td>
</tr>
<tr>
<td>NAVD</td>
<td>North American Vertical Datum</td>
</tr>
<tr>
<td>NMED</td>
<td>New Mexico Environment Department</td>
</tr>
<tr>
<td>POL</td>
<td>petroleum oil and lubrication</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>PID</td>
<td>photoionization detector</td>
</tr>
<tr>
<td>PVC</td>
<td>polyvinyl chloride</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>QC</td>
<td>Quality Control</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act</td>
</tr>
<tr>
<td>RFI</td>
<td>RCRA Facility Investigation</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>SVE</td>
<td>soil vapor extraction</td>
</tr>
<tr>
<td>SVOC</td>
<td>semi-volatile organic compound</td>
</tr>
<tr>
<td>TB</td>
<td>trip blank</td>
</tr>
<tr>
<td>TBD</td>
<td>to be determined</td>
</tr>
<tr>
<td>TPH</td>
<td>total petroleum hydrocarbons</td>
</tr>
<tr>
<td>TSA</td>
<td>Technical Support Area</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic compound</td>
</tr>
<tr>
<td>WGS</td>
<td>World Geodetic System</td>
</tr>
<tr>
<td>WSMR</td>
<td>White Sands Missile Range</td>
</tr>
</tbody>
</table>
### NMED GUIDANCE CROSS-REFERENCE

<table>
<thead>
<tr>
<th>NMED HRMB Standard Operating Procedures Facility Wide Work Plans Outline</th>
<th>HELSTF TSA RFI Work Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Project Management Plan</td>
<td>Section 6.0 – Project Management</td>
</tr>
<tr>
<td>1.1 Background</td>
<td>3.1</td>
</tr>
<tr>
<td>1.2 Purpose and Scope</td>
<td>1.1</td>
</tr>
<tr>
<td>1.3 Project Structure</td>
<td>6.1</td>
</tr>
<tr>
<td>2.0 Facility Description</td>
<td>Section 1.0 - Introduction</td>
</tr>
<tr>
<td>2.1 Description</td>
<td>1.2, 3.1</td>
</tr>
<tr>
<td>2.2 Environmental Setting</td>
<td>Section 2.0 – Environmental Setting</td>
</tr>
<tr>
<td>3.0 Quality Assurance Project Plan</td>
<td>Section 5.0 – QA Project Plan</td>
</tr>
<tr>
<td>3.1 Background</td>
<td>3.1</td>
</tr>
<tr>
<td>3.2 Assessment Strategy</td>
<td>2.1, 4.2</td>
</tr>
<tr>
<td>3.3 Field Sampling</td>
<td>Section 4.0 – Field Sampling Plan</td>
</tr>
<tr>
<td>3.4 Site Management and Record Keeping</td>
<td>4.5.3, 4.6.4, 4.7</td>
</tr>
<tr>
<td>4.0 Records Management Plan</td>
<td>6.2</td>
</tr>
<tr>
<td>4.1 Organization</td>
<td>6.1</td>
</tr>
<tr>
<td>4.2 Description</td>
<td>6.2</td>
</tr>
<tr>
<td>4.3 Description of Records Management Facilities</td>
<td>N/A</td>
</tr>
<tr>
<td>4.4 Coordination</td>
<td>N/A</td>
</tr>
<tr>
<td>5.0 Health and Safety Plan</td>
<td>Appendix B – Site Safety and Health Plan</td>
</tr>
<tr>
<td>5.1 Introduction</td>
<td>1.0 of App. B</td>
</tr>
<tr>
<td>5.2 Personnel</td>
<td>2.0 of App. B</td>
</tr>
<tr>
<td>5.3 Site History and Description</td>
<td>4.0 of App. B</td>
</tr>
<tr>
<td>5.4 Hazard Assessment</td>
<td>4.3 of App. B</td>
</tr>
<tr>
<td>5.5 Personal Protective Equipment</td>
<td>4.4 of App. B</td>
</tr>
<tr>
<td>5.6 Decontamination</td>
<td>4.8</td>
</tr>
<tr>
<td>5.7 Emergency and Contingency Plan</td>
<td>4.5 of App. B</td>
</tr>
<tr>
<td>5.8 Record Keeping</td>
<td>6.2.5</td>
</tr>
<tr>
<td>6.0 Waste Management Plan</td>
<td>Appendix A – MSOP 14.0</td>
</tr>
<tr>
<td>6.1 Introduction</td>
<td>Section 1 of MSOP 14.0</td>
</tr>
<tr>
<td>6.2 Regulatory Requirements</td>
<td>Section 2 of MSOP 14.0</td>
</tr>
<tr>
<td>6.3 Waste Management</td>
<td>4.10</td>
</tr>
<tr>
<td>7.0 Public Involvement Plan</td>
<td>Possible future action –</td>
</tr>
<tr>
<td>7.1 Introduction</td>
<td>to be determined</td>
</tr>
<tr>
<td>7.2 Involvement Process</td>
<td>to be determined</td>
</tr>
</tbody>
</table>
WORK PLAN FOR THE
RCRA FACILITY INVESTIGATION AT THE HELSTF TSA SITE

1.0 INTRODUCTION

On March 16, 2000, the White Sands Missile Range (WSMR) Environmental Compliance Division was notified that a release of unleaded gasoline had occurred at the Technical Support Area (TSA) Petroleum/Oil/Lubricants (POL) Station at the High Energy Laser System Test Facility. The New Mexico Environment Department (NMED) was immediately notified and an investigation was begun to define the extent of contamination. Upon completion, WSMR initiated an interim corrective measure to recover some of the lost fuel thru the use of soil vapor extraction. The process recovered approximately 1,790 gallons of gasoline.

As a result of the successful interim corrective measure, it is necessary to determine how much of the contamination remains in the subsurface before completing a risk assessment and corrective measures study (CMS). This document describes the work planned to investigate the remaining soil and/or groundwater contamination resulting from the gasoline spill.

1.1 Objectives and Scope

The objectives of this investigation are to:

- Measure the remaining concentration of gasoline constituents present in the soil.
- Determine whether groundwater has been impacted.
- Further characterize the geology and hydrology of the site.
- Determine possible contaminant transport pathways

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.

1.2 Location

The High Energy Laser System Test Facility (HELSTF) is located approximately 20 miles east-northeast of the WSMR Main Post Headquarters on U.S. Highway 70 in Otero County (Figure 1-1). The facility has a Petroleum/Oil/Lubricants Station at the Technical Support Area which is about 300 yards beyond the entrance to HELSTF off U.S. Highway 70.

1.3 Regulatory Background

A release of unleaded gasoline was discovered at the TSA Petroleum/Oil/Lubricants Station at HELSTF on March 16, 2000. The New Mexico Environment Department’s Ground Water Quality Bureau was immediately notified in accordance with Section 1203 of the New Mexico Water Quality Control Commission Regulations [20 New Mexico Administrative Code 6.2]. NMED personnel directed White Sands to perform studies to determine the extent of contamination.
Since discovery of the contamination, regulatory oversight for all corrective actions at the WSMR have been delegated to the NMED Hazardous Waste Bureau. Therefore all subsequent activities will be performed in accordance with the regulations established under the Hazardous Waste Act (NMSA 1978, sections 74-4-1 through 14), Title 20 of the New Mexico Administrative Code, Chapter 4.1, Title 40 of the Code of Federal Regulations Parts 260-273 and the guidance published by the New Mexico Environment Department.

This Work Plan follows the guidance set forth for conducting a Resource Conservation and Recovery Act 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.

2.0 ENVIRONMENTAL SETTING

2.1 Climate

The climate at the site is typical of an arid southwestern basin. Annual precipitation is about 7 inches. Much of this precipitation occurs between July and September during brief heavy thunderstorms.

The temperature during the winter ranges from 30 to 60 degrees Fahrenheit. “Nighttime temperatures reach freezing on most nights from November to mid-March, but an average of only 1 day a year remains freezing” (Neher and Bailey, 1976). During the summer temperatures can rise in excess of 100 degrees Fahrenheit.

The infrequent precipitation and warm weather leads to arid soil and sparse vegetation. Strong westerly winds give rise to considerable dust storms that are most frequent during the spring.

2.2 Regional Geology

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 Bolson. The Tularosa Basin is a large flat valley bounded by the Organ, San Augustin, San Andres and Oscura Mountains to the west (Figure 2-1). The eastern limit of the basin lies outside of the range, and is formed from north to south by the Jicarilla, Sierra Blanca, Sacramento, Cornudas, and Hueco Mountains.
The Tularosa Basin is actively subsiding relative to the north-south trending normal faults (Figure 2-2) that produce mountain ranges on either side of the basin. Lake Lucero, the lowest elevation in the basin, is 3,887 feet above mean sea level (MSL). The mountain elevations range on average between 5,500 and 9,000 feet above MSL. The Sierra Blanca Peak rises to a height of 12,000 feet MSL.

Figure 2-1.
Relief Map Showing Mountain Ranges.

Figure 2-2.
Generalized East-West Cross Section of the Southern Part of the Tularosa Basin, North of Highway 70 (USACE, 1989).
Erosion of the mountain fronts transports clastic sediment into the basin where it is deposited. As subsidence continues, the sediments may be re-worked by wind and water, but are ultimately buried under sediments produced by younger depositional events.

The nature of the bolson-fill deposits varies both laterally and vertically throughout White Sands. Coarse-grained, poorly sorted sediments deposited near mountain fronts grade into fine-grained, well-sorted sediments towards the center of the basin (Kelly, 1973). Sediments further from the mountain fronts also contain a greater percentage of clay and gypsum.

The HELSTF facility is located near the depositional axis of the basin, just south of the eolian gypsum dunes of the White Sands National Monument. As a result of the central basin setting and the proximity to the source of the gypsum sand (Lake Lucero), the subsurface geology at HELSTF consists of unconsolidated, fine-grained clastic sediments interspersed with gypsum and minor selenite re-deposited from solution.

2.3 Hydrogeology

There are no surface outlets for drainage from the basin. All precipitation evaporates, infiltrates into the groundwater or forms intermittent streams and lakes. Lake Lucero, the most prominent expression of surface water, is in the center of the alkali flats and is usually dry.

The Tularosa Basin, an otherwise closed system, connects with the Hueco Basin at the New Mexico/Texas state line to form a single aquifer system called the Hueco-Tularosa aquifer. “This complex groundwater reservoir is the primary source of water for the City of El Paso and Ciudad Juarez, and for military installations and smaller cities in New Mexico, Texas, and Mexico. Recharge occurs primarily from precipitation and infiltration of mountain runoff through major arroyos; and recharge rates are much less than groundwater withdrawals” (Creel, B.J. and Hawley, J.W, 2001).

Potable water is largely confined to alluvial fans along the mountain ranges in the basin. Water quality decreases as it moves away from the mountain fronts and mixes with slower moving brackish water at the basin interior. HELSTF, located within the alkali flats, does not produce potable water. It receives water from three supply wells (MAR-1, MAR-2, and MAR-3) located seven miles to the west along Range Road 7 (Figure 2-3 on the following page).

Water generally flows away from the mountains and toward the interior of the basin. The groundwater gradient decreases toward the center of the basin, but eventually increases as it turns and flows south toward the Hueco Basin.

2.4 Land Use

The White Sands Missile Range (WSMR) is a U.S. Army installation under the Developmental Test Command, headquartered at Aberdeen Proving Ground, Maryland. WSMR was established July 9, 1945 as the White Sands Proving Ground (the name was changed in 1958), to be America’s testing range for the new concept of missile weapons. The New Mexico desert was selected to be the nation’s testing range for several reasons: the desert is sparsely populated, has almost year-round clear weather and unlimited visibility, and as such, affords relatively easy recovery of spent missiles.
Today the installation functions as an outdoor laboratory consisting of a large complex of test ranges, launch sites, impact areas and instrumentation sites required to develop and test tactical and strategic weapons and weapons systems. The High Energy Laser System Test Facility develops and tests laser systems for use as strategic and tactical weapons. The Technical Support Area, which is isolated from the main complex, provides shelter for utility and maintenance operations.

3.0 SITE BACKGROUND

3.1 Site History

The POL station (Figure 3-1) included a 3,000-gallon aboveground storage tank (AST) (Photograph 3-1). Underground piping ran between the AST and the dispenser (Photograph 3-2). The AST is mounted within a concrete secondary containment structure and stores unleaded gasoline for motor vehicle fueling. Leaks were not observed from the aboveground appurtenances and the release was not visually detected.
Figure 3-1. Site Plan of the HELSTF Technical Support Area.

Photograph 3-1. AST at HELSTF TSA.
Initial reports that 750 gal of fuel were missing from inventory suggested that a release had occurred in the underground supply lines to the dispenser. A detailed audit of the fuel deliveries versus consumption fixed the final loss estimate at 1,485 gallons prior to shutdown of the system in March 2000.

3.2 Previous Investigations

Hand Auger Investigation

On 17 March 2000, three initial hand auger borings were completed at the TSA POL Station to determine the location and severity of the unleaded gasoline release. On 24 March 2000, three additional qualitative hand auger borings were completed to approximately determine the extent of contamination. A photo-ionization detector (PID) was used to screen for volatile components during completion of the additional hand auger borings.

Based on the analytical and qualitative results obtained from the initial hand auger borings, it was confirmed that an unleaded gasoline release occurred at the HELSTF TSA POL Station. The leak was identified as having occurred at the joint between the dispenser and the
underground piping from the AST. It was estimated that the plume’s radius was approximately 16-18 ft horizontally and vertical extent exceeded 18 ft bgs. White Sands immediately initiated a drilling investigation to further determine the horizontal and vertical extent of contamination.

Drilling Investigation

A total of nine investigative soil borings were drilled within and surrounding the release site. The location of each soil boring is shown in Figure 3-2. All borings were drilled using a CME 750 continuous-flight, hollow-stem auger drill rig with 4.25-inch inside diameter auger flights. Soil samples were collected using a 2.5-inch outside diameter, 2.5 ft long split-barrel sampler.

Figure 3-2. Locations of Soil Borings Installed with Hollow-Stem Auger, May 2000. (Note: Hand Auger borings are not shown.)
All investigative soil borings were completed to a depth of approximately 40 ft. Soil samples were collected from each boring at 5.0 ft intervals for chemical analysis (GRO, BTEX and MTBE). The results of the soil analyses represent conditions during the snapshot of time from May 2 and 3, 2000. As shown by the isoconcentration contours in Figures 3-3, 3-4 and 3-5, gasoline was detected in a smear zone directly beneath the source area. Maximum concentrations were encountered at a depth of 17 ft.

Lateral migration was increased at a depth between 20-25 ft. Gasoline found a preferential pathway in a more conductive, permeable sand layer that was encountered across the study area. Lateral migration at this level evidently reduced the rate of vertical migration into the more clay-rich sediments below. Shut-off of the source at nearly 1,500 gallons may have combined with the surface tension of the fluid to arrest the contaminant migration in the configuration encountered during the soil boring program.

During the investigation, White Sands determined that interim remedial action using soil vapor extraction may be required. In anticipation of this action, four soil borings were completed as vapor recovery wells HVW-01, HVW-02, HVW-03, and HVW-04).

---

**Figure 3-3.**
Locations of Soil Borings Installed with Hollow-Stem Auger, May 2000. (Segments A-A' and B-B' Correspond to Cross-Sections in Figures 3-4 and 3-5, respectively.)
Figure 3-4. Extent of Soil Contamination Along Section A-A'.

Figure 3-5. Extent of Soil Contamination Along Section B-B'.

Note: All values are to milligrams or TPH per kilogram of soil (mg/kg).

Legend:
- 100 - Isoconcentration contours for TPH in soil (mg/kg), May 2000
- ND - No detection

1" = 10 feet

700b9005-2

700b9005-3
One up-gradient and two downgradient groundwater monitor wells were installed to:
1) determine the groundwater quality at the site and, 2) monitor the potential migration of
gasoline via the regional aquifer if contaminants are detected in groundwater. The locations of
the three regional water table wells relative to the source area are shown in Figure 3-6 as
HMW 48, HMW 49 and HMW 50).

Figure 3-6. Location of Monitoring Wells.

Groundwater samples were collected from each of the three monitoring wells in the regional
aquifer and analyzed for GRO, BTEX and MTBE. Concentrations of these analytes in all three
wells were all below the detection limits.

The compete report detailing the hand auger and drilling investigations can be found in the
Phase I RCRA Facility Investigation entitled "HELSTF Technical Support Area

3.3 Summary of Site Geology and Hydrogeology

Sediments are predominantly clayey silts interspersed with sandier intervals. Several thin sand
layers punctuate the stratigraphic column and may represent sediment deposition by meandering
streams or, in some cases, eolian deposition. Thicker, clay-rich intervals separating the sandy
layers probably represent sedimentation in shallow, ephemeral pools formed after stream
avulsion or precipitation events in the central basin setting.
A thin sand layer encountered at approximately 23 ft bgs is of particular interest because it may represent the preferential pathway that allowed the lateral spreading of gasoline seen at this depth in Figures 3-4 and 3-5. At soil boring SB-08, which was subsequently completed as vapor extraction well HVW-04, the sand layer was saturated with water.

During the investigation, two water-bearing zones were encountered. The first zone, located approximately 34 ft bgs is perched in nature and laterally discontinuous. The second water-bearing zone encountered during the investigation is the regional groundwater table, which was determined to be approximately 90 ft bgs. The regional aquifer is in unconsolidated silty sands and moderately sorted sand layers.

### 3.4 Interim Response Action

During the investigation, White Sands determined that an interim response action using soil vapor extraction (SVE) was appropriate. In anticipation of this action, four soil borings were completed as vapor recovery wells.

The SVE system was installed on October 16, 2000 and operated continuously through February 24, 2001 for a total of 2,012.6 hours. The system was connected to vapor extraction well HVW-01 throughout the entire length of operation. The SVE system consisted of a vacuum pump driven by a six-cylinder industrial rated internal combustion engine. The extracted hydrocarbons were burned in the engine through the process of compressive thermal oxidation. White Sands estimates that the SVE system removed from the subsurface and subsequently burned approximately 1,790 gal of gasoline.

A full discussion of the interim response measures can be found in a previously published report entitled, *HELSTF Technical Support Area Petroleum/Oil/Lubricants Station Investigation*, January 2002.

### 4.0 FIELD SAMPLING PLAN

This section describes the data collection and sampling procedures to be used during this project. The procedures cover each activity to be completed by the field sampling team, including drilling, soil sampling, well installation, groundwater sampling, quality control measures, sample integrity, decontamination, surveying and waste management. The standard operating procedures (SOPs) included in Appendix A will be followed except where otherwise specified in this section.

### 4.1 Basis

The field data acquired during the previous investigations was reviewed and forms the basis for our understanding of the site. The data was sufficient to define the horizontal and vertical extent of gasoline contamination in the soil. The investigations concluded that the majority of the release was held in surface tension between the ground surface and approximately 28 ft bgs.
Groundwater contamination was not detected, but the existing wells may not provide adequate coverage as required by 40 CFR 264.97 (a). Therefore additional wells are proposed as part of this workplan. Concentrations of benzene and toluene were detected in a shallow, perched water-bearing zone. However, this water is not considered an aquifer since it has a limited thickness and is discontinuous over a very short distance. Characterization of the contamination in this stratum will be thru soil sampling rather than monitoring wells.

Although the extent of soil contamination was previously defined, a substantial amount of the mass was removed thru the interim response action. New borings are proposed in order to resample the soil and measure concentrations of contaminants. In addition, borings are proposed to establish background concentrations of lead. This information will be used to calculate the remaining human health and ecological risks from the contamination.

4.2 Approach and Implementation

Soil borings will be drilled in the same locations as the previous investigation in order to measure the remaining concentration of contaminants. Additional borings will be located in areas unaffected by the contamination to establish background concentrations of lead. Monitoring wells will be installed downgradient of the source at less of a distance than the previous downgradient well in order to ensure that they are located within the potential impact zone of the source.

These activities will help establish new baseline concentrations of soil contaminants and determine if any migration of contamination to the groundwater has occurred. 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.

4.3 Soil Borings

Nine soil borings will be drilled in the same locations as those in the previous investigation (Refer to figure 3-2). An offset of 5 feet from the previous borehole will ensure that the soil is undisturbed. Five additional borings will be located in areas unaffected by the contamination. The soil borings will be drilled using a hollow-stem rig supervised by a site geologist using industry-standard methods. Each soil boring will be drilled to 40 feet in depth.

4.3.1 Soil Boring Sampling Procedure

Split spoon samples will be collected over each 5-foot length of the drill stem using a wire line retrieval system for the split-barrel core apparatus. The site geologist will inspect (for any evidence of contamination) and log the samples as they are retrieved. An organic vapor analyzer using a photoionization detector (PID) will be used to provide additional screening for contaminants.

When the split-barrel is removed from the boring and opened, any material appearing to be slough will be removed. The soil core will be screened using a PID to determine the interval with the highest VOC concentration. The desired interval suspected will be sampled according to SW846 Method 5030 for volatile organic compounds.
Samples collected for inorganic analysis and other compounds with low volatility will be sampled by placing the material into sampling jars using new, disposable gloves and tongue depressors. 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 containers required are filled, excess soil will be containerized with other soil cuttings and properly disposed. All sampling equipment will be decontaminated prior to sample collection.

Samples will be submitted to the laboratory for analysis of VOCs, SVOCs, GRO and lead using the matrix reporting limits in Table 5-2. Samples collected for background concentrations will be sampled for lead only using the same matrix reporting limits.

Backfilling of the open boreholes will be accomplished with 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.

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).

4.3.2 Soil 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,
- 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.

4.4 Monitoring Wells

Two down-gradient groundwater monitoring wells will be installed in the regional aquifer to an approximate depth of 100 feet. The wells will be installed using a hollow-stem rig supervised by a qualified scientist using industry-standard methods. The proposed locations for the monitoring wells will be 25 feet downgradient of the spill and 100 feet downgradient of the spill with an offset of 20 feet to the east. Refer to Figure 4-1 for proposed locations (HMW-51 and HMW-52).
Geotechnical samples will be collected from the monitoring well boreholes to provide data for evaluation of remedial alternatives in the Corrective Measures Study, should selection of a remedy be warranted.

The monitoring wells will be constructed of 4-inch diameter Schedule 40 PVC risers and 0.010 mill slot PVC screens. The screen will be five feet in length and positioned to split the water table. A five-foot sump will be placed at the bottom of the well to prevent sediment buildup from blocking the screen.

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.

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.
4.5 Ground Water Sampling

The three existing and two new groundwater monitoring wells will be sampled a minimum of 24 hours following development of the new wells. Groundwater samples will be analyzed for benzene, ethylbenzene, toluene, xylene, methyl-tert-butyl ether and lead using the aqueous matrix reporting limits in Table 5-2. Additionally, sulfate, alkalinity, pH, conductivity and total dissolved solids will be analyzed. Metals will be analyzed for both total (unfiltered) and dissolved (filtered) concentrations.

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.

4.5.1 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.

4.5.2 Groundwater Sampling Procedure

Prior to sampling, the monitoring well will be purged with a bladder pump in order to remove any stagnant water in the well. The pump will be positioned near the center of the wetted screen interval where the formation is most conductive. This interval will be selected based on boring logs and pumping rates during purging. The pumping rate will be adjusted to prevent the water level in the well from dropping more than one foot below the static water level. This minimizes loss of volatiles due to water cascading down the well screen. Purging will continue until the field parameters of pH, temperature and conductivity stabilize or at least three casing volumes are removed. These parameters are considered stable when three consecutive readings have a temperature ± 0.5 °C, pH is ± 0.1 units and conductivity is ± 1%. All purged water will be containerized in approved containers at the well location.

Once purging is completed, the well will be sampled with the bladder pump in the same position at a rate no more than 100 mL/min but less than the purge rate so that the water flows smoothly into the container with little agitation. Containers will be supplied by the laboratory with appropriate preservatives already added.

4.5.3 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
- 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.

4.6 Quality Control Samples

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 Quality control (QC) samples will be collected and analyzed as part of the investigation. QC samples will be collected in the field and sent to the same laboratory as the rest of the field samples. QC samples include trip blanks, field blanks, rinsate blanks, and replicates.

4.6.1 Trip Blanks

With each shipment of VOCs from a sampling area, personnel will include one trip blank. A trip blank is a sample bottle filled with high-performance liquid chromatography-grade water or equivalent organic-free water that is transported to the field site, handled like a sample, and returned to the laboratory for analysis. Trip blanks are analyzed for VOCs only.

4.6.2 Field Blanks

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 will be collected and analyzed for all parameters of interest for the project. Upon collection, a description of the water source for the field blank sample will be documented in the Field Logbook.

4.6.3 Rinsate Blank

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 will be collected at a rate of one per day per sampling team during the sampling event and analyzed for all parameters of interest for the project.
4.6.4 Replicate Samples

Replicate samples are "split" laboratory samples and will be collected from the same sampling point and the same depth at a rate of one for every ten samples, for a frequency rate of ten percent. 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.

The samples will go to the primary laboratory as a regular field sample or sent to a different laboratory for equivalent analyses, thus serving as external QA samples. Replicate samples measure the precision of the entire measurement system, including both sampling and analytical procedures.

4.7 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.

4.7.1 Sample Identification

Samples will be identified as described in SOP number 2.2 located in Appendix A.

4.7.2 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 with a single line through the information with the corrector's initials by the line.
4.7.3 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 5-1. 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.

4.7.4 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 paragraphs.

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.

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.

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.

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.
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.

4.7.5 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 to 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.

4.7.6 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 ice bath will be measured (to verify that the contents of the cooler were kept below 4°C as required for sample preservation by the respective analytical methods) 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.

4.8 Decontamination

Each piece of reusable, small or non-dedicated sampling equipment will be decontaminated before mobilization to each site and between each sampling activity.

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.)

New disposable gloves will be worn at all times when handling samples, sampling equipment, or containers. Disposable gloves will be changed out for new ones between each sampling activity.

4.9 Location Surveying

A registered land surveyor in the State of New Mexico will survey all newly installed monitoring wells. A trained field technician using GPS equipment will survey all new soil borings. The survey coordinate system will be WGS 84 for the horizontal datum and NAVD 83 for the vertical datum.

4.10 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. It is presumed that the waste will be non-hazardous based on the concentrations of soil contaminants measured in the previous investigations.

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.

All investigation-derived waste will be managed in accordance with procedures described in SOP 14.0 located in Appendix A.

5.0 QUALITY ASSURANCE PROJECT PLAN

This plan presents, in specific terms, the policies, organization, functions, and quality assurance/quality control project requirements. The purpose of this quality assurance project plan is to establish the analytical and documentation protocols to be used when collecting, reviewing, and analyzing soil and groundwater data.

5.1 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 work plan. 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:

• Case narrative discussing any data outliers.
• 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 sample 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 accuracy, precision, completeness, representativeness, and comparability.
5.1.1 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:

\[
\text{Percent Recovery} = \left( \frac{C_2 - C_1}{C_0} \right) \times 100\%
\]

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.

5.1.2 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:
Where:

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

- \( C_1 \) = 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.

### 5.1.3 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:

\[ C = \frac{P_1 \times 100\%}{P_0} \]

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.

### 5.1.4 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 non-representative 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.

### 5.1.5 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.

5.2 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 5-1 on the following page.

### Table 5-1.
Test Methodologies, Hold Times, and Preservatives for Soils and Water.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Container</td>
<td>Max. Hold Time</td>
<td>Container</td>
<td></td>
</tr>
<tr>
<td>Physical Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Conductivity</td>
<td>EPA 120.1</td>
<td>NA</td>
<td>1 liter Polyethyl.</td>
<td>7 days</td>
</tr>
<tr>
<td>Laboratory pH</td>
<td>EPA 150.1</td>
<td>NA</td>
<td>1 liter Polyethyl.</td>
<td>28 days</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>EPA 160.1</td>
<td>NA</td>
<td>1 liter Polyethyl.</td>
<td></td>
</tr>
<tr>
<td>Dissolved Sulfate</td>
<td>EPA 300.0</td>
<td>NA</td>
<td>1 liter Polyethyl.</td>
<td>28 days</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>SM 2320B</td>
<td>NA</td>
<td>1 liter Polyethyl.</td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td>SW 846 6010</td>
<td>8 oz. Glass</td>
<td>1 liter Polyethyl.</td>
<td>180 days</td>
</tr>
<tr>
<td>VOCs</td>
<td>SW 846 8260</td>
<td>4 oz. Glass</td>
<td>3-40 ml Glass</td>
<td>14 days</td>
</tr>
<tr>
<td>SVOCs</td>
<td>SW 846 8270</td>
<td>4 oz. Glass</td>
<td>2-1 liter Amber Glass</td>
<td>7 days extraction / 40 days analysis</td>
</tr>
<tr>
<td>Total Petroleum</td>
<td>SW 846 8015B</td>
<td>4 oz. Glass</td>
<td>3-40 ml Glass</td>
<td>14 days</td>
</tr>
<tr>
<td>Hydrocarbons - GRO</td>
<td>Modification</td>
<td>14 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

5.2.1 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 5-2.

5.2.2 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, as described in the DQOs.

5.3 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 would 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, damaged sample containers, etc.

5.4 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 Site Characterization 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 ±0.2 °C for temperature, ±0.1 units for pH, and ±1 % for conductivity.

5.5 Technical Data

Technical data refers to data of several types, such as potentiometric surface measurements, groundwater flow calculations, and lithologic thickness 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 Coordinator for verification. Technical data will be evaluated and reported in the Site Characterization Report.

5.6 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".
Table 5-2.
Laboratory reporting limits by analytical method.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Aqueous (µg/L)</th>
<th>Solid (µg/gd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline range TPH</td>
<td>8015B</td>
<td>NA</td>
<td>20,000</td>
</tr>
<tr>
<td>VOCs</td>
<td></td>
<td></td>
<td>1.4-Trichlorobenzene</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2-Chloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,1-Dichloropropene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2-Chlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2,3-Trichlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2,3-Trichloropropane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2,4-Trichlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,2,4-Trichloropropene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,3-Dichlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,3-Dichloropropane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1,4-Dichlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>1-Chloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>2-Chlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>2,2-Dichloropropane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>2-Chloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>2-Chloroethene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>2-Chlorotoluene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>4-Chlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>4-Methyl-2-pentanone</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Acetone</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Benzene</td>
<td>8260B</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Bromobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Bromochloromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Bromoform</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>n-Butylbenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>n-Octylbenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Carbon Tetrachloride</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Chloroethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Chloroform</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Dichlorodifluoromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>8260B</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Hexachlorobutadiene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Isopropylbenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>n-Propylbenzene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Styrene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Toluene</td>
<td>8260B</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Trichlorofluoromethane</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Vinyl Chloride</td>
<td>8260B</td>
<td>NA</td>
<td>5</td>
</tr>
<tr>
<td>Xylene (total)</td>
<td>8260B</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Additional water quality parameters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfate</td>
<td>300</td>
<td>5</td>
<td>NA</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>310.1</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>TDS</td>
<td>60.1</td>
<td>10</td>
<td>NA</td>
</tr>
<tr>
<td>Turbidity</td>
<td>20.1</td>
<td>1 µmhos/cm</td>
<td>NA</td>
</tr>
<tr>
<td>Conductivity</td>
<td>20.1</td>
<td>1 µmhos/cm</td>
<td>NA</td>
</tr>
<tr>
<td>Laboratory pH</td>
<td>100.1</td>
<td>0.01 pH</td>
<td>NA</td>
</tr>
</tbody>
</table>
5.6.1 Field Activities

Field activities that are improper will be corrected as quickly as possible. The project task 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.

5.6.2 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.

5.6.3 Laboratory

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

5.6.4 Implementation and Reporting

Following problem identification, the responsible individual, as assigned by the Task Manager, 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.
6.0 PROJECT MANAGEMENT

The project organization reflects the relationship between the White Sands Missile Range point-of-contact and the contractor team assembled to plan, organize, control, and execute this project. Within the contractor project management system, the key positions are the General Manager, Task Manager and Task Coordinator. The basic organization chart for this project is shown on Figure 6-1 on the following page.

6.1 Duties and Responsibilities

6.1.1 Technical Inspector

The technical inspector is an employee of the U.S. Army and functions as the point of contact for the White Sands Missile Range. For this project, the Technical Inspector's responsibilities include:

- Develops scope of work
- Reviews and approves workplans
- Acquires funding
- Point of contact for the public and regulatory agency

6.1.2 General Manager

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

- Overall project management
- Total planning, organization and execution of the RFI Workplan.
- Maintaining contact with the Technical Inspector throughout the work
- Directing the Task Manager in conducting a successful project
- Providing resources to the Task Manager to accomplish project responsibilities
- Guiding the Task Manager on the approach to a public relations program
- Reviewing and approving all deliverables

6.1.3 QA/QC Manager

The QA/QC Manager for this project is responsible for the following:

- Acting for the General Manager in his absence
- Reviewing project progress
- Ensuring project QC protocols and procedures are followed
- Documenting that all quality objectives have been met
- Assisting the Task Coordinator in evaluating alternatives to meeting project objectives
- Providing guidance on the allocation of resources
6.1.4 Task Manager

The Task Manager for this project will be responsible and accountable to the General Manager for overall direction and performance of the project including:

- Developing and executing the Work Plan
- Directing the Task Coordinator
- Keeping General Manager and Technical Inspector appropriately informed
- Approving uses of technical resources
- Coordinating all assigned resources
- Periodic review of progress and progress reporting
- Resolving Work Plan issues
- Schedule and budget tracking
- Quality and timeliness of deliverables
- Work performed by subcontractors
- Technical liaison between the Task Coordinator and the General Manager
6.1.5 Task Coordinator

The Task Coordinator 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 RFI Work Plan. Specific responsibilities include:

- Day to day execution of the Work Plan
- Reporting project progress to the Task Manager
- Coordinating, directing and overseeing field technical support staff
- Providing overall direction and supervision of the site work 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 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

6.1.6 Site Health and Safety Officer

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

- Directing all health and safety activities on site
- Reporting safety-related incidents or accidents to the Task Manager
- Temporarily suspending field activities, if health and safety of personnel are endangered
- Maintaining health and safety equipment on-site
- Conducting pre-work and 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

6.1.7 Project Chemist

As part of the project team, the project chemist will provide technical support during sample collection and analysis. The project chemist will report to the Task Coordinator and duties will include:

- Evaluating analytical data to determine usability of results
- Verifying laboratory procedures and QA protocols
- Immediate notification to the Task Manager of potential data problems
- Confirming field QC procedures to obtain representative data
6.2 Data Management and Reporting

BAE SYSTEMS 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 Work Plan and the site-specific Work Plans contained herein.

6.2.1 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 Standard Operating Procedures for sampling and management of investigative derived waste as Appendix A.

6.2.2 Site Specific Health and Safety

BAE Systems 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 BAE Systems, 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 B.

6.2.3 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.

6.2.4 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 Evaluation of Human and Ecological Exposure Potential
   6.1 Human Health
   6.2 Ecological

7.0 Summary and Conclusions

8.0 Recommendations

Appendices
   Laboratory Data and QA/QC Evaluation Results
   Risk Assessment Methods
   Field Data
6.2.5 Record Keeping

Original copies of all field notes, chain of custody, analytical results and survey data will be retained in the project files. Copies of this information will be included in the Site Characterization Report, which will be retained in the WSMR Environmental Services Directorate Library.
REFERENCES


APPENDIX A

Standard Operating Procedures
STANDARD OPERATING PROCEDURES

1.0 Quality Control Program
1.1 Chain of Custody
1.2 Field Activity Documentation
2.0 Sample Handling, Packing, and Shipping
2.1 Sample Labeling
2.2 Sample Numbering
2.3 On-Site Sample Storage
3.1 Subsurface Soil Sampling While Drilling
3.3 Duplicate and Split Sample Preparation
4.0 Calibration and Maintenance of Measuring and Test Equipment
4.1 Field Instrument QA/QC
5.0 Water Level Measurements in Monitoring Wells
6.0 Field Equipment Decontamination
6.1 Drilling, Development, and Heavy Equipment Decontamination
8.0 Monitoring Well Installation
8.1 Monitoring Well Development
9.0 Ground Water Sampling
10.0 Lithologic Logging
12.0 Hollow Stem Auger Drilling
13.0 Field QC Sampling
14.0 Management of Investigation-Derived Waste
15.0 Preparation, Revision, and Approval of Plans and Procedures
16.0 Quality Inspection and Inspection Records
BAE SYSTEMS
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

Quality Control Project Plans

5 PROCEDURE

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


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 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.

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., HNO₃, H₂SO₄, 4°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 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 sample collector delivers the samples to the laboratory and relinquishes the sample directly to a laboratory representative.

- 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 sample collectors 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 sample collector lists the courier affiliation and waybill number on the Chain of Custody Record.
- The sample collector relinquishes custody by signing his 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 sample collector 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.

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.

6.0 REQUIRED FORMS

Chain of Custody Record
1 PURPOSE

This purpose of this Standard Operating Procedure (SOP) is to define 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 waterproof pages.
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 “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.

6 REQUIRED FORMS

None.
BAE SYSTEMS
Standard Operating Procedures
SAMPLE HANDLING, PACKING, 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.


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 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.).
5.1.2 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.

5.2 Field Packaging

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

5.2.2 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.

5.2.3 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.

5.2.4 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.

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

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

5.3 Sample Packaging

5.3.1 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.

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

5.3.3 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.

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

Chain of Custody Record
BAE SYSTEMS
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, 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 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., retaining 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.
BAE SYSTEMS
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.


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., retaining 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.
BAE SYSTEMS
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., retaining 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.
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
BAE SYSTEMS
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


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., retaining 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.

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\(\frac{1}{2}\) 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\(\frac{1}{2}\) 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 BAE-SOP No. 6.0.

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 BAE-SOP 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 BAE-SOP 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 BAE-SOP 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:

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

5.2.16 One of the sample sleeves shall be utilized for lithologic logging per BAE-SOP 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.

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 BAE-SOP 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 BAE-SOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per BAE-SOP No. 1.1. Samples stored on-site will be subject to the provisions of BAE-SOP 2.3.

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
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 BAE SYSTEMS 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.
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.
11. Decontaminate all equipment according. 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.
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.
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 Tubes

The following steps must be followed when sampling subsurface soils with split‐spoon or Shelby tubes:
Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.

Proceed with site sampling to the point of obtaining split sample(s).

Follow the specific media-sampling plan.

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.

Seal sample containers and wipe outside surfaces.

Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.

Split samples will have a separate chain of custody record.

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.

Decontaminate all equipment. Place all disposables in the appropriate receptacles.

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

Document activities.

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.


6 REQUIRED FORMS

Chain of Custody Record
BAE SYSTEMS
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.
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.

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

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.

6 REQUIRED FORMS

None
1 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to define 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, 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 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);
- 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

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

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

4.2 Other:

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

5 PROCEDURE

5.1 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 a 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.

5.2 Equipment and Instrument Inspection and Maintenance

5.2.1 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.

5.2.2 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

Field Logbook
1 PURPOSE

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

2 REFERENCES


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.
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 BAE-SOP 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.
5.2.5 Measure the distance from the water surface to the permanent reference point. For aboveground "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 BAE-SOP 5.1.

5.2.8 Cap and relock the well.

6 REQUIRED FORMS

Field Logbook
BAE SYSTEMS
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.


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.

3.3 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.
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 methanol 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.

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.), is 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.

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.

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. Waste disposal will be in accordance with the project-specific Investigation-Derived Waste Management Plan.

5.6.2 Small quantities of decontamination solutions may be allowed to evaporate to dryness.

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

Field Logbook
BAE SYSTEMS
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.


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.

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 BAE-SOP 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. 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

Field Logbook.
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


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.

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.

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.

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 BAE-SOP 6.0. Decontaminate the drilling rig and all drilling equipment before monitoring well installation per BAE-SOP 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.

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 BAE-SOP 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 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.

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.

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
BAE SYSTEMS
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 for 48 hours after completion when a cement bentonite grout is used to seal the annular space, or after 7 calendar days beyond internal mortar collar placement.

2 REFERENCES


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.

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.
- Well development logs.

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 BAE-SOPs 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 BAE-SOP 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 Activity Daily Log 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 BAE-SOP No. 5.0. Calculate the volume of water in the well (cased well volume) as follows:

\[ p \times \left( \frac{d}{2} \right)^2 \times (h_1 - h_2) \times 7.48 = \text{cased well volume (in gallons)} \]

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)

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 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 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 Well Development Record.

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. 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 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

Well Development Record Form
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


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

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 rotor squeezes 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 displace the groundwater.

4.4 Bailer

A bailer is an enclosed cylindrical tube containing a floating ball check-valve at the bottom. Lowering the bailer into water causes the ball to float allowing water to enter the cylinder. Raising the bailer through the water causes the ball to settle, creating a seal to trap the water 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.
• 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 and monitoring well purge and sample forms

5  PROCEDURE

This section contains the procedures involved with groundwater sampling. Proper groundwater 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 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.

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 equipment is being used, decontaminate according to BAE-SOP 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 on the Field Activity Daily Log 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 Sampling Information Form.

5.2.6 Obtain a depth to water level measurement according to the procedures outlined in BAE-SOP 5.0. Calculate the volume of water in the well (cased well volume) as follows:

\[ p \times \left( \frac{d}{2} \right)^2 \times (h_1 - h_2) \times 7.48 = \text{cased well volume (in gallons)} \]

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 Field Logbook.

5.2.7 If using non-dedicated 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.

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 Sampling Information 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.

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 BAE-SOP No. 2.1. The sample will be assigned a sample number per BAE-SOP No. 2.2.

5.2.18 Document the sampling event on the Field Logbook.

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 BAE-SOP No. 2.1, following appropriate custody procedures described in BAE-SOP No. 1.1. Samples stored temporarily on site will be maintained per BAE-SOP 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 5.1.2.2.

5.3.3 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 well.

5.3.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.1.2.4 and 5.1.2.5.

5.3.5 Obtain a water level measurement and calculate the cased well volume per Section 5.1.6.

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.

5.3.9 Begin and conduct purging as described in Sections 5.1.2.9 and 5.1.2.10.

5.3.10 Purging will be considered complete per Section 5.1.2.10. 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 5.1.2.12.

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 5.1.2.15. 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 5.1.2.17.

5.3.17 Document the sampling event on the Field Logbook.

5.3.18 Appropriately seal, store, handle, and ship the samples per Sections 5.1.2.19 and 5.1.2.20.

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 5.1.2.2.

5.4.3 Conduct equipment decontamination as described in Section 5.1.2.3.

5.4.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.1.4 and 5.1.5.

5.4.5 Obtain a water level measurement and calculate the cased well volume per Section 5.1.6.

5.4.6 If using non-dedicated 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 5.1.2.9 and 5.1.2.10.

5.4.9 Purging will be considered complete per Section 5.1.2.10. 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 5.1.2.12.

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 5.1.2.15. 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 5.1.2.17.

5.4.16 Document the sampling event on the Field Logbook.

5.4.17 Appropriately seal, store, handle and ship the samples per Sections 5.1.2.19 and 5.1.2.20.

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 5.1.2.1.

5.5.3 Decontaminate purging and sampling equipment according to BAE-SOP No. 6.0.

5.5.4 Conduct wellhead inspection and air space monitoring as discussed in Sections 5.1.2.4 and 5.1.2.5.

5.5.5 Obtain a water level measurement and calculate the cased well volume per Section 5.1.2.6.

5.5.6 Secure the bailer to a five foot length of Teflon™ coated stainless bailer wire with a bowline knot or clip. Attach the bailer wire to bailing line or chain.

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 and brought to the immediate attention of the field geologist or engineer.

5.5.8 Purging will be considered complete per Section 5.1.2.10. 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 5.1.2.12.

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 5.1.2.15.

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 5.1.2.17.

5.5.15 Document the sampling event on the Field Logbook.

5.5.16 Appropriately seal, store, handle, and ship the samples per Sections 5.1.2.19 and 5.1.2.20.

6 REQUIRED FORMS

Field Logbook
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

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 record 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

4.2 Optional Equipment
1. Hand lens
2. Brunton or equivalent compass
3. Pocket penetrometer
5 PROCEDURE FOR FILLING OUT SOIL BORING/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
  - 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 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):

<table>
<thead>
<tr>
<th>Sand or Gravel</th>
<th>Blows per Foot</th>
<th>Silt or Clay</th>
<th>Blows per Foot</th>
<th>Thumb Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td>VL (Very Loose)</td>
<td>0-4</td>
<td>VSO (Very Soft)</td>
<td>0-2</td>
<td>Very easy-inches</td>
</tr>
<tr>
<td>L (Loose)</td>
<td>4-10</td>
<td>SO (Soft)</td>
<td>2-4</td>
<td>Easily inches</td>
</tr>
<tr>
<td>MD (Medium Dense)</td>
<td>10-30</td>
<td>M (Medium Soft)</td>
<td>4-8</td>
<td>Moderate effort-inches</td>
</tr>
<tr>
<td>D (Dense)</td>
<td>30-50</td>
<td>ST (Stiff)</td>
<td>8-15</td>
<td>Indented easily</td>
</tr>
<tr>
<td>VD (Very Dense)</td>
<td>&gt; 50</td>
<td>VST (Very Stiff)</td>
<td>15-30</td>
<td>Indented by nail</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H (Hard)</td>
<td>&gt; 30</td>
<td>Difficult by nail</td>
</tr>
</tbody>
</table>

• 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:

<table>
<thead>
<tr>
<th>Action or Measurement</th>
<th>Acceptable Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>GRAIN</td>
<td>Grain size (soil)</td>
</tr>
<tr>
<td>For soils:</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Coarse</td>
</tr>
<tr>
<td>CF</td>
<td>Coarse to Fine</td>
</tr>
<tr>
<td>F</td>
<td>Fine</td>
</tr>
<tr>
<td>FM</td>
<td>Fine to Medium</td>
</tr>
<tr>
<td>LG</td>
<td>Large</td>
</tr>
<tr>
<td>vM</td>
<td>Medium</td>
</tr>
<tr>
<td>MC</td>
<td>Medium to coarse</td>
</tr>
<tr>
<td>SMALL</td>
<td>Small</td>
</tr>
<tr>
<td>VC</td>
<td>Very coarse</td>
</tr>
<tr>
<td>VF</td>
<td>Very fine</td>
</tr>
</tbody>
</table>

Rock texture codes are available, but have not been included here since they are not expected.

Soil Classification and Lithology.

<table>
<thead>
<tr>
<th>Action or Measurement</th>
<th>Acceptable Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>USCS</td>
<td>Unified Soil Classification System augmented by lithology and special codes</td>
</tr>
<tr>
<td>USCS Codes:</td>
<td>Separate dual USCS codes by a hyphen.</td>
</tr>
<tr>
<td>CH</td>
<td>Fat clay, inorganic clay of high plasticity</td>
</tr>
<tr>
<td>CL</td>
<td>Lean clay, sandy clay, silty clay, or low to medium plasticity</td>
</tr>
<tr>
<td>GC</td>
<td>Clayey gravel, gravel-sand-clay mixtures</td>
</tr>
<tr>
<td>GM</td>
<td>Silty gravel, gravel-sand-silt mixtures</td>
</tr>
<tr>
<td>GP</td>
<td>Gravel, poorly graded, gravel-sand mixtures</td>
</tr>
<tr>
<td>Action or Measurement</td>
<td>Acceptable Entries</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>GW</td>
<td>Well graded gravel-sand mixture, little or no fines</td>
</tr>
<tr>
<td>MH</td>
<td>Silt, fine sandy or silty soil with high plasticity</td>
</tr>
<tr>
<td>ML</td>
<td>Silty and very fine sand, silty or clayey fine sand or clayey silt with slight plasticity</td>
</tr>
<tr>
<td>OH</td>
<td>Organic clays of medium to high plasticity, organic silts</td>
</tr>
<tr>
<td>OL</td>
<td>Organic silts and organic silty clays of low plasticity</td>
</tr>
<tr>
<td>PT</td>
<td>Peat or other highly organic soil</td>
</tr>
<tr>
<td>SC</td>
<td>Clayey sand, sand-clay mixtures</td>
</tr>
<tr>
<td>SI</td>
<td>Shells</td>
</tr>
<tr>
<td>SM</td>
<td>Silty-sand, sand-silt mixtures</td>
</tr>
<tr>
<td>SP</td>
<td>Sand, poorly-graded, gravelly sands</td>
</tr>
<tr>
<td>SW</td>
<td>Sand, well-graded, gravelly sands</td>
</tr>
<tr>
<td>WD</td>
<td>Wood</td>
</tr>
</tbody>
</table>

**USCS**

Unified Soil Classification System augmented by lithology and special codes

| Special: |
| ASH | Ash |
| ASPHLLT | 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

<p>| 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 |
| B | Boulders |
| BDWX | Badly weathered |
| CAL | Calcareous |
| CARB | Carbonaceous |
| CC | Concretions |
| CEM | Cemented |</p>
<table>
<thead>
<tr>
<th>Action or Measurement</th>
<th>Code</th>
<th>Description</th>
<th>Acceptable Entries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code</td>
<td></td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>CHE</td>
<td>With chemicals</td>
<td>(based on headspace reading)</td>
<td></td>
</tr>
<tr>
<td>CL</td>
<td>Clayey</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td>Clay strata or lenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCOLOR</td>
<td>Discolored</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAULT</td>
<td>Faulted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FECC</td>
<td>Iron concentrations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FILL</td>
<td>Disturbed soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRACT</td>
<td>Fractured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRIA</td>
<td>Friable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Gravelly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HPL</td>
<td>Highly plastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRNST</td>
<td>Ironstained</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIG</td>
<td>Lignite fragments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MICA</td>
<td>Micaceous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ML</td>
<td>Silty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOT</td>
<td>Mottled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>Organic matter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ODOR</td>
<td>Odiferous</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OX</td>
<td>Oxidized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODIF</td>
<td>Lithology modifications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(continued)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RT</td>
<td>Rootlets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>Sandy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDL</td>
<td>Sandstone lenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SDS</td>
<td>Sandstone fragments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SH</td>
<td>Shale fragments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHLN</td>
<td>Shale lenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHLY</td>
<td>Shaly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIS</td>
<td>Silt strata or lenses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SL</td>
<td>Slickensides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLF</td>
<td>Shell fragments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SLWX</td>
<td>Slightly weathered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td>Solid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THSK</td>
<td>Thin streaks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TR</td>
<td>Trace</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRCL</td>
<td>Trace of clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRG</td>
<td>Trace of gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRML</td>
<td>Trace of silt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRMN</td>
<td>Trace of manganese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRS</td>
<td>Trace of sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WCL</td>
<td>With clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WFE</td>
<td>With iron oxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WG</td>
<td>With gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WGML</td>
<td>With gravel and silt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WLAM</td>
<td>With laminations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WML</td>
<td>With silt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WS</td>
<td>With sand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WX</td>
<td>Weathered</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6 REQUIRED FORMS

Soil Boring Log Forms
BAE SYSTEM
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

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).

3.1 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.

3.2 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.)
- 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.

5.1.2.1.1 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.

5.1.2.1.2 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

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.

5.2.1.3 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.
5.2.1.4 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.

5.2.1.5 Cuttings and fluids containment during drilling should be observed and supervised by the Program Geologist, as per specifications in the project work plans.

5.2.1.6 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.

5.2.1.7 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.

5.2.1.8 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.

5.2.1.9 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.

5.2.1.10 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.

5.2.2 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.

5.2.1 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
BAE SYSTEMS
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.


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.
5.0 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.

5.1.3 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.

5.1.4 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
BAE SYSTEMS
Standard Operating Procedures
MANAGEMENT OF INVESTIGATION- Derived WASTE

1 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for the proper management of investigation-derived waste (IDW) generated during environmental activities under contract number DAAD07-95-C-0125. Management includes waste minimization, hazardous waste determination, storage, labeling and transportation to the White Sands Missile Range Hazardous Waste Minimization Center.

During environmental investigations at the White Sands Missile Range (WSMR), BAE SYSTEMS sampling crews may generate potentially contaminated IDW, including but not limited to the following types of materials:
- Saturated and unsaturated soil
- Groundwater
- Non-aqueous phase liquid (NAPL)
- Decontamination water
- Personal Protective Equipment (PPE) and miscellaneous refuse

Deviations from this procedure should be detailed in site-specific waste management plans approved by the New Mexico Environment Department (NMED).

2 REGULATORY AUTHORITY

The NMED has consolidated authority for all remedial investigations and corrective actions at the WSMR under the Hazardous Waste Bureau (HWB). The bureau regulates these activities under the New Mexico Hazardous Waste Act (NMSA 1978, sections 74-4-1 through 14), the corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 4.1), and the New Mexico Solid Waste Act (NMSA 1978, sections 74-9-1 through 74-9-42) and its corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 9.1).

The federal regulations governing hazardous waste, 40 CFR 260-273 (also known as RCRA) have been adopted by New Mexico almost in their entirety and are referred to in this document.

The transportation of hazardous waste (and some non-hazardous waste) is regulated under the DOT Hazardous Material Regulations (49 CFR 171-178). The New Mexico Hazardous Waste Act and the corresponding regulations refer the reader to the DOT Hazardous Material Regulations when addressing transportation of hazardous waste beyond manifesting requirements. The transportation of other non-hazardous waste is regulated under the New Mexico Solid Waste Act (NMSA 1978, sections 74-9-1 through 74-9-42) and its corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 9.1).
3 REFERENCES

3.1 State of New Mexico, 1983. *Hazardous Waste Act (NMSA 1978, sections 74-4-1 through 14)*. Santa Fe, New Mexico.

3.2 New Mexico Environment Improvement Board, June 2000. *New Mexico Hazardous Waste Management Regulations (20 NMAC 4.1)*. Santa Fe, New Mexico.


3.4 New Mexico Environment Improvement Board, November 1995. *New Mexico Solid Waste Management Regulations (20 NMAC 9.1)*. Santa Fe, New Mexico.


3.7 EPA, 1991. Memo from S. Lawrence (Director of Office of Solid Waste) to John Ely addressing the EPA’s “Contained-In Policy”.


3.9 Forsythe, G. (Environmental Compliance Division, WSMR), July 10, 2002. Email to Don Emig: *Transporting items across U.S. 70*.

4 RESPONSIBILITIES

4.1 The project Task Manager and Task 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).

4.2 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 nonconformance memorandums, etc.) if problems occur.

4.3 The project Sampling Team Leader assigned to environmental and QC sampling activities is responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures.
4.4 All staff members are responsible for reporting deviations from procedures to the Project Task Coordinator.

5 REQUIRED MATERIALS

- Indelible black ink pens.
- Paint pens for marking drums
- Drum Labels

6 PROCEDURES

6.1 Waste Management Procedures Overview

These procedures are conservative in their approach to waste management so that they may ensure the protection of human health and the environment and comply with regulatory requirements that are applicable or relevant and appropriate requirements (ARARs). They include the management of waste from the point of generation to the transfer of responsibility at the WSMR Hazardous Waste Minimization Center (HWMC).

The HWMC is responsible for the transportation and disposal of all wastes from the WSMR. The center makes the final waste determination for all waste streams using information provided by their customers. The center is the repository for all of the waste determination analytical data, waste profiles, manifests and certificates of disposal for the WSMR.

6.2 Waste Minimization

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.
6.3 Waste Determinations

The initial waste determination may be established using the guidelines outlined below. This determination should be used to properly manage the waste until the final waste determination is made by the HWMC. A copy of the analytical data and supporting documentation shall be provided to the HWMC upon completion of the initial waste determination. The center will notify the project Task Coordinator if they do not concur with the initial waste determination. If there is a discrepancy, the two parties shall meet and review the conclusions and supporting data. Appropriate corrective actions shall be subsequently taken to ensure that the waste is being properly managed.

6.3.1 Background

Investigation derived waste (IDW) originates from solid waste or environmental media. Solid waste as defined in 40 CFR 261.2 is any discarded material that is not excluded by 261.4(a) or that is not excluded by variance granted under 260.30 and 260.31. The reader should familiarize himself or herself with the exclusions, but it is not expected that they will apply. Examples of IDW that is solid waste are personal protective equipment, disposable equipment, non-aqueous phase liquid and decontamination water.

The EPA describes environmental media as being soil, groundwater or sediment (EPA, 1991). The presumption is that they were not discarded and therefore do not meet the definition of solid waste. The EPA has established and upheld in court of law, a policy, which addresses the applicability of RCRA to contaminated environmental media. This policy is known as the “contained-in-policy”. Simply put, the environmental media will be considered a solid waste, if it “contains” a solid waste. Examples of IDW that is environmental media are soil cuttings and purge water.

6.3.2 Regulatory Requirement

RCRA compels the solid waste generator under 40 CFR 262.11, to determine if that waste is a hazardous waste using the following method:

(a) He should first determine if the waste is excluded from regulation under 40 CFR 261.4.
(b) He must then determine if the waste is listed as a hazardous waste in subpart D of 40 CFR part 261.

Note: Even if the waste is listed, the generator still has an opportunity under 40 CFR 260.22 to demonstrate to the Administrator that the waste from his particular facility or operation is not a hazardous waste.

(c) For purposes of compliance with 40 CFR part 268, or if the waste is not listed in subpart D of 40 CFR part 261, the generator must then determine whether the waste is identified in subpart C of 40 CFR part 261 by either:

1. Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or
2. Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.
(d) If the waste is determined to be hazardous, the generator must refer to parts 261, 264, 265, 266, 268, and 273 of this chapter for possible exclusions or restrictions pertaining to management of the specific waste.

6.3.3 Waste Analysis

It is the policy of the HWMC to make waste determinations based on analytical data and supported by generator knowledge. They also require that the analytical data be no older than one year.

The sample collected for waste analysis should be representative of the material being evaluated. Acquiring a representative sample can include compositing and statistical analysis.

Waste analysis should be performed for those analytes that are suspected to be present based on site information and/or generator knowledge. The approved testing methods are indicated in 40 CFR 261 Subpart C. When generator knowledge is absent a full waste characterization should be performed. This would include running the toxicity characteristic leaching procedure for the entire Table 1 constituents listed in 40 CFR 261.24 and ignitability, corrosivity and reactivity.

6.3.4 Methodology

Waste determinations will be established as soon as practical after the waste is generated. The determination is made using the three-step process outlined below. Sites that have not been previously investigated are inherently problematic. It often requires substantial individual judgment in making waste management decisions. It is recommended that the person responsible for waste management handle the material as though it were hazardous waste, if sufficient information is not available at the time of generation. This would include labeling the drums as hazardous waste and managing them accordingly. Refer to section 6.5.1 of this procedure for further instruction on proper labeling of containers lacking adequate waste determination.

Step 1: Is the waste a solid waste?

The EPA’s “contained-in policy” should be referred to for direction in determining whether environmental media is a solid waste. The policy provides that environmental media will be considered a solid waste if it contains a listed waste or exhibits the characteristics of a hazardous waste.

The EPA has not defined what volume or concentration of a listed waste constitutes “contained-in”. They have advised that the determination be made in consultation with the regulatory authority and be based on conservative risk-based screening levels.

This document advises the use of the universal treatment standards (UTS) provided in 40 CFR 268.48 for determination as to whether the media contains the chemical(s), which gave origin to the listing. These standards are utilized to determine whether underlying hazardous constituents require further treatment as required by the Land Disposal Restrictions in 40 CFR Part 268 prior to disposal. This document presumes that the UTS would provide adequate screening for waste disposal purposes. Any material left onsite at a concentration below the UTS, would still be subject to risk based cleanup criteria for corrective action. Therefore this procedure presumes
that the environmental media contains a listed waste if the UTS are exceeded for the chemical that gave origin to the listing.

If the environmental media does not contain a listed waste or exhibit the characteristic of a hazardous waste, it shall be considered to contain a solid waste when any constituent exceeds the appropriate detection limit or established background level for organic and inorganic naturally occurring compounds.

Other investigation-derived waste is a solid waste at the point at which it is discarded.

Step 2: Is the solid waste a hazardous waste?

Once the waste has been declared a solid waste, it is necessary to determine whether it is hazardous. The process is the same whether or not it is environmental media. The only difference being whether the “mixture rule” or the “contained-in” policy applies.

Review the site history and interview current and former employees to determine whether a listed (F, K, P or U) waste caused the contamination. The EPA has stated that one may assume a listed waste did not cause the contamination if the documentation for making such a determination is unavailable or inconclusive and the facility owner/operator has made a good faith effort to do so (EPA, 1998). If a listed waste caused the contamination, then the (non-environmental media) solid waste will be considered a hazardous waste, based on the “mixture rule”. Environmental media containing by a listed waste is considered a hazardous waste based on the “contained in policy”.

Analyze the waste for the Subpart C hazardous waste characteristics (ignitability, corrosivity, reactivity and toxicity). If the levels exceed the values provided in 40 CFR 261.21 thru 261.24 the material exhibits a characteristic of a hazardous waste and shall be managed as such.

Step 3: Does the waste contain an underlying hazardous constituent?

Identification of underlying hazardous constituents (UHC) is an important part of waste profiling in order to satisfy the land disposal restrictions. Although the management activities covered in this procedure do not address disposal options, gathering this information up front is an important step.

Sufficient laboratory analysis should be performed to determine whether other contaminants are present in the waste. The analysis should be based on generator knowledge of the waste and include those contaminants that may reasonably be expected. The results should be provided to the HWMC for evaluation as UHCs when considering disposal options.

Storage of IDW

Waste may be stored in a variety of portable containers, such as 5-gallon buckets, 55-gallon drums, rolloff boxes, and baker tanks. The specifications of each device will depend on the hazardous waste determination.
Containers used to store hazardous waste must meet the requirements of 40 CFR 262.34 (c)(1) (Satellite Accumulation), by being in good condition, being compatible with the waste and being closed except when adding or removing waste. Containers must also satisfy the DOT shipping requirements appropriate for the hazard classification. Refer to column 8 of the Hazardous Materials Table in 49 CFR 172.101. The containers will be marked with appropriate hazardous waste labels as prescribed in 40 CFR 262.34 (c)(1)(ii) and will be transported within 3 days of generation to the HWMC.

Non-hazardous solid waste must meet the requirements of 20 NMAC 9.1, Section 106 by being covered, reasonably clean and leak proof. The containers will be labeled, indicating the contents and potential health, safety, and environmental hazards associated with the waste (20 NMAC 9.1 Section 703) and will be shipped to the HWMC for disposal within 45 days of generation in accordance with Section 712 of 20 NMAC 9.1.

IDW that has been classified as hazardous waste “pending analysis” must be moved to a permitted 90-day storage facility within three days of generation and stored until analytical results have been received and reviewed. It is imperative that analytical results be received sufficiently in advance of the 90-day limit to allow for disposal within that time period.

Drums used for storage of liquid waste 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 containers must be covered and sealed daily before field personnel leave the site.

6.4 Container Labeling and Marking

All containers used to store investigation-derived waste at the White Sands Missile Range will be labeled by the end of each workday. Containers will be assigned numbers sequentially. Duplicate numbers will be avoided by reviewing the Field Logbook before assigning a number to an IDW drum. Containers will be marked on the side and lid using a paint marker. Marking will include the following:

- Container number
- Dates of first use and last use
- Site Identification (include SWMU #, sample type, sample No.)
- Level of PPE worn when IDW was generated

Non-hazardous waste containers will be labeled using the green label (figure 1). The contents will be written in the space provided at the bottom.

Hazardous waste containers will be labeled using the yellow label (figure 2). The proper shipping name will be filled in the space provided at the bottom of the label. The contents of the container (ie. decontamination water, soil cuttings) will be marked on the side and top of the container, as practical, with the other information listed above.

Containers of IDW that do not have a hazardous waste determination will be labeled as Hazardous Waste using the label in Figure 2 and a Pending Analysis label shown in Figure 3.
6.4.1 Field Logbook

The field operations leader will keep all container inventory information in the Field Logbook. The Field Logbook will contain the following information:

1. Unique container ID number
2. Site ID
3. Container contents
4. Dates:
   - Container filled
   - Sample collected
   - Container transfer to HWMC
   - Analytical results received
5. Hazardous waste determination
6. Date the containers were turned over to the Hazardous Waste Minimization Center

6.5 Alternate Disposal of Environmental Media

Environmental media determined to be non-hazardous waste may be placed back within the area of investigation provided that the concentration of contaminants are below (in order of preference):

1. Established naturally occurring organic and inorganic background levels.
2. Human Health Standards for groundwater (20 NMAC 6.2 Section 3103).
3. NMED Residential and/or DAF 20 Soil Screening Levels (whichever is lower).
4. EPA Region IX Preliminary Remediation Goals and DAF 20 Soil Screening Levels.

Environmental media will not be placed within the area of investigation even if the above criteria are met, if it is known to exceed established ecological risk criteria.
6.6 Record keeping

The Investigation Contractor will maintain completed Field Logbooks and waste characterization data packages that they generate.

6.7 Transportation

BAE SYSTEMS may transport hazardous and non-hazardous waste within the boundaries of the White Sands Missile Range without a manifest, bill of lading, placarding, DOT container marking or Hazardous Material Transporter registration. BAE SYSTEMS may also cross non-range roads to transport hazardous and non-hazardous waste between contiguous properties of WSMR, without being subject to the DOT Hazardous Materials Regulations or the Uniform Hazardous Waste Manifest (the manifest) requirements of RCRA (G. Forsythe, 2002).

BAE SYSTEMS will not transport the waste along non-range roads, even within the boundaries of the WSMR. If this is necessary, BAE SYSTEMS shall require these transportation services be provided by the HWMC.

If the waste will be transported offsite, a manifest must be prepared. The manifest is a form used to track the movement of hazardous or non-hazardous waste from the point of generation to the point of ultimate disposition ("cradle to grave") (40 CFR part 262, Subpart B). The manifest generally requires the following information:

- Name, address and US EPA ID No. of the generator, transporter, and the destination facility
- U.S. DOT description of the waste being transported and any associated hazards
- waste quantity
- name and phone number of a contact in case of an emergency
- special handling or hazard information
- Generators Certification (Signature required by authorized Gov’t POC)
- other information required either by EPA or the state

In all cases the “Generator” shall be White Sands Missile Range and the manifest should be signed by the authorized Government point of contact. **UNDER NO CONDITION SHOULD A BAE SYSTEMS OR NORTH WIND EMPLOYEE SIGN AS OR FOR THE GENERATOR ON A MANIFEST.**
Purpose

This Standard Operating Procedure (SOP) establishes the methods and responsibilities associated with the preparation, revision, and approval of quality-affecting documents.

REFERENCES

None.

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.).

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.

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.

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

Manual Change Request
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.
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 B

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

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF ACRONYMS</td>
<td>B-iii</td>
</tr>
<tr>
<td>REVIEWS AND APPROVALS</td>
<td>B-iv</td>
</tr>
<tr>
<td>1.0 INTRODUCTION</td>
<td>B-1</td>
</tr>
<tr>
<td>2.0 HEALTH AND SAFETY ORGANIZATION</td>
<td>B-2</td>
</tr>
<tr>
<td>2.1 Project Organization</td>
<td>B-2</td>
</tr>
<tr>
<td>2.2 Responsibility and Authority of Key Personnel</td>
<td>B-2</td>
</tr>
<tr>
<td>2.2.1 Task Manager</td>
<td>B-2</td>
</tr>
<tr>
<td>2.2.2 Task Coordinator</td>
<td>B-3</td>
</tr>
<tr>
<td>2.2.3 Site Health &amp; Safety Officer</td>
<td>B-4</td>
</tr>
<tr>
<td>3.0 SITE WORK PLAN SUMMARY</td>
<td>B-4</td>
</tr>
<tr>
<td>3.1 Project Objective</td>
<td>B-4</td>
</tr>
<tr>
<td>3.2 Project Tasks</td>
<td>B-4</td>
</tr>
<tr>
<td>4.0 SITE CHARACTERIZATION AND ANALYSIS</td>
<td>B-5</td>
</tr>
<tr>
<td>4.1 General Site Information</td>
<td>B-5</td>
</tr>
<tr>
<td>4.2 Anticipated Hazards</td>
<td>B-6</td>
</tr>
<tr>
<td>4.2.1 Chemical Hazards</td>
<td>B-6</td>
</tr>
<tr>
<td>4.2.2 Physical Hazards</td>
<td>B-6</td>
</tr>
<tr>
<td>4.2.3 Unexploded Ordnance</td>
<td>B-7</td>
</tr>
<tr>
<td>4.2.4 Noise</td>
<td>B-7</td>
</tr>
<tr>
<td>4.2.5 Electrical Hazards</td>
<td>B-8</td>
</tr>
<tr>
<td>4.2.6 Underground Utility Lines</td>
<td>B-8</td>
</tr>
<tr>
<td>4.2.7 Biological Hazards</td>
<td>B-8</td>
</tr>
<tr>
<td>4.2.8 Heat Stress</td>
<td>B-8</td>
</tr>
<tr>
<td>4.2.9 Cold</td>
<td>B-9</td>
</tr>
<tr>
<td>4.3 Personal Protection for Site Work</td>
<td>B-9</td>
</tr>
<tr>
<td>4.5 Smoking</td>
<td>B-12</td>
</tr>
<tr>
<td>5.0 SITE MONITORING</td>
<td>B-12</td>
</tr>
<tr>
<td>6.0 ACCIDENT PREVENTION PLAN</td>
<td>B-12</td>
</tr>
<tr>
<td>7.0 COMPLIANCE AGREEMENT</td>
<td>B-19</td>
</tr>
<tr>
<td>8.0 DAILY HEALTH AND SAFETY BRIEFING COMPLIANCE AGREEMENT</td>
<td>B-20</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>List of Figures</strong></td>
<td></td>
</tr>
<tr>
<td>Figure 1-1. Site Location Map.</td>
<td>B-1</td>
</tr>
<tr>
<td>Figure 2-1. Project Personnel Organization Chart</td>
<td>B-3</td>
</tr>
<tr>
<td>Figure 3-1. Location of Project Site, LC-38 Diesel Spill.</td>
<td>B-5</td>
</tr>
<tr>
<td>Figure 4-1. Emergency Route to Medical Facility from the Project Site.</td>
<td>B-10</td>
</tr>
<tr>
<td><strong>List of Tables</strong></td>
<td></td>
</tr>
<tr>
<td>Table 4-1 Emergency Contact Telephone Numbers</td>
<td>B-11</td>
</tr>
<tr>
<td>Table 5-1 Site Monitoring Summary</td>
<td>B-12</td>
</tr>
</tbody>
</table>
## LIST OF ACRONYMS

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

This plan serves as a site-specific addenda to the Accident Reporting and Safety Program dated 14 September 1995, developed by BAE SYSTEMS, formally 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 groundwater investigation at the HELSTF TSA POL Site. This Site-Specific Health and Safety Plan was approved by the following individuals:

__________________________    ____________
Joel Giblin                  Date
Health and Safety Officer
BAE SYSTEMS

__________________________    ____________
Jennifer Davis               Date
Site Health and Safety Officer
BAE SYSTEMS

__________________________    ____________
Fred Bourger                 Date
Task Manager/Deputy Program Manager
BAE SYSTEMS

__________________________    ____________
Donald K. Emig, Ph.D., P.E.  Date
General Manager
BAE SYSTEMS
SITE SPECIFIC HEALTH AND SAFETY PLAN
SOIL INVESTIGATION AT LC-38 DIESEL SPILL SITE

1.0 INTRODUCTION

A release was discovered at the High Energy Laser Systems Test Facility (HELSTF) Technical Support Area (TSA) Petroleum/Oil/Lubricants Station in March 2000. Initial estimates placed the volume of gasoline lost at 1,500 gallons.
The investigation revealed that the release occurred as a result of a poor connection between the dispenser and the underground piping leading from the above ground storage tank. Soil contamination was found to extend from the surface to approximately 30 feet below the ground surface (bgs).

A soil vapor extraction system was installed in October 2000 and temporarily operated at the site for a total of four months as an interim response measure. The operation was highly successful. It is estimated that approximately 1,790 gallons of gasoline were removed from the subsurface, exceeding the initial loss estimate.

The proposed action will consist of the collection and analysis of soil samples from borings around the area of the release, the installation of two new monitoring wells and the sampling of the new and existing groundwater-monitoring wells.

A site investigation was immediately initiated to determine the nature and extent of contamination. Shallow soil samples were obtained using a hand auger to quickly characterize the problem. Further characterization was completed in May and June 2000 when soil samples were obtained using a drill rig equipped with split spoons. The drill rig also placed three monitor wells to determine if the groundwater had been impacted by the spill.

2.0 HEALTH AND SAFETY ORGANIZATION

2.1 Project Organization

The project organizational structure and key project personnel are shown on Figure 2-1 on the following page. The BAE SYSTEMS personnel assigned specific health and safety responsibilities are identified below.

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 BAE SYSTEMS DPM.

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.
Appendix B

Work Plan for the RCRA Facility Investigation at the HELSTF TSA Site

- 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.

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.

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 BAE SYSTEMS, formally 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 nine soil borings near the leak source and the installation of two down-gradient groundwater monitoring wells (Figures 3-1 on following page).

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
Figure 3-1. Location of Project Site, HELSTF TSA POL.

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 leak of unleaded gasoline was identified as having occurred at the joint between the dispenser and the underground piping from the AST. The LC-38 Diesel release occurred from tank S-24061, located immediately south of Building 24068. The site is located about 300 yards beyond the entrance to HELSTF off U.S. Highway 70.

White Sands is considered arid, with an average rainfall of only 10.8 inches, mostly occurring during late summer as thunderstorms. Average summer high temperature is 92 °F with lows of about 65 °F. During winter months, the average high is 57 °F with an average low of 36 °F. Average annual humidity readings are about 37 percent.
Sediments are predominantly clayey silts interspersed with sandier intervals. Several thin sand layers punctuate the stratigraphic column and may represent sediment deposition by meandering streams or, in some cases, eolian deposition. Thicker, clay-rich intervals separating the sandy layers probably represent sedimentation in shallow, ephemeral pools formed after stream avulsion or precipitation events in the central basin setting.

4.2 Anticipated Hazards

4.2.1 Chemical Hazards

Petroleum hydrocarbons, specifically unleaded gasoline, 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.

Unleaded Gasoline, BTEX, and MTBE

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 not 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.

![Figure 4-1. Emergency Route to Medical Facility from the Project Site.](image-url)
## Table 4-1. Emergency Contact Telephone Numbers.
(Fire and medical emergency numbers are bolded)

<table>
<thead>
<tr>
<th>Organization</th>
<th>Contact</th>
<th>Telephone*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire Station #2</strong> <em>(Nike Avenue at LC-38)</em></td>
<td></td>
<td>Land Line on WSMR: 117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Line/Cell Phone: 678-9128 Off Range: 911</td>
</tr>
<tr>
<td><strong>Fire Station #1</strong> <em>(Main Post)</em></td>
<td></td>
<td>Land Line on WSMR: 117</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Line/Cell Phone: 678-1234 Off Range: 911</td>
</tr>
<tr>
<td><strong>HELSTF Ambulance Service/ Medical Aid Station</strong> <em>(Building 26020)</em></td>
<td></td>
<td>Land Line/Cell Phone: 679-5164 or 679-5167 Off</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Range: 911</td>
</tr>
<tr>
<td><strong>Post Clinic Emergency Room</strong> <em>(Building 530)</em></td>
<td></td>
<td>Land Line/Cell Phone: 678-2882</td>
</tr>
<tr>
<td><strong>Memorial Medical Center Emergency Room</strong> <em>(Las Cruces, NM)</em></td>
<td></td>
<td>Land Line/Cell Phone: 521-2286 or 911</td>
</tr>
<tr>
<td><strong>Police</strong></td>
<td></td>
<td>Land Line on WSMR: 118</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Line/Cell Phone: 678-1234 Off Range: 911</td>
</tr>
<tr>
<td><strong>Emergency Operations Center</strong> <em>After Hours – Staff Duty Officer</em></td>
<td></td>
<td>678-3803</td>
</tr>
<tr>
<td><strong>White Sands Missile Range</strong> <em>Environment and Safety Directorate</em></td>
<td></td>
<td>678-2224</td>
</tr>
<tr>
<td><strong>WS-ES-EC Technical Inspector</strong> <em>(desk)</em></td>
<td>Hector Magallanes</td>
<td>678-2073</td>
</tr>
<tr>
<td><strong>BAE SYSTEMS Office, Building 126, White Sands, NM, Front Desk</strong></td>
<td>Stephanie Gamboa</td>
<td>678-0263</td>
</tr>
<tr>
<td><strong>Site Safety and Health Representative</strong></td>
<td>Jennifer Davis</td>
<td>678-6445</td>
</tr>
<tr>
<td><strong>North Wind Environmental Task Coordinator</strong></td>
<td>Leonard Habel</td>
<td>678-0891</td>
</tr>
<tr>
<td><strong>BAE SYSTEMS Deputy Program Manager / Task Manager / QA/QC Manager</strong></td>
<td>Fred Bourger</td>
<td>678-3426</td>
</tr>
<tr>
<td><strong>BAE SYSTEMS Health and Safety Officer</strong></td>
<td>Joel Giblin</td>
<td>678-0910</td>
</tr>
<tr>
<td><strong>BAE SYSTEMS General Manager</strong></td>
<td>Donald K. Emig, Ph.D., P.E.</td>
<td>678-7907</td>
</tr>
<tr>
<td><strong>NMED Hazardous Waste Bureau</strong> <em>(Project Regulatory Agency)</em></td>
<td>Cheryl Frischkorn <em>(505) 827-1961</em></td>
<td></td>
</tr>
</tbody>
</table>

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

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.

<table>
<thead>
<tr>
<th>Chemical / Physical Agent</th>
<th>Action Level</th>
<th>Monitoring Equipment</th>
<th>Sampling and Analysis</th>
<th>Frequency of Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile Organic Compounds</td>
<td>20 ppm&lt;sup&gt;a&lt;/sup&gt; in the breathing zone</td>
<td>PID</td>
<td>Direct Reading</td>
<td>During drilling within the contaminated zone</td>
</tr>
<tr>
<td>Explosive Conditions</td>
<td>LEL: 1.4% UEL: 7.6%</td>
<td>Combustible Gas Meter</td>
<td>Direct Reading</td>
<td>During drilling within the contaminated zone</td>
</tr>
<tr>
<td>Noise Levels</td>
<td>85 dBA&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Sound Level Meter</td>
<td>Direct Reading</td>
<td>During all drilling activities</td>
</tr>
</tbody>
</table>

Notes:
<sup>a</sup> ppm - parts per million
<sup>b</sup> 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. BAE SYSTEMS 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 BAE SYSTEMS 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.

X 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 gases 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:

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

**Hazard 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:

- Personnel operating heavy equipment or vehicles shall maintain a constant awareness of personnel and stationary objects in the areas adjacent to its operation.
- Spotters shall be utilized to assist operators in manipulating vehicles and equipment into tight or confined areas.
- 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.
- Ensure operators are adequately trained and/or licensed as necessary to operate their equipment or motor vehicles.
- All moving heavy equipment must have properly functioning backup alarms.
- 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:

- Drink plenty of fluids, preferably water before, during and after each activity
- Acclimate to site conditions by slowly increasing work loads
- 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

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

- Mechanical equipment (i.e., dolly, hoist, fork lift) shall be utilized whenever possible to minimize manual labor.
- Size up the job before lifting and get help if needed. The maximum weight to be manually lifted by BAE SYSTEMS and/or subcontractor personnel is 60 pounds (27.2 kilograms).
- 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:

- Where direct verbal communication is limited, portable 2-way radios, and/or hand signals shall be utilized to facilitate communication among workers.
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

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).

Inspect noise control devices (i.e., mufflers) on equipment to ensure they are working properly.

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.

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:

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.

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.

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 BAE SYSTEMS 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.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B-19
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