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FINAL

SAMPLING AND ANALYSIS PLAN

LONG TERM GROUNDWATER MONITORING PROGRAM

VOLUME I - FIELD SAMPLING PLAN ADDENDUM

VOLUME II - QUALITY ASSURANCE PROJECT PLAN

VOLUME III - SITE SAFETY AND HEALTH PLAN ADDENDUM

FALL 1997 SAMPLING

July 1997

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49 CES/CEV
Holloman Air Force Base
New Mexico

FINAL

FIELD SAMPLING PLAN ADDENDUM

LONG TERM GROUNDWATER MONITORING PROGRAM

HOLLOMAN AIR FORCE BASE, NEW MEXICO

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Prepared for:

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

49 CES/CEV
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LIST OF ACRONYMS/ABBREVIATIONS

µg/l	Micrograms per Liter
µs/cm	Microseconds per centimeter
AFB	Air Force Base
AGE	Aerospace Ground Equipment
ASTM	American Society for Testing and Materials
BEC	Base Environmental Coordinator
BRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
C	Degrees Celsius
SAP	Chemical Data Acquisition Plan
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
DOD	Department of Defense
DOT	Department of Transportation
DPT	Direct Push Technology
DQCR	Daily Quality Control Report
DTW	Depth To Water
EPA	Environmental Protection Agency
F	Degrees Fahrenheit
FID	Flame Ionization Detector
FSP	Field Sampling Plan
ft	Feet
GC	Gas Chromatograph
ID	Identification
IDW	Investigation-Derived Waste
IRFNA	Inhibited Red Fuming Nitric Acid
IRP	Installation Restoration Program
IWFNA	inhibited white fuming nitric acid
LEL	Lower Explosion Limit
LIMS	Location Information Management
LPH	Liquid Phase Hydrocarbons
LTM	Long Term Groundwater Monitoring
LOX	liquid oxygen
mg/kg	Milligrams per Kilogram
mg/l	Milligrams per Liter

LIST OF ACRONYMS/ABBREVIATIONS (continued)

MRD	Missouri River Division
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSL	Mean Sea Level
NFA	No Further Action
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMED	New Mexico Environment Department
NTU	Nephelometric Turbidity Units
O_2	Oxygen Meter
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PA/SI	Preliminary Assessment/Site Investigation
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
POL	Petroleum, Oils, and Lubricants
ppb	parts per billion
PPE	Personal Protection Equipment
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource, Conservation and Recovery Act of 1976
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SOP	Standard Operating Procedure
SOS	Scope of Services
SSHP	Site Safety and Health Plan
SVE	Soil Vapor Extractor System
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TB	Trip Blank
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TOC	Top of Casing
TOX	Total Organic Halogens
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons

LIST OF ACRONYMS/ABBREVIATIONS (continued)

UDMH	Unsymmetrical dimethylhydrazine
USACE	United States Army Corps of Engineers
UST	Underground Storage Tank
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compounds

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) Addendum has been prepared to support the Long Term Groundwater Monitoring (LTM) Program for selected sites at Holloman Air Force Base (AFB), New Mexico. The selected sites are part of the Installation Restoration Program (IRP) and are regulated under the Comprehensive Environmental Response Compensation Liability Act (CERCLA) and the Resource, Conservation and Recovery Act of 1976 (RCRA). The LTM program consists of the collection of groundwater samples for site-specific analytical parameters once every two (2) years for a total of 10 years. The purpose of the LTM program is to fulfill Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED) requirements to conditionally close out the designated sites in the program. The original 1995 CDAP was prepared for LTM at 12 sites. These same sites, but excluding Site OT-45, plus six additional sites, for a total of 17 sites will be part of the 1997 LTM sampling program.

This SAP Addendum is separated into three volumes: a Field Sampling Plan (FSP) (Volume I) Addendum, a Quality Assurance Project Plan (QAPP)(Volume II), and a Site Safety and Health Plan (SSHP) (Volume III) Addendum. This FSP comprises the groundwater monitoring procedures and site-specific LTM sampling plans. The QAPP provides guidance on the analytical methods, and quality assurance/quality control (QA/QC) procedures required for the project. Since a different laboratory will be used, the QAPP is a completely revised document. This SSHP is comprised of the health and safety issues that are involved with the project. The FSP and SSHP addenda have been prepared to address only those changes to the 1995 CDAP and to describe the new sites added to the 1997 LTM program.

1.1 Document Purpose

The purpose of this SAP Addendum is twofold: (1) to ensure that data collected during these activities are of adequate quality for the purposes of assessing potential impacts to soils and groundwater; and (2) to adequately characterize investigation-derived waste (IDW) for proper disposal. This SAP addresses the quality assurance elements required by "General Chemistry Supplement to the Scope of Services", U.S. Army Corps of Engineers (USACE), Omaha District (January 1996). Field investigation procedures have been

prepared in accordance with the "General Geology Supplement to the Scope of Services", (USACE, May 1992) and the 1995 CDAP.

The SAP has been prepared in a manner which will permit the addition of future sites to the LTM program by simply providing addenda to Section 3.0 of the FSP. Currently, the existing CDAP covers LTM at the following sites (Figure 1-1):

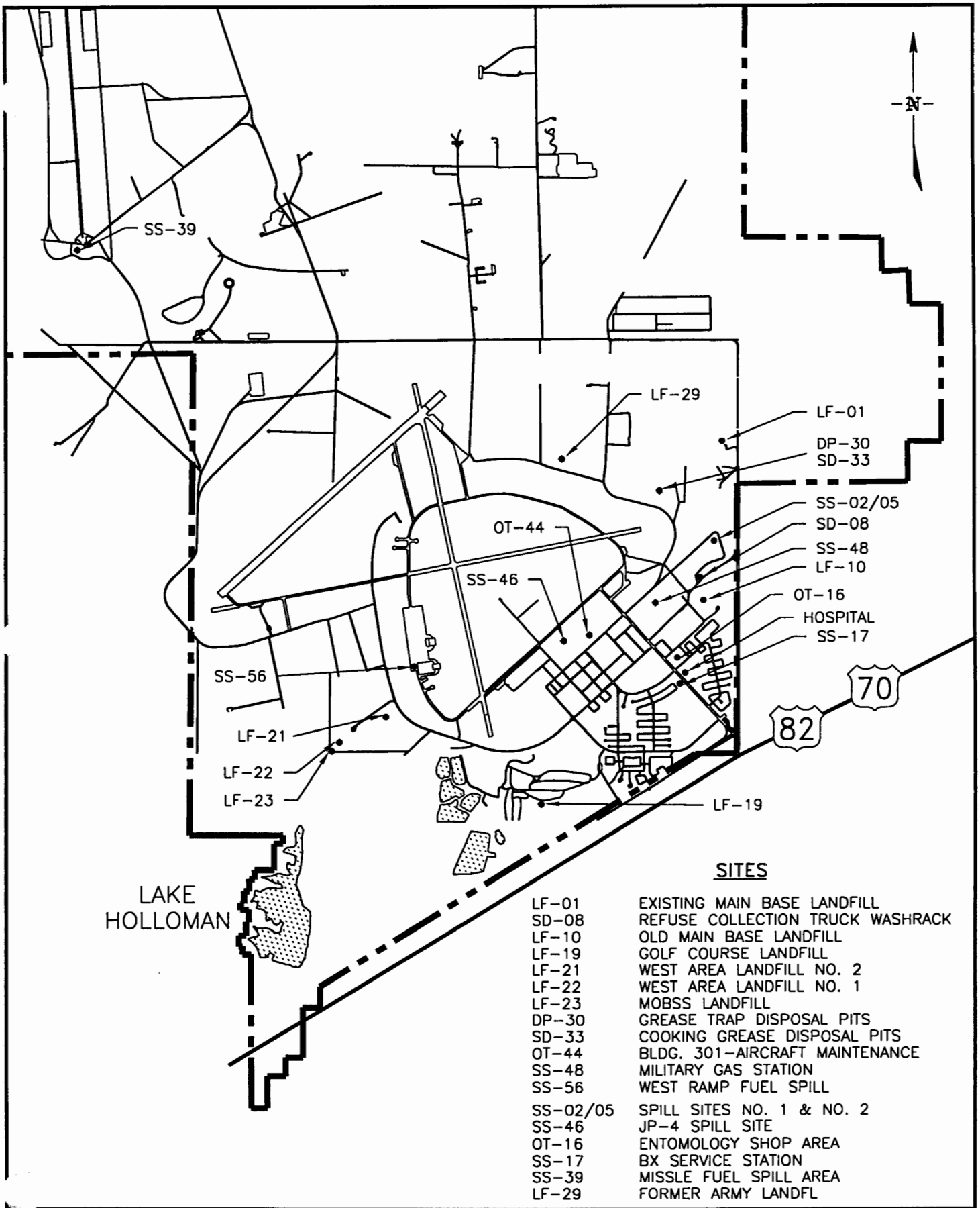
LF-01	Main Base Landfill
LF-10	Old Main Base Landfill
SD-08	Refuse Collection Truck Washrack
LF-19	Golf Course Landfill
LF-21	West Area Landfill No. 2
LF-22	West Area Landfill No. 1
LF-23	MOBBS Landfill
OT-44	Building 301 Aircraft Maintenance Area
OT-45	Aerospace Ground Equipment (AGE) Refueling Station
SS-48	Military Gas Station
SS-56	West Ramp Fuel Spill
DP-30 & SD-33	Grease Trap Disposal Pits

Sites addressed in this SAP Addendum which were not included in the original 1995 CDAP include the following:

SS-02 & SS-05	Spill Sites 1 & 2
SS-46	JP-4 Spill Site
OT-16	Entomology Shop Area
SS-17	BX Service Station
SS-39	Missile Fuel Spill Area
LF-29	Former Army Landfill

Site OT-45 has been removed from the LTM program for 1997.

Also, for 1997, four additional monitoring wells will be installed and sampled as part of the LTM; one at SS-56 and three at SS-46.



SITES

LF-01	EXISTING MAIN BASE LANDFILL
SD-08	REFUSE COLLECTION TRUCK WASHRACK
LF-10	OLD MAIN BASE LANDFILL
LF-19	GOLF COURSE LANDFILL
LF-21	WEST AREA LANDFILL NO. 2
LF-22	WEST AREA LANDFILL NO. 1
LF-23	MOBSS LANDFILL
DP-30	GREASE TRAP DISPOSAL PITS
SD-33	COOKING GREASE DISPOSAL PITS
OT-44	BLDG. 301-AIRCRAFT MAINTENANCE
SS-48	MILITARY GAS STATION
SS-56	WEST RAMP FUEL SPILL
SS-02/05	SPILL SITES NO. 1 & NO. 2
SS-46	JP-4 SPILL SITE
OT-16	ENTOMOLOGY SHOP AREA
SS-17	BX SERVICE STATION
SS-39	MISSLE FUEL SPILL AREA
LF-29	FORMER ARMY LANDFL

FIGURE 1-1 SITE LOCATION MAP HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	1:5000	SHN

96-332\FIG1-1.DWG 7/16/97 (R13)

1.2 Document Organization

Revisions and modifications to the 1995 LTM sites are described in Section 2.0.

Site-specific information and groundwater sampling procedures, including the number of samples and analytical parameters for the six new sites for 1997 are presented in Section 3.0. The 1995 CDAP discussed twelve sites in Sections 3.1 through 3.12; this 1997 addendum discusses six new sites in Sections 3.13 through 3.18. Monitoring well drilling, installation, and development procedures for the four new wells are presented in Appendix A. These procedures were not addressed in the 1995 CDAP. Standard Operating Procedures (SOPs) for groundwater sampling presented in the 1995 will be followed for the 1997 LTM.

2.0 MODIFICATIONS TO THE 1995 CDAP

The following section describes only the changes or modifications made to the original 12 sites addressed in the 1995 CDAP. Modifications include such items as well substitution, and revised casing elevations for existing or newly installed wells. Table 2-1, below, provides information needed for the 1997 LTM, and illustrates the changes from the 1995 sampling program.

Table 2-1. 1997 LTM Modifications to the 1995 LTM CDAP

Site	'95 Wells	'97 Wells	New TOC	Notes
LF-01	MW-1	S1-MW 1	4099.39	
	MW-3	S1-MW 2	4098.62	
	MW-5	S1-MW 5	4114.89	
	IW-2	IW2	4100.69	
LF-19	MW-1	MW-19-01	4048.70	
	MW-2	MW-19-02	4045.63	
	MW-3	MW-19-03	4049.29	
LF-21	MW-1	MW-21-01	4046.59	
	MW-2	MW-21-02	4042.97	
	MW-3	MW-21-03	4041.77	
	MW-4	MW-21-04	4039.99	
OT-45	MW-2			Site removed from LTM
	MW-3			
	MW-4			
	MW-7			
SS-48	MW-1	S55-MW 02	4081.39	
	MW-3	S55-MW 04	4080.16	
	MW-4	S55-MW 05	4079.16	
	MW-5	S55-MW 07	4078.70	
SS-56	WCC-2	WR-WCC-3	TBD	
	WCC-3	WR-WCC-5	TBD	
	WCC-4	MW-56-01	TBD	
	WCC-5			

TOC = top of casing (PVC)
TBD = to be determined

QA/QC samples will be collected at sites and wells specified in the 1995 CDAP, with the exception of Site OT-45. This site was removed from the LTM program by the NMED and will not be part of the LTM in 1997. Therefore, those QA/QC samples will be collected at Site LF-01 in 1997.

3.0 SITE SPECIFIC REQUIREMENTS FOR NEW (1997) LONG TERM MONITORING SITES

This section describes the sampling protocol to be followed at the new sites designated for 1997 LTM at Holloman AFB, New Mexico. The groundwater monitoring will be conducted as part of the Base-wide LTM program. Sites that are still included in the 1995 LTM program will follow the same procedures as outlined in the 1995 CDAP.

Special clearance procedures are necessary to access Site SS-56 (West Ramp Fuel Spill) and at Site SS-46. Therefore, at least five (5) days prior to the scheduled field activities Warren Neff, the Base Environmental Coordinator (BEC), should be contacted at (505) 475-5395, to obtain the proper clearance for the area.

The 1997 LTM analytical results for each site will be compared to site-specific historical data. A draft and draft final groundwater sampling report will be prepared after the one biennial round of sampling. The report will summarize (in tabular format) significant contaminants found during the sampling program for each site. The report will relate any findings concerning probable releases at each site.

SS-02 & SS-05

POL Spill Site No. 1 and 2

3.13 SS-02 & SS-05 POL Spill Sites No. 1 and 2

3.13.1 *Existing Conditions*

These two petroleum, oil and lubricant (POL) sites are located within the POL compound in the eastern portion of the main base area. Figure 3-13 is a map of the site with monitoring well locations. The two sites are being remediated together, and for the purpose of this work plan are considered one site. From the early 1960s to the late 1970s, the former 25,000 gallon fuel tanks were periodically over filled at site SS-02. JP-4 and aviation fuel spills occurred throughout the unlined bermed area. The amount of fuel spilled is unknown. The tanks were removed in 1987, but the saddle tanks were left in place and covered with soil.

At site SS-05 approximately 30,000 gallons of JP-4 fuel was spilled in 1978 when a drain valve for a 4-inch fuel line was accidentally left open. The fuel line was used for filling the former 25,000 gallon tanks with JP-4 fuel. Interviews with POL personnel indicated the 30,000 gallon spill accumulated primarily in the southeast corner of the former unlined bermed area with fuel draining through the berm drain valve to a low spot southeast of the berm. Personnel also indicated that approximately 28,500 gallons of fuel was recovered with the remaining fuel seeping into the gravel base of the POL storage area. An estimated 1,500 gallons was released and no interim remedial action was performed.

The PA/SI for the site was completed in 1988. The RI was completed in June 1992. Sixteen soil borings were drilled and eight (8) monitoring wells were installed during the RI. Total Petroleum Hydrocarbon (TPH) values up to 17,500 ppm were detected in soil borings. Benzene was detected in soil borings with maximum concentrations of 48 ppm. Benzene was also detected in groundwater samples, with a maximum concentration of 2.9 ppm. A soil vapor extraction (SVE) system was constructed and became operational in April 1995. As of March 1996, the SVE system has removed an estimated 17,000 pounds of TPH. The system is scheduled to run through 1998. The primary risk driver for this site is the connection between the contaminated non-potable groundwater and the adjacent arroyo which has been designated as Waters of the United States.

3.13.2 *Decision Document or Scope of Work Source*

A Decision Document was signed in September 1995 by the installation commander and NMED conditionally closing SS-02 & SS-05 based on contaminant level reduction to 1,000 ppm TPH via SVE. In addition, EPA Region VI requires that SS-02 & SS-05 undergo LTM for a period of ten years to ensure that no further migration of contaminants is occurring. The document describes past site use, current conditions, and investigation results, and provides recommendations for LTM.

3.13.3 *Long Term Groundwater Monitoring*

During site investigations, eight (8) groundwater monitoring wells (MW-02 & 05-01 through MW-02 & 05-08) were installed at the site. All wells are operable and accessible for groundwater sampling. LTM will be performed on four (4) of the monitoring wells at the site. The wells to be sampled will include MW-02 & 05-03, MW-02 & 05-05, MW-02 & 05-06, and MW-02 & 05-08. The wells will be sampled and analyzed for volatile organic compounds and field parameters of pH, temperature and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected for SS-02 & SS-05 is summarized in Table 3-13.

Table 3-13. Summary of LTM Program at SS-02 & SS-05

Wells To Be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-02 & 05-03	4096.28	Volatile organics by Method 8260A.	• 0
MW-02 & 05-05	4094.35		
MW-02 & 05-06	4082.37		
MW-02 & 05-08	4083.96		

TBD = to be determined
TOC = in feet above mean sea level (MSL).

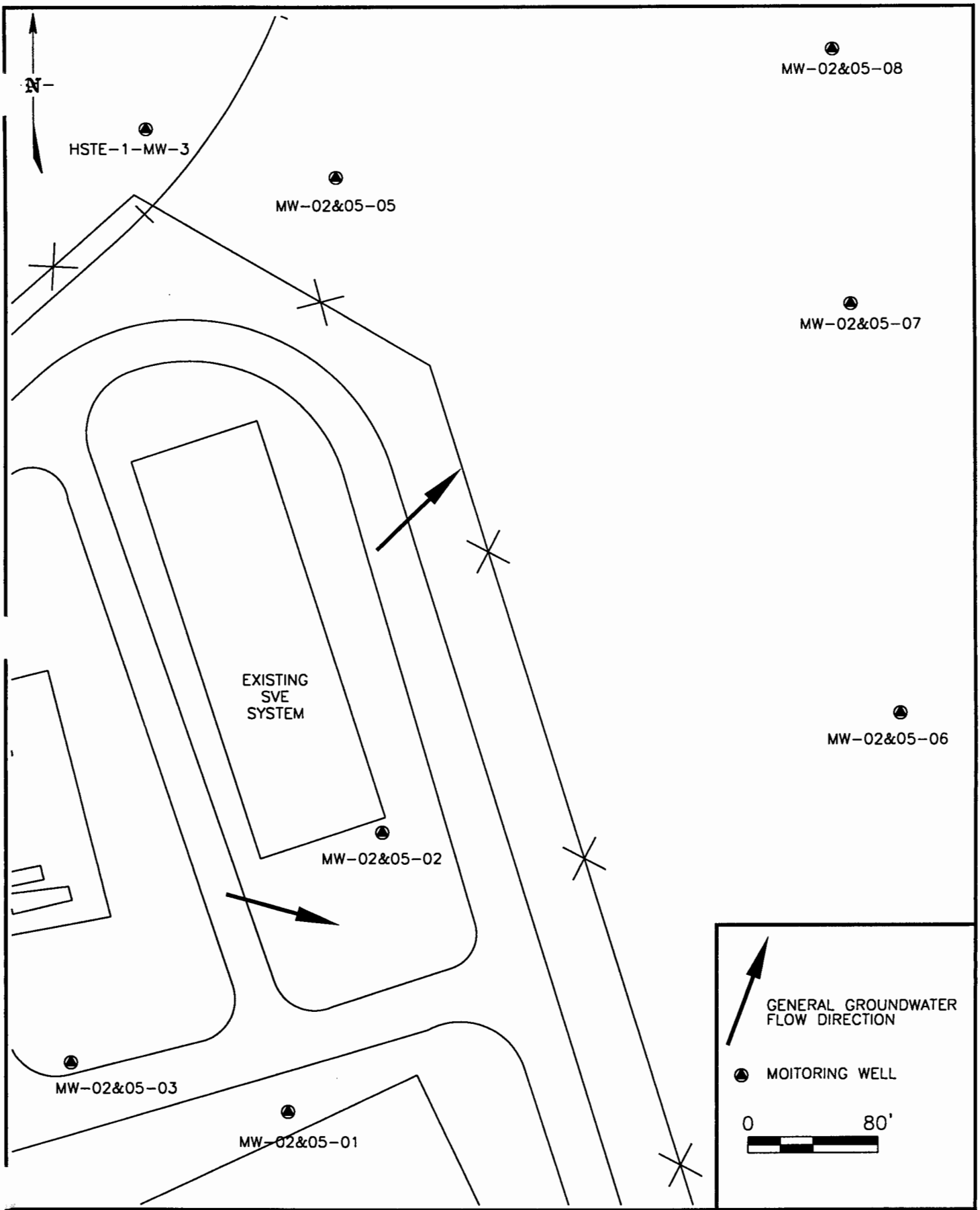


FIGURE 3.13 SITES SS-02 & 05 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
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SS-46

JP-4 Spill Site

3.14 SS-46 JP-4 Spill Site

3.14.1 *Existing Conditions*

SS-46 is a 25,000 gallon JP-4 underground waste fuel tank which was installed in 1978 without containment. The tank is located on the southeast side of Taxiway 4 (Figure 3-14). There are no permanent structures at Site SS-46. The entire site is covered by a concrete hardstand. Waste fuel was stored in the tank and analyzed by the base fuels lab for eventual disposition. An RI was conducted on the site in 1988 which included the installation of four (4) groundwater monitoring wells. TPH, benzene, chlorobenzene and toluene were detected in groundwater samples collected from the well. A baseline risk assessment (BRA) conducted on the site determined that the site posed no threat and that a site closeout/no further action (NFA) was recommended. The tank was taken out of service in 1989 and was removed as part of a 1995 tank removal project coordinated by the base.

3.14.2 *Decision Document or Scope of Work Source*

A Decision Document was signed by the installation commander in September of 1991. The NMED has agreed to sign the Decision Document if periodic groundwater monitoring is initiated. The document describes past site use, current conditions, and investigation results, and provides recommendations for LTM.

3.14.3 *Long Term Groundwater Monitoring*

During site investigations, four (4) groundwater monitoring wells were installed at the site. Subsequently, the wells and tanks were removed as part of the German Air Force hangar construction. Three new groundwater monitoring wells will be installed at the site for LTM. The new wells will be designated as MW-46-01, MW-46-02, and MW-46-03. Sampling and analysis will include the parameters of total and dissolved lead, volatile organic compounds, and TPH; and the field parameters of pH, temperature and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected is summarized in Table 3-14.

Table 3-14. Summary of LTM Program at SS-46

Wells To Be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-46-01 MW-46-02 MW-46-03	TBD (New Well 1) TBD (New Well 2) TBD (New Well 3)	• Total/Dissolved lead by Methods 7421. • Volatile Organic Compounds by Method 8260A.	• 0

TBD = to be determined
TOC = in feet above mean sea level (MSL).

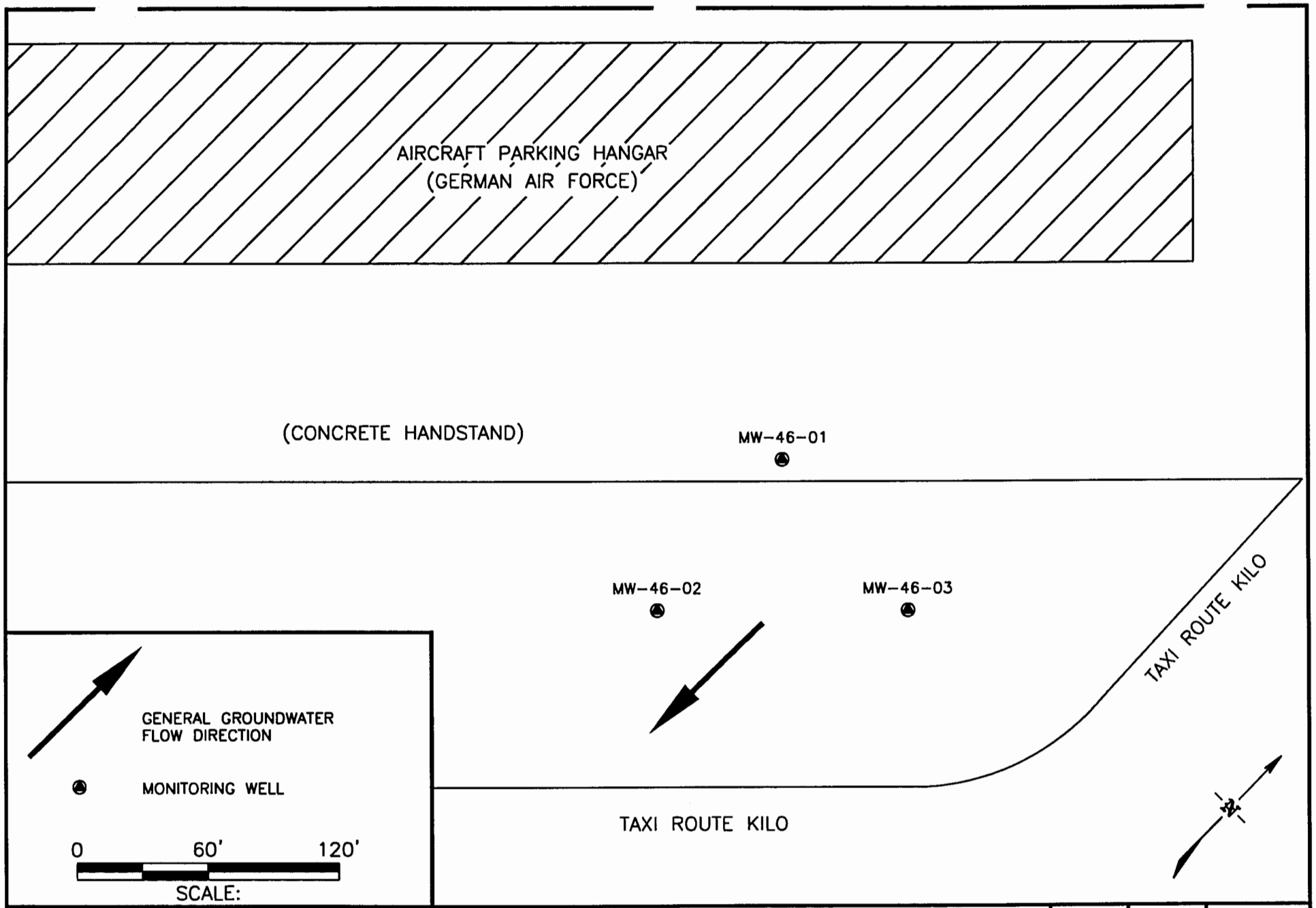

FIGURE 3.14 SITE SS-46 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	SHOWN	SHN

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OT-16

Entomology Shop Area

3.15 Site OT-16 Entomology Shop Area

3.15.1 *Existing Conditions*

The site is located at Building 21 in the southeastern portion of the main base area (Figure 3-15). Rinse water from washing of pesticide mixing equipment was discharged from 1977 to 1980 to a septic tank leach field located in back of the building. Diesel fuel, used to stabilize pesticides, may also have been discharged. From 1980 to 1988 rinse water was discharged into a pit/boring on the northwest side of the building. A pesticide holding tank is located on the southwest side of Building 21, although no spills were reported or documented at the tank or the concrete containment box.

A PA conducted in 1983 identified this site as a potential contaminant source. The Phase I RI was completed in 1992. 4,4-DDT (12.0 ppm), alpha-BHC (0.2 ppm), delta-BHC (6.5 ppm) and methyl parathion (1.5 ppm) were detected in the surface soils indicating that a release had occurred. Several pesticides DDD (10 ppm), DDE (6.1 ppm), DDT (36 ppm), Aldrin (1.7 ppm), Chlordane (34 ppm), Heptachlor (770 ppm) and gamma-BHC (2.8 ppm) were also detected. Organochlorine pesticides and VOCs were detected in all four (4) monitoring wells, the highest concentration was benzene (0.0023 ppm), dieldrin (1.5 ppm), trichloroethene (4.2 ppm), alpha-BHX (1.5 ppm) and gamma-BHC (1 ppm). The investigation to delineate soil and groundwater contamination detected PCB-1260 (639 ppm), TPH (10,300 ppm) and heptachlor epoxide (386 ppm) in soils and heptachlor epoxide (0.315 ppm) and gamma-BHC (0.372 ppm) in groundwater. The RI concluded that no action is necessary to protect human health and the environment.

3.15.2 *Decision Document or Scope of Work Source*

A Decision Document is anticipated to be signed by September 1997, conditionally closing the site based on attainment of less than 1,000 ppm TPH at OT-16 via excavation. Although PCB levels at OT-16 do not pose a risk to human health or the environment, PCB-contaminated soil were removed concurrently with TPH-contaminated soils in 1997. In addition, EPA Region VI requires that OT-16 be monitored for a period of ten years to ensure that no further migration of contaminants is occurring.

3.15.3 *Long Term Groundwater Monitoring*

During site investigations, four (4) groundwater monitoring wells (118-MW1601, 118-MW1602, 118-MW1603, 118-MW1604) were installed at the site. All wells are operable and accessible for groundwater sampling. LTM will be performed on the four (4) monitoring wells at the site. The wells will be sampled and analyzed for volatile organic compounds, organochlorine pesticides; and field parameters of pH, temperature and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected for OT-16 is summarized in Table 3-15.

Table 3-15. Summary of LTM Program at OT-16

Wells To Be Sampled	Top Of Casing Elevation (TOC)	Analytes	No. Of QA/QC Samples
118-MW1601 118-MW1602 118-MW1603 118-MW1604	4079.90 4077.71 4076.89 4077.30	• Volatile organics by Method 8260A. • Organochlorine pesticides by Method 8080A.	• 1 Duplicate QC sample to contractor lab. • 1 Duplicate QA sample to USACE MR Lab of all analytes. (LIMS No. 4366) • 1 trip blank (volatile organics) with each sample shipment. • Collect two (2) extra containers from one (1) well for organochlorine pesticides and volatile organics for matrix spike and matrix spike duplicate analyses.

TOC = in feet above mean sea level (MSL).

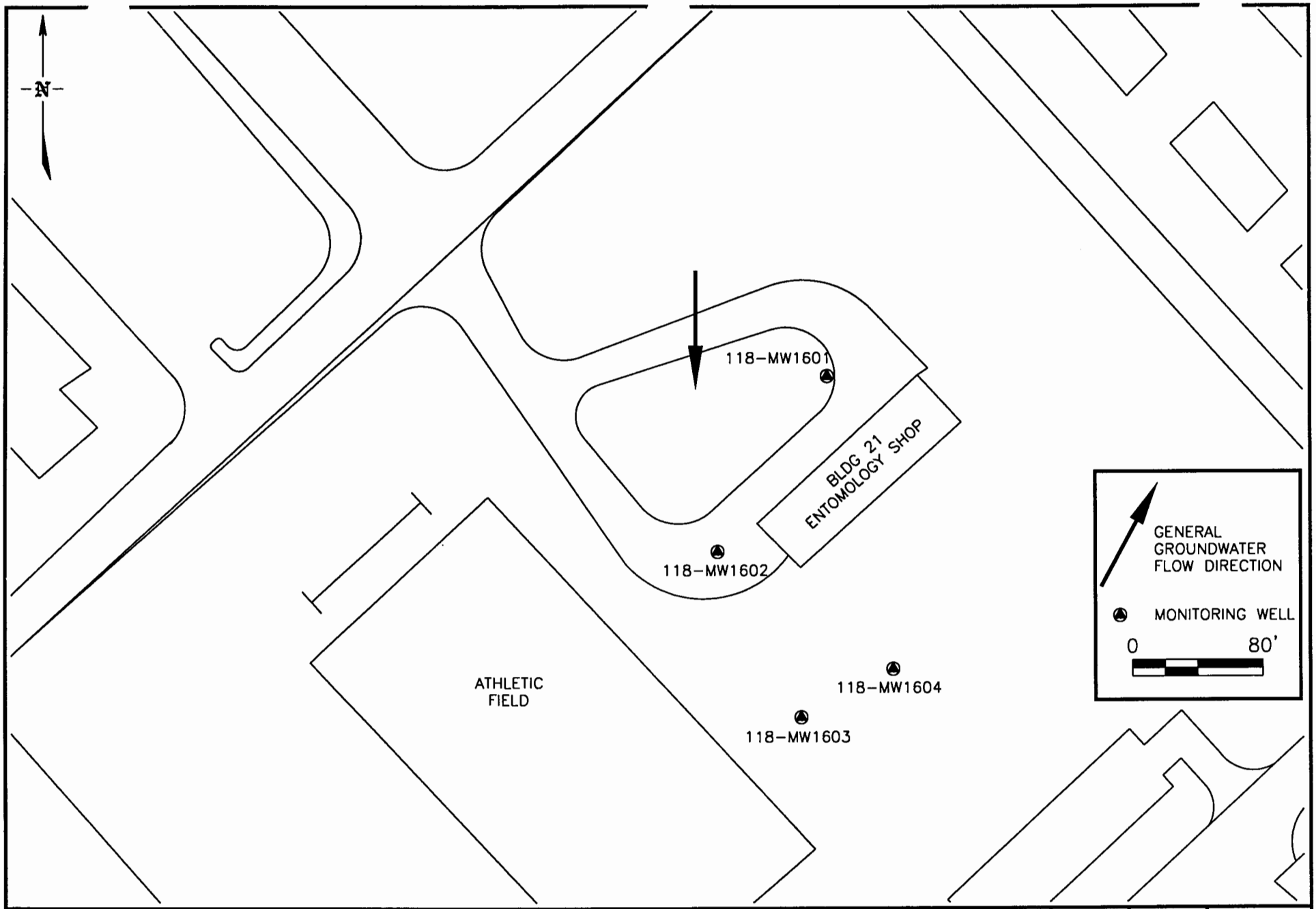

FIGURE 3.15 SITE OT-16 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	SHOWN	SHN

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SS-17

BX Service Station

3.16 Site SS-17 BX Service Station

3.16.1 *Existing Condition*

The site is located on First Street in the main portion of the base and approximately 2,500 feet from the main gate (Figure 3-16). Site SS-17 is an eight acre site with numerous buildings, including the service station, convenience store, car wash and several residences. The service station has been in its present location since the early 1950s. The base hospital is located about 420 feet to the northeast; an elementary school is located 600 feet to the northwest; and base residential housing is located 200 feet to the southeast of the service station. The site contamination extends under adjacent properties.

Discrepancies in the gasoline storage inventories led to the discovery of leaking underground fuel lines. In 1981, test borings were drilled to assess the extent of contamination. Gasoline thickness up to 4 feet were found in monitoring wells in some areas. Two recovery wells were installed. An RI completed in 1984 included the installation of fifteen (15) monitoring wells and fourteen (14) test holes at SS-17. The RI concluded that an estimated 71,000 gallons of free phase product (gasoline) remained in the subsurface. In January 1987 recovery operations resumed using three recovery wells and two recovery trenches. Changes recommended in a 1988 Technical Report were implemented in 1989 and included more recovery wells. These operations recovered a total of 42,000 gallons of free product at SS-17.

An RI/FS was completed in 1990 and 1991. The five underground storage tanks (USTs) at the site were removed and replaced with above ground tanks in February 1992. In July 1993, a thirty day SVE pilot test was conducted on a small area of the site. Borings completed prior to the pilot testing revealed TPH (8,340 ppm) and benzene (53.6 ppm) soil concentrations. TPH concentrations in the subsurface soils were reduced by 48% and benzene concentrations were reduced by 70%. In late 1994, investigations revealed a leak from a pipe under a dispenser island. It is estimated that 4,000 gallons of product was released. Construction and operation of a full scale SVE/bioremediation system began in September 1995. As of June 1997, 45,000 pounds of TPH have been removed.

3.16.2 *Decision Document or Scope of Work Source*

A Decision Document was signed in September 1996, conditionally closing SS-17 based on attainment of less than 1,000 ppm TPH via SVE. In addition, NMED requires that SS-17 be monitored for a period of ten years to ensure that no further migration of contaminants is occurring.

3.16.3 *Long Term Groundwater Monitoring*

During the RI, twenty (20) groundwater monitoring wells were installed at the site. However, due to construction activities and well abandonment, the total number of monitoring wells is now less that twenty. LTM will be performed on four (4) of the monitoring wells at the site. Sampling will be conducted at W-4,TH-22,and two newly installed monitoring wells, MW-BX-01 and MW-BX-02. Well identification numbers for two new wells will be determined at time of completion. The four wells will be sampled and analyzed for volatile organic compounds, and field parameters of pH, temperature and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected are summarized in Table 3-16.

Table 3-16. Summary of LTM Program at SS-17

Wells To Be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
W-4 TH-22 MW-BX-01 MW-BX-02	4074.40 4071.50 TBD TBD	• Volatile organics by Method 8260A.	• 0

TOC = in feet above mean sea level (MSL).
TBD = to be determined

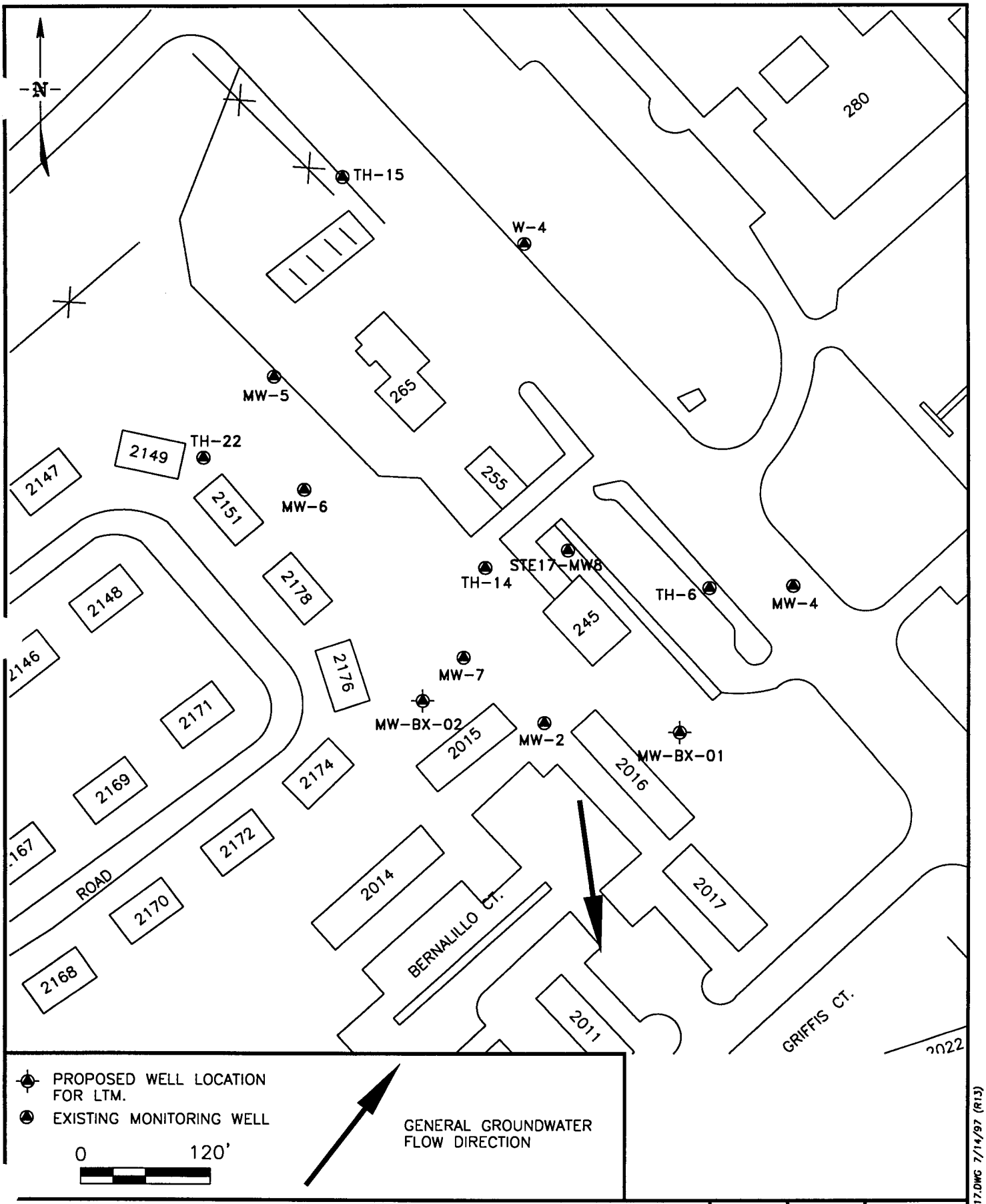


FIGURE 3.16 SITE SS-17 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE: 7/97	SCALE: SHOWN	DRAWN BY: SHN

96-332\SITESS17.DWG 7/14/97 (R13)

SS-39

Missile Fuel Spill Area

3.17 Site SS-39 Missile Fuel Spill Area

3.17.1 *Existing Condition*

The site is located approximately 3.5 miles northwest of the main base area near Building 1176 (Figure 3-17). The site consists of two outfall areas located further downslope from the oxidizer and propellant spill drain pipes and drainage troughs and sumps located near Building 1176. Facilities at SS-39 were involved with the fueling, detanking and routine maintenance of test sleds. Fuels used at the track included unsymmetrical dimethyldradazine (UDMH), aniline, JP-4, inhibited red fuming nitric acid (IRFNA), inhibited white fuming nitric acid (IWFNA), liquid oxygen (LOX), JPX, dyes and solid rocket propellants. Solvents, such as trichloroethane, were commonly used in sled maintenance activities.

During a PA in 1983, SS-39 was identified as a potential contaminant source. An RI was completed in 1992. Results of the RI revealed arsenic (28 ppm), beryllium (0.58 ppm), lead (1,300 ppm) and trichlorethene (95 ppm) in soils and TCE (0.24 ppm), carbon tetrachloride (0.0058 ppm) and lead (0.019 ppm) in groundwater near Building 1176. An RI, completed in 1994, delineated soil and groundwater contamination. Fifteen groundwater samples were taken and TCE concentrations ranged from 2.76 ppm directly east of the site to 0.028 ppm 200 feet south of the site (downgradient). The RI and associated RA conducted indicated that no action is necessary to protect human health or the environment.

3.17.2 *Decision Document or Scope of Work Source*

A Decision Document is anticipated to be signed by September 1997 with a recommendation for LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

3.17.3 *Long Term Groundwater Monitoring*

During the RI, four (4) groundwater monitoring wells were installed at SS-39. All wells are operable and accessible for groundwater sampling. LTM will be performed on the four (4) monitoring wells. Sampling will be conducted at MW-39-01, MW-39-02, MW-39-03,

and MW-39-04. The wells will be sampled for volatile organic compounds, and field parameters of pH, temperature, and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected are described in Table 3-17.

Table 3-17. Summary of LTM Program at SS-39

Wells To Be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-39-01 MW-39-02 MW-39-03 MW-39-04	4059.86 4051.15 4040.63 4053.34	• Volatile organics by Method 8260A.	• 1 Duplicate QC sample to contractor lab. • 1 Duplicate QA sample to USACE MR Lab of all analytes. (LIMS No. 4366) • 1 trip blank (volatile organics) with each sample shipment.

TOC = in feet above mean sea level (MSL).

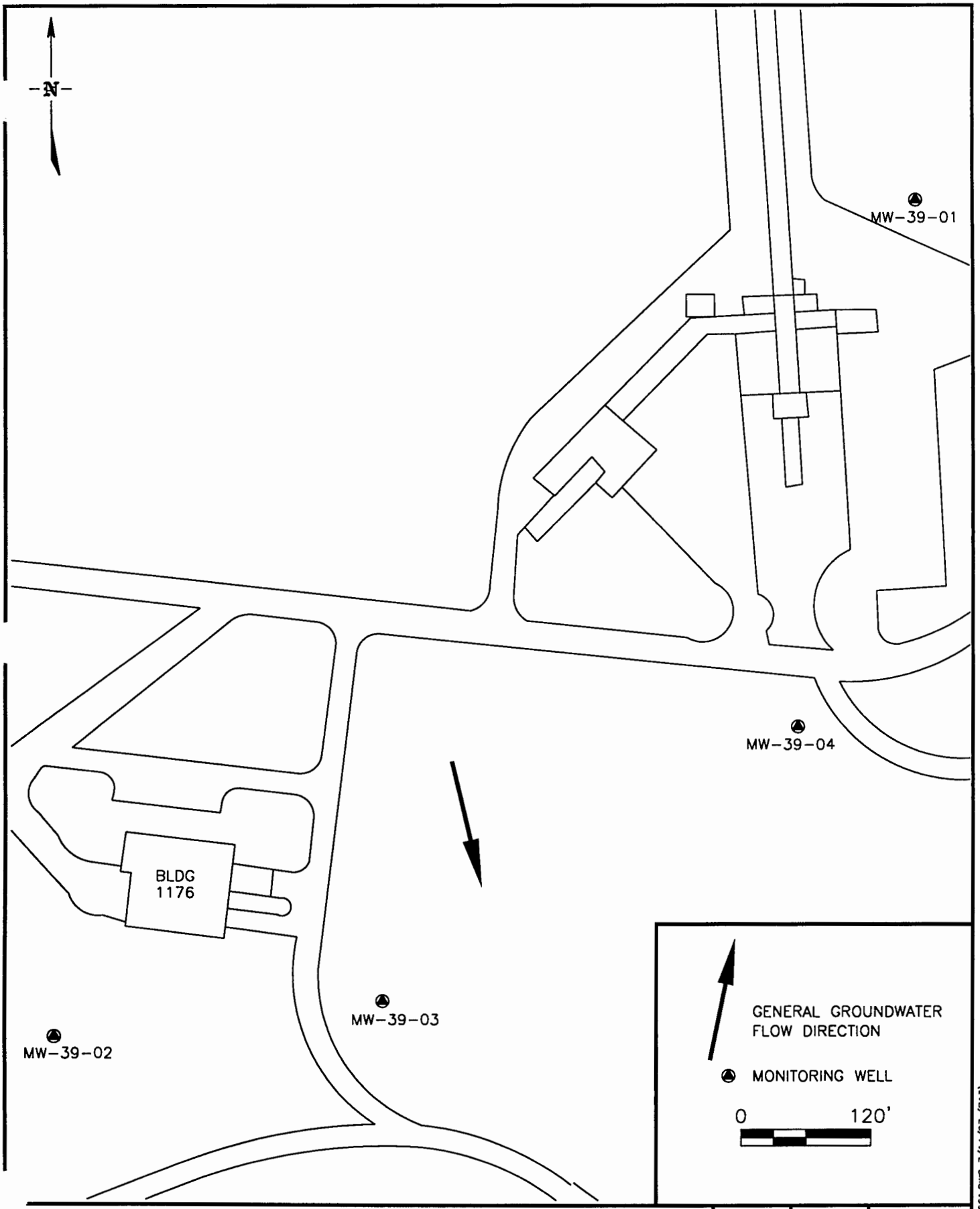


FIGURE 3.17 SITE SS-39 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	SHOWN	SHN

96-332\BLDG1661.DWG 7/14/97 (R13)

LF-29

Former Army Landfill

3.18 Site LF-29 Former Army Landfill

3.18.1 *Existing Condition*

The site occupies approximately three acres in the North Base area and is located approximately 300 feet north of Building 1001 (Figure 3-18). The site is surrounded by a small (3 ft high) earthen berm than extends 400 feet north-south and 350 feet east-west.

From the early 1950s to 1975, the Army disposed of spent munitions and missiles at the site. Materials were also dumped outside the berm, roughly 200 feet south of the landfill border. These materials appear to be primarily construction debris.

During an RI, four monitor wells were installed at the site. Groundwater samples were collected and analyzed for VOCs, total metals, organophosphorus pesticides, organochlorine pesticides, polychlorinated biphenyls (PCBs), explosives, chlorinated herbicides, anions, and TDS. The only VOC detected was chloroform, which was detected in monitoring wells MW-29-03 (22 μg/L) and MW-29-04 (5 μg/L). 4,4'-DDD was detected at a concentration of 0.028 μg/L in monitoring well MW-29-03. With the exception of lead, all inorganic compounds were detected within the range of concentrations present in Base-wide upgradient monitoring wells. Lead was detected at a concentration of 2 μg/L in monitor well MW-29-02. The monitoring well locations are shown in Figure 3-18.

A quantitative risk assessment was conducted for LF-29 as part of the RI. It was concluded that the site does not pose an unacceptable risk to human health or the environment, however EPA Region IV requested more characterization be carried out.

During a Phase II RFI, three monitoring wells were installed downgradient and one well was installed upgradient of the site to provide adequate flow path coverage.

No inorganic compounds were detected above background ranges in the groundwater samples. Delta-BHC concentrations were detected below the detection limit in the monitoring wells. Several other organochlorine pesticide and chlorinated herbicide concentrations were detected below detection limits in monitoring well MW-29-05.

Chloroform concentrations were detected in five out of seven groundwater samples, but were not detected in the associated method blanks. With the exception of the sample from monitoring well MW-29-03, all concentrations were below detection limits. From the time of the RI in 1991 to the Phase II RFI in 1994, the chloroform concentration detected in monitor well MW-29-03 decreased from 22 to 11 μg/L. 1,2-dichloroethane (DCA) concentrations (ranging from 0.82 to 9.3 μg/L) were detected in three monitoring wells (MW-29-02, MW-29-06, and MW-29-08) downgradient of the site. However, a DCA concentration of 350 μg/L was measured in the upgradient monitor well MW-29-05. With the exception of the upgradient well MW-29-05, benzene concentrations were detected below the detection limit in each monitoring well. A benzene concentration of 3100 μg/L was detected in monitoring well MW-29-05.

3.18.2 *Decision Document or Scope of Work Source*

The site was approved for NFA by NMED in June 1997, however NMED is recommending LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

3.18.3 *Long Term Groundwater Monitoring*

During the RI, eight (8) groundwater monitoring wells (MW-29-01 through MW-29-08) were installed at the Landfill. All wells are operable and accessible for groundwater sampling. LTM will be performed on four (4) of the monitoring wells. Sampling will be conducted on MW-29-01, 06, 07, and 08. The wells will be sampled and analyzed for volatile organic compounds, and semi-volatile organic compounds, and field parameters of pH, temperature, and specific conductivity. Groundwater sampling will be performed in accordance with Section 2.0 and the SOPs presented in Appendix A of the 1995 CDAP. The number and type of groundwater and QA/QC samples to be collected are described in Table 3-18.

Table 3-18. Summary of LTM Program at LF-29

Wells To Be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-29-01 MW-29-06 MW-29-07 MW-29-08	4103.37 4101.64 4098.29 4100.43	• Volatile organics by Method 8260A. • Semivolatile organics by Method 8270B	• 1 Duplicate QC sample to lab. • 1 Duplicate QA sample to USACE MR Lab of all analytes. (LIMS No.4366) • 1 trip blank (volatile organics) with each sample shipment.

TOC = in feet above mean sea level (MSL).

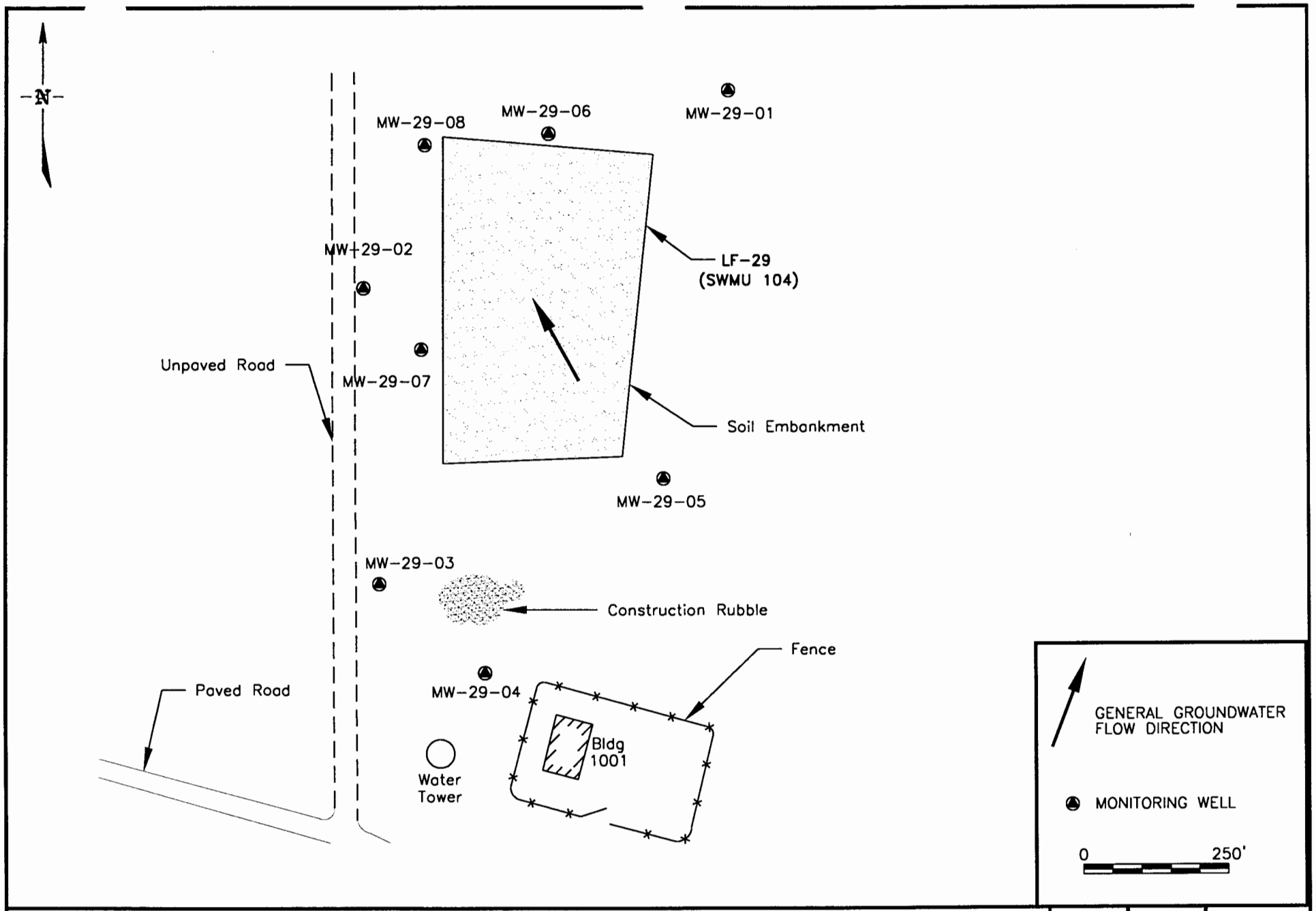


FIGURE 3.18 SITE LF-29 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	SHOWN	SHN

96-332\SWMU104.DWG 7/14/97 (R13)

APPENDIX A

Well Installation at Sites SS-46 & SS-56

This section serves as an appendix and gives descriptions of equipment, and field procedures necessary to drill and install four (4) monitoring wells at the two sites, SS-46 & SS-56.

Well Installation and Development - Sites SS-46 & SS-56

In order to continue long term monitoring at Sites SS-46 & SS-56, new monitoring wells need to be installed and developed prior to sampling. Three monitoring wells will be installed and developed at Site SS-46 to replace the four wells that were removed during the underground storage tank (UST) removal and building construction. One monitoring well will be installed and developed at SS-56 to replace an existing monitoring well that is dry (Figure A-1).

The following sections describe the procedures that will be followed for drilling, installing, and developing the new monitoring wells. After completing well development, the wells will be surveyed. The sampling of the new wells will follow previously established protocols set out in the July 1995 LTM CDAP.

Well Drilling

TERC contract and HAFB personnel will assist FEC in locating utilities in each area prior to drilling. FEC will submit the dig permits prior to mobilizing to the site. Proposed wells locations will be confirmed with TERC and HAFB personnel prior to commencing drilling.

Drilling will be accomplished using a CME-75 auger drilling rig with continuous flight hollow-stem augers. The augers will be advanced in five foot increments. Sampling will be achieved by driving a split spoon sampler inside of and ahead of the augers to collect undisturbed soil samples.

Cuttings will be placed on plastic sheeting for volatile organic vapor screening.

Each boring will be logged by a qualified FEC geologist using the Unified Soil Classification System. Consistent with the scope of services, lithologic logging will be achieved by viewing the cuttings as they are brought to the surface and by examination of the retrieved samples. Drilling activities will only be performed during daylight hours.

The three wells to be installed at Site SS-46 will be approximately 20 feet in depth and have a 10-foot screened section across the water table. The one well at Site SS-56 will be approximately 15 feet deep and have a screen section between 5 and 7.5 feet.

Well Construction

Well casing (riser) will consist of new, two-inch diameter schedule 40 PVC, have threaded flush joints, and be free of contamination. The well screen will be new, 2-inch diameter, Schedule 40 PVC continuous wrap screen. The well screen will have 0.010-inch slots and range from 5 to 10 feet in length. The well will be placed with 1-foot of sand below the base of the well casing. The screen will be set to have the water table intersect the mid point of the screen interval. A generalized monitoring well construction schematic is shown in Figure A-2. All equipment and materials will be steam cleaned prior to constructing the well.

The filter pack surrounding the well screen will consist of new, clean, washed, well rounded "Colorado Silica Sand" or equivalent sand type. A 20-40 gradation or previously established standard gradation will be used to construct the filter pack. The filter pack will be placed from the ground surface and will extend approximately 1-foot below and 1 to 2-feet above the well screen. The filter pack will be placed as the drill casing is removed from the boring.

A minimum 2-foot thick filter pack seal will be placed directly above the filter pack. The seal will consist of sodium bentonite pellets that will not exceed one-half inch diameter. The bentonite pellet seal will be placed in 6-inch lifts. Each lift will be hydrated using clean, potable water and will be allowed to hydrate for a minimum of 30 minutes. After placing the final lift, the bentonite seal will be allowed to hydrate an additional two hours before placement of the annular space seal. The filter pack seal will be placed as the drill casing is removed from the hole.

An annular space seal will be placed above the filter pack seal to 3-feet below ground surface. The grout will consist of 7 gallons of water to one 94 pound bag of grout mixture and contain 5 to 7% bentonite. The grout placement will be achieved through a side discharging tremie pipe, or placed from the ground surface if the well is shallow. The annular space seal will be placed as the augers are removed from the hole.

The wells will be completed with a flush mount surface completion in concrete. The finished completions will match existing grade. The new monitoring wells will be equipped with a vented locking cap and the flush mount will be water tight. The location of the monitoring wells will require coring through the concrete hardstand.

Well Development

The new wells will be developed using mechanical surging and/or pumping and bailing until little or no sediment is present in the extracted well water. After developing the well (surging and pumping), the well will be continuously pumped, if possible, using a 2-inch submersible pump. Pumping will continue until the water chemistry stabilizes, but will not exceed 20 well casing volumes or 4 hours of pumping.

IDW Management

The Base and the New Mexico Environment Department have a notice of intent (NOI)/IDW handling policy in place and after screening the soil and review of the results for groundwater, the soil and water will be spread out or discharged to the ground surface. Any volume of soil or water which exceeds an MCL and cannot be discharged to the ground surface will be handled by the TERC contractor and/or the Base. The TERC contractor will follow IDW handling procedures outlined in the 1995 CDAP and/or their Waste Management Plan. All soil and water that is contained in drums will be moved to the storage yard at the end of each day.

Drilling Soil Cuttings

Soil cuttings will be initially spread out on plastic and screened with an organic vapor analyzer (PID). If no contamination is evident, the cuttings will be spread out on the ground at the storage yard or another site. If obvious contamination is observed, the cuttings will be sampled and tested by the TERC contractor and if TPH concentration is less than 1000 ppm, the cuttings will be spread out on the ground at the site. If the concentration is greater than 1000 ppm, the cuttings will be drummed and staged in the storage yard for disposal by the TERC contractor and/or the Base.

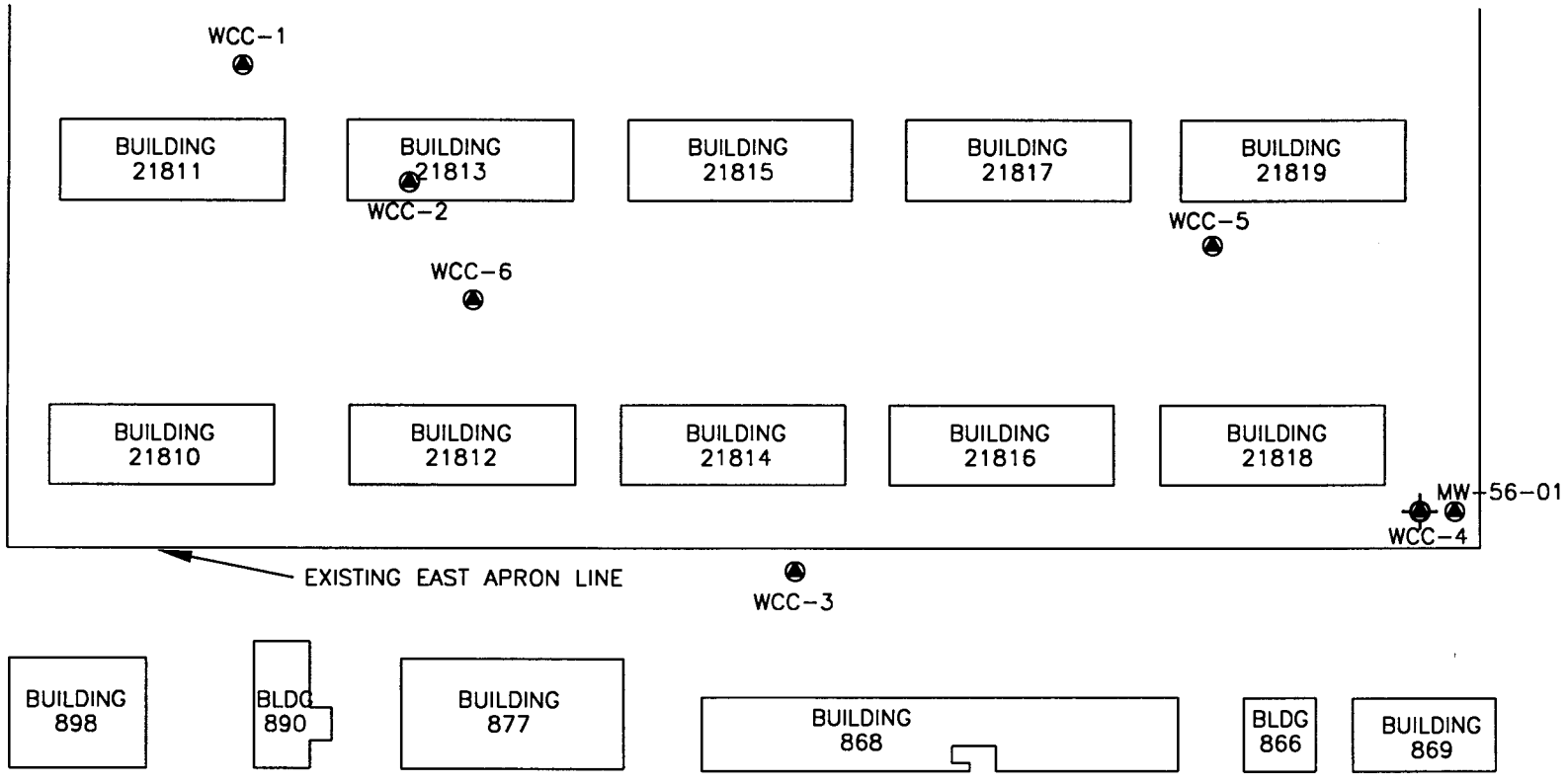
Decontamination Water

Drilling decontamination water will be allowed to evaporate as much as possible prior to pumping the water into a Base supplied tank or drum(s). The TERC contractor will then transport the container to the necessary disposal area (T-38).

Any sediment left in the bottom of the decontamination pad will be treated in the same manner as the majority of the soil cuttings which will depend upon screening or testing.

Development Water

Development water from the four new wells and well sampling purge water will be drummed and stored in the storage yard pending analysis from the well sampling. The water generated from all the wells at an individual site will be placed in the same drum. Upon approval from the Base, the TERC contractor will then discharge the water to the ground at the storage yard or, if necessary, handle the drums for proper disposal. If any volume of the water exceeds an MCL or cannot be discharged to the ground, it will be managed by the TERC contractor on the base and the procedures will follow their established Waste Management Plan.



LEGEND

MONITORING WELL

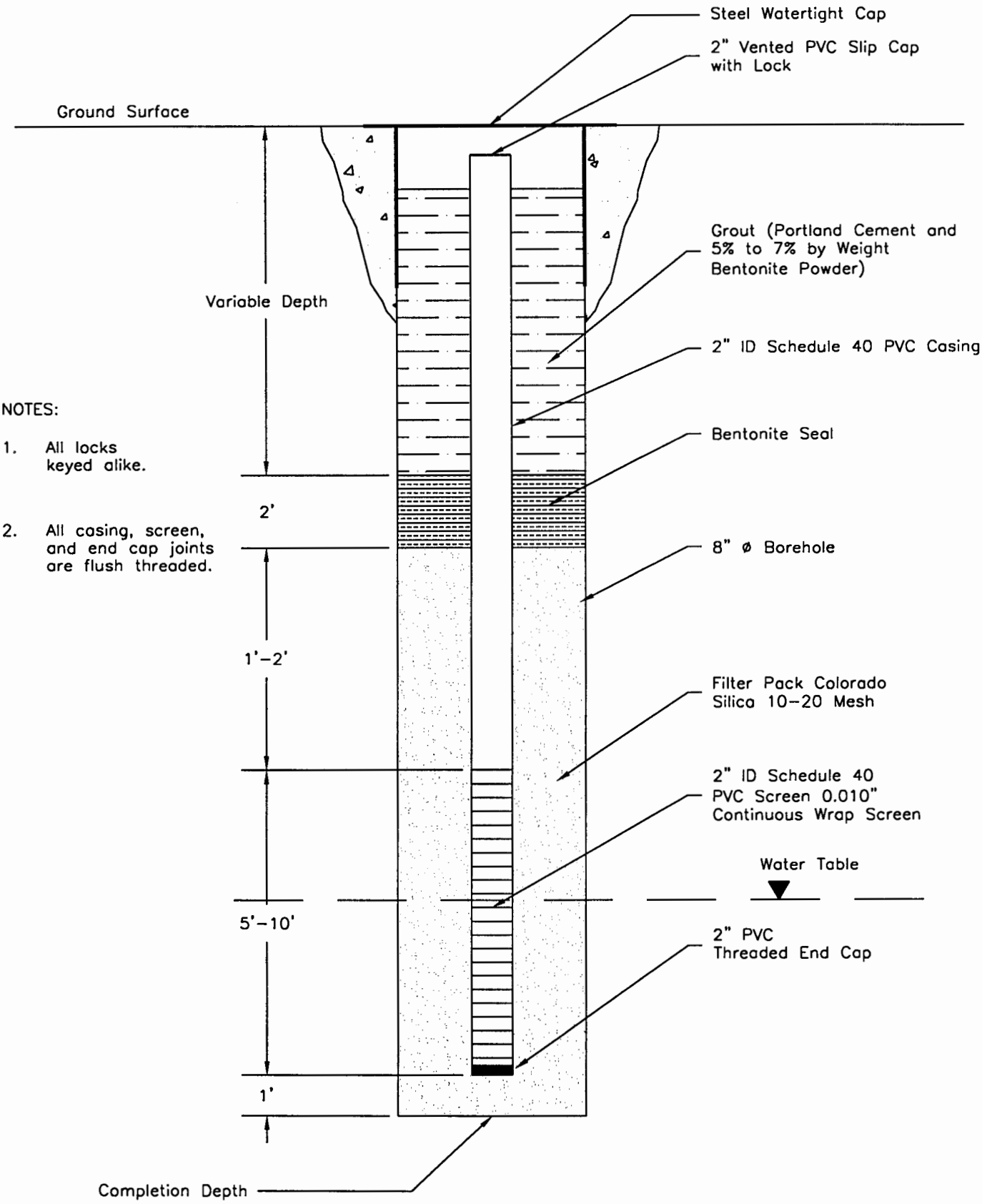
PROPOSED MONITORING WELL

N

0 300'

FIGURE A-1 SITE SS-56 HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	SHOWN	SHN

96-332\SITESS56.DWG 7/16/97 (R13)



NOTES:

1. All locks keyed alike.
2. All casing, screen, and end cap joints are flush threaded.

FIGURE A-2 MONITORING WELL CONSTRUCTION SCHEMATIC HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE:	SCALE:	DRAWN BY:
	7/97	NTS	SHN

96-332\WELLDIAG.DWG 7/14/97 (R13)

APPENDIX B

Summary Of Sites From 1995 Long Term Monitoring

SUMMARY OF SITES FROM 1995 LONG TERM MONITORING

The following section summarizes those sites that were part of the 1995 LTM and were carried over into the 1997 LTM. Site tables and figures are included describing the wells and analytical to be sampled at each site and the well locations at each site. For further details about the site, see the 1995 LTM CDAP.

Table B-1. Summary of LTM Program at LF-01

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
S1-MW1 S1-MW2 S1-MW5 IW2	4099.39 4098.62 4114.89 4100.69	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A.	• 1 Duplicate QC sample to contractor lab. • 1 Duplicate QA sample to USACE MR Lab of all analytes. (LIMS No. 4366) • 1 trip blank (volatile organics) with sample shipment

TOC is in feet above mean sea level (MSL).

Table B-2. Summary of LTM Program at LF-10

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
S10-MW2 S10-MW3 S10-MW4 S10-MW6	4089.00 4084.21 4083.01 4083.50	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A.	• 1 Duplicate QC sample to contractor lab. • 1 Duplicate QA sample to USACE MR Lab of all analytes. (LIMS No. 4366) • 1 trip blank (volatile organics) with sample shipment

TOC is in feet above mean sea level (MSL).

Table B-3. Summary of LTM Program at SD-08

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-08-01 MW-08-03 MW-08-04 MW-08-05	4088.51 4088.24 4084.22 4086.82	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-4. Summary of LTM Program at LF-19

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
LF-19-01 LF-19-02 LF-19-03	4048.70 4044.99 4049.29	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A. • Chlorinated herbicides by Method 8150B. • PCBs by Method 8080A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-5. Summary of LTM Program at LF-21

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-21-01 MW-21-02 MW-21-03 MW-21-04	4046.59 4042.97 4041.77 4039.99	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A. • Chlorinated herbicides by Method 8150B. • PCBs by Method 8080A.	• 1 trip blank (volatile organics) with sample shipment. • 1 duplicate QC sample to contractor lab. • 1 duplicate QA sample to USACE MR lab of all analytes except for chlorinated herbicides. (LIMS No. 4366). • Collect two (2) extra containers from one (1) well for organochlorine pesticides and volatile organics for matrix spike and matrix spike duplicate analysis.

TOC is in feet above mean sea level (MSL).

Table B-6. Summary of LTM Program at LF-22

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-22-01 MW-22-02 MW-22-03 MW-22-04	4038.99 4038.67 4038.87 4040.10	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A. • Chlorinated herbicides by Method 8150B. • PCBs by Method 8080A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-7. Summary of LTM Program at LF-23

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW-23-01 MW-23-02 MW-23-03 MW-23-04	4037.15 4030.50 4030.44 4030.95	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A. • Chlorinated herbicides by Method 8150B. • PCBs by Method 8080A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-8. Summary of LTM Program at OT-44

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
S50-MW1 S50-MW2 S50-MW3 S50-MW6	4069.69 4069.90 4069.66 4069.97	• Volatile Organic compounds by Method 8260A.	• Trip blank with sample shipment. • 1 duplicate QC sample to contractor lab. • 1 duplicate QA sample to USACE MR Lab (LIMS No. 4366)

TOC is in feet above mean sea level (MSL).

Table B-9. Summary of LTM Program at SS-48

Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
S55-MW2 S55-MW4 S55-MW5 S55-MW7	4081.39 4080.16 4079.16 4078.70	• Total/Dissolved lead by Method 7421. • Volatile Organic compounds by Method 8260A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-10. Summary of LTM Program at SS-56

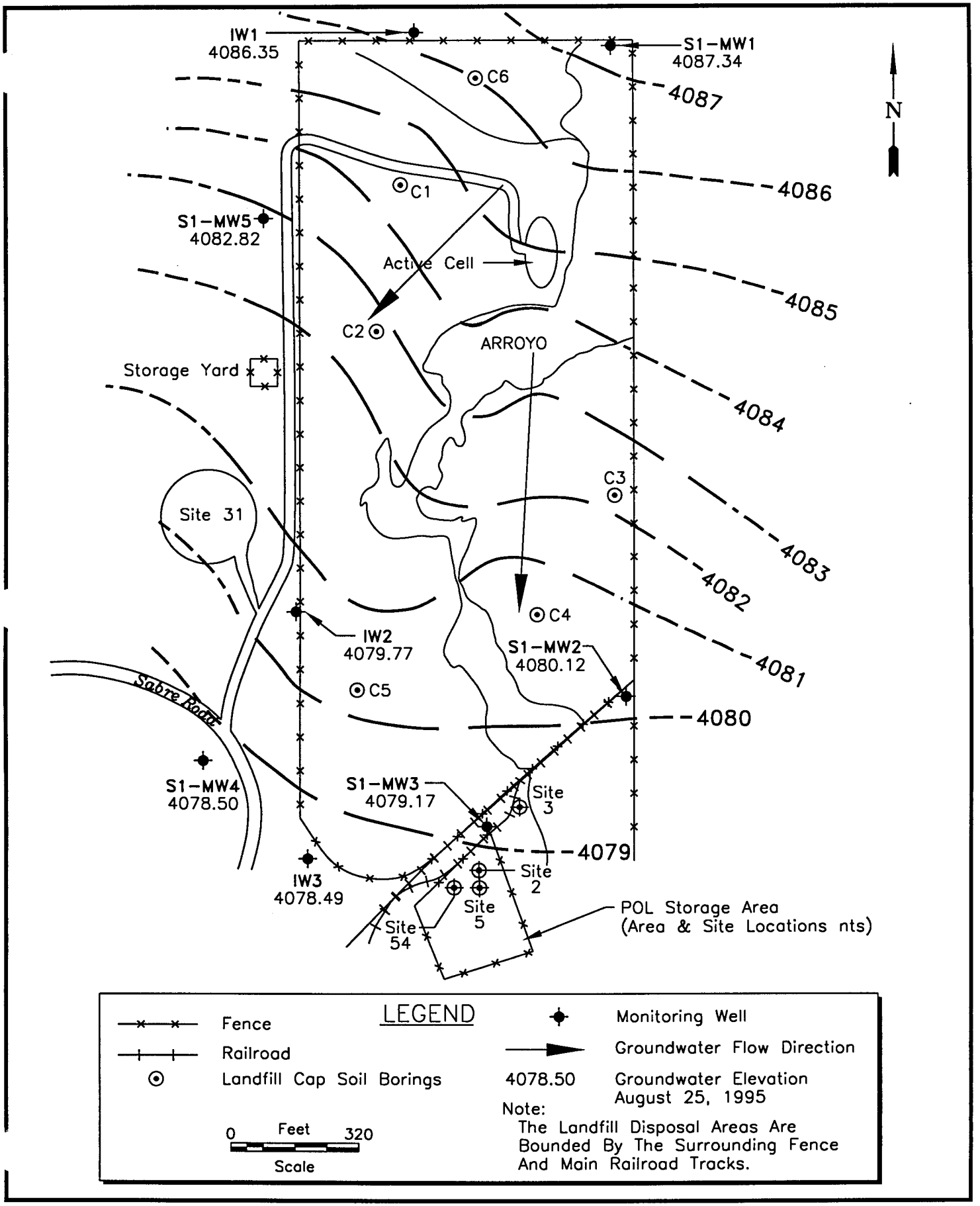
Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
WR-WCC-3 WR-WCC-5 MW-56-01	TBD TBD TBD (new well)	• Total/Dissolved lead by Method 7421. • Volatile Organic compounds by Method 8260A.	• 0

TOC is in feet above mean sea level (MSL).

Table B-11. Summary of LTM Program at DP-30 and SD-33

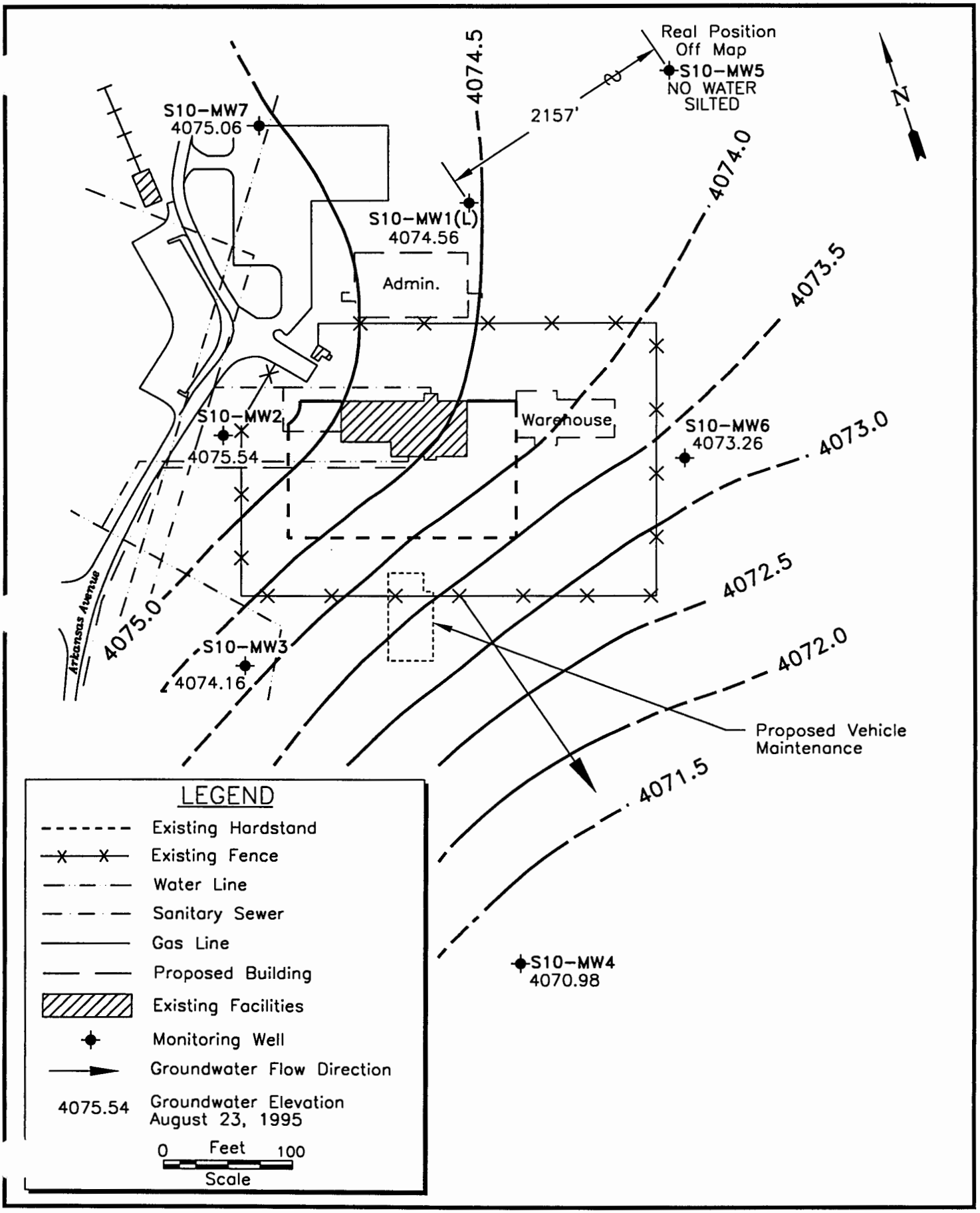
Wells to be Sampled	Top of Casing Elevation (TOC)	Analytes	No. of QA/QC Samples
MW30 & 33-01 MW30 & 33-02 MW30 & 33-03 MW30 & 33-04	4104.70 4104.00 4102.98 4102.30	• Total/Dissolved TAL metals by Methods 6010A/7000. • Volatile Organic compounds by Method 8260A. • Organochlorine pesticides by Method 8080A. • Chlorinated herbicides by Method 8150B. • PCBs by Method 8080A.	• 1 QC duplicate to contractor lab. • 1 QA duplicate to USACE MR lab for all analytes (LIMS No. 4366). • 1 trip blank (volatile organic compounds) with sample shipment. • Collect two (2) extra containers from one (1) well for organochlorine pesticides and PCBs for matrix spike and matrix spike duplicate analysis.

TOC is in feet above mean sea level (MSL).



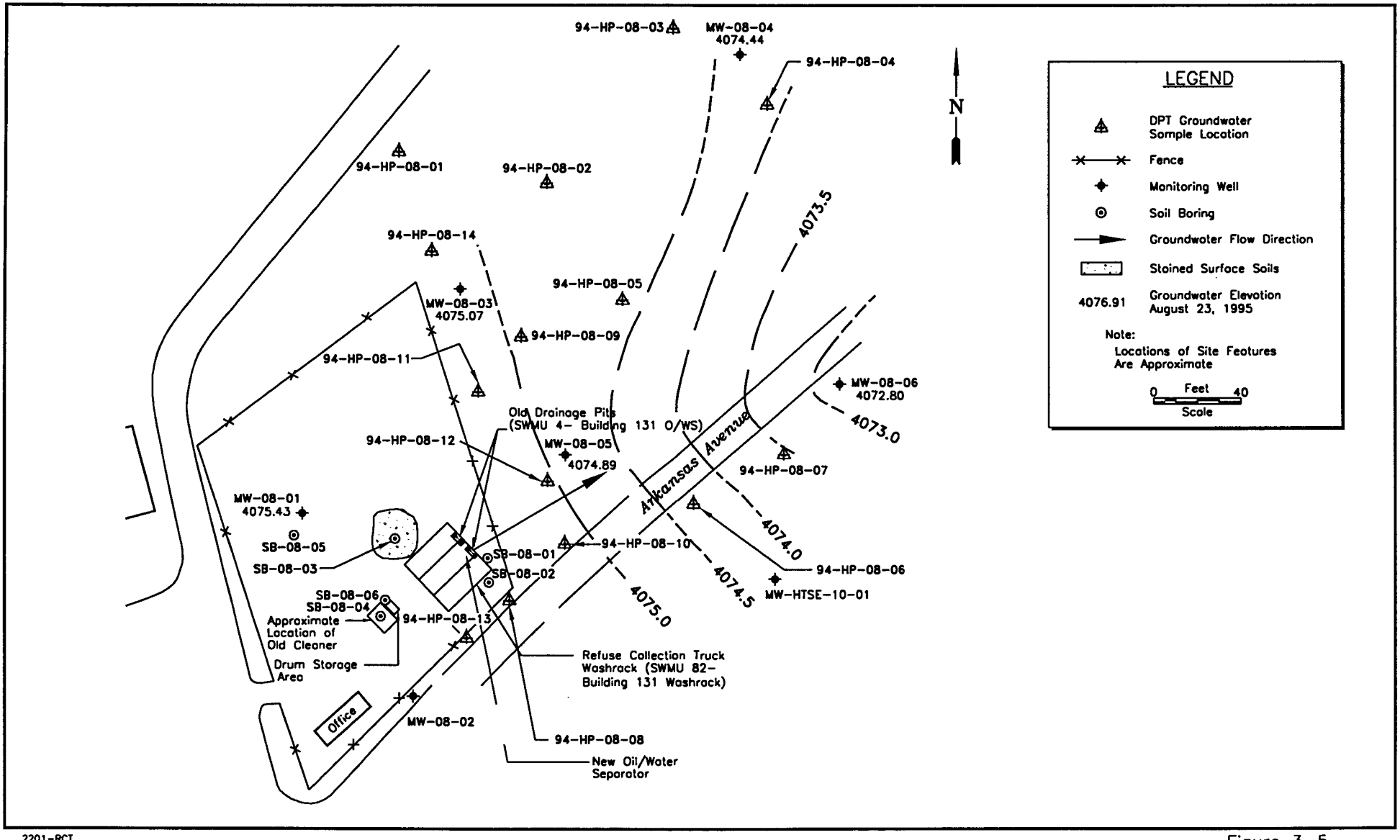
2201-MBL

Figure 3-1. Groundwater Contour Map, August 25, 1995
Site LF-01, Main Base Landfill



2201-OMB

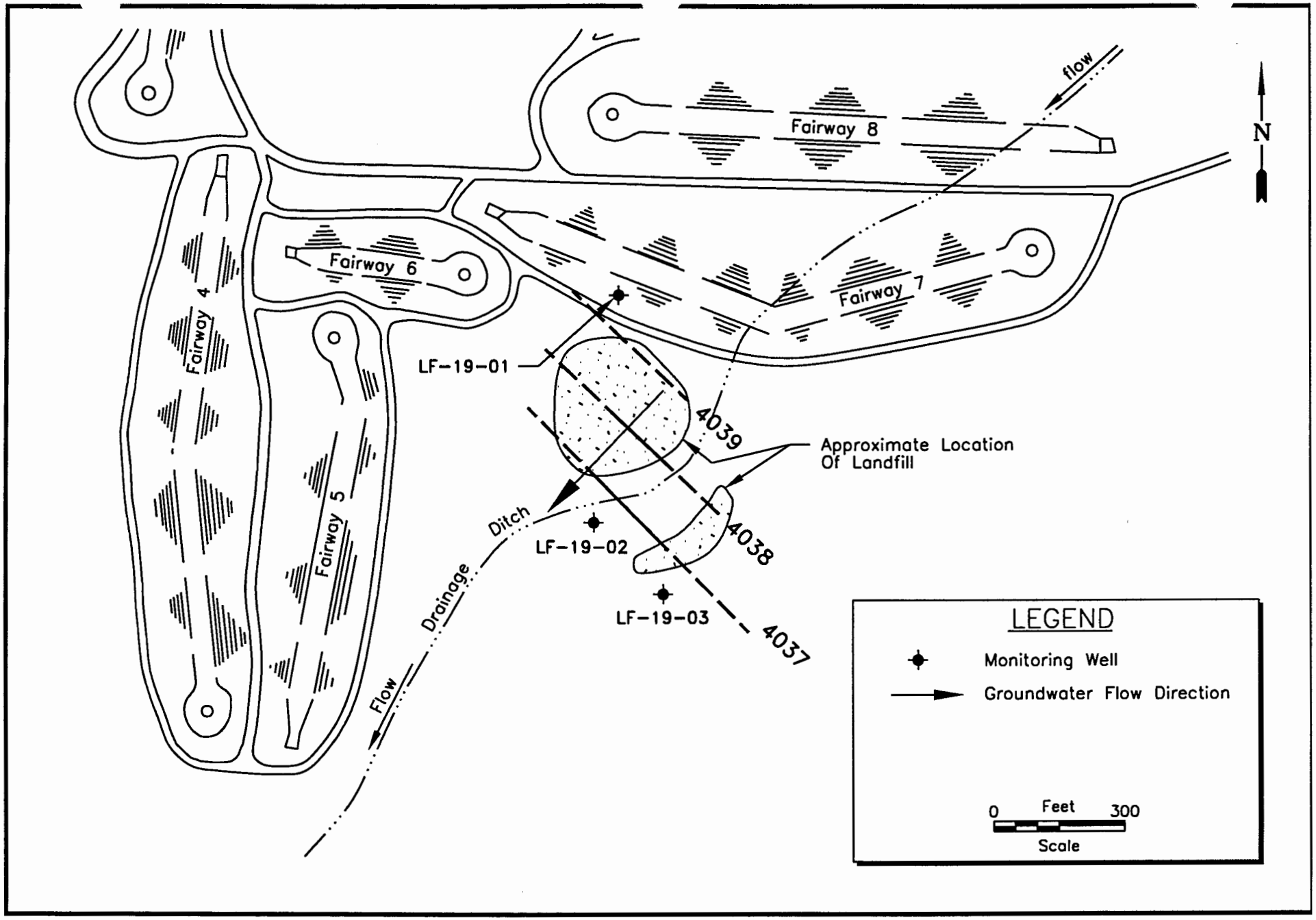
Figure 3-3. Groundwater Contour Map, August 23, 1995
Site LF-10, Old Main Base Landfill



2201-RCT

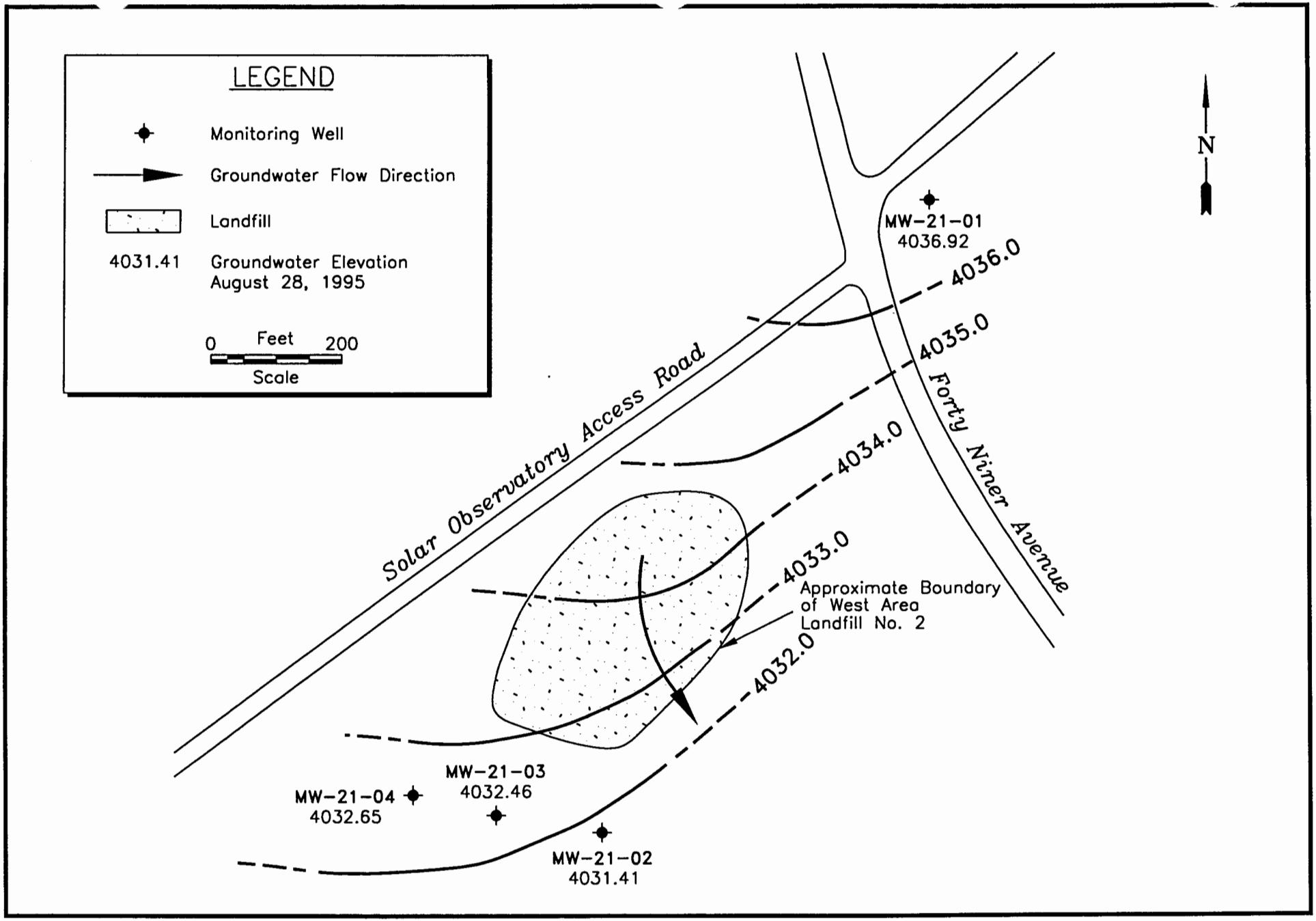
Figure 3-5

Groundwater Contour Map, August 23, 1995
Site SD-08, Refuse Collection Truck Washrack



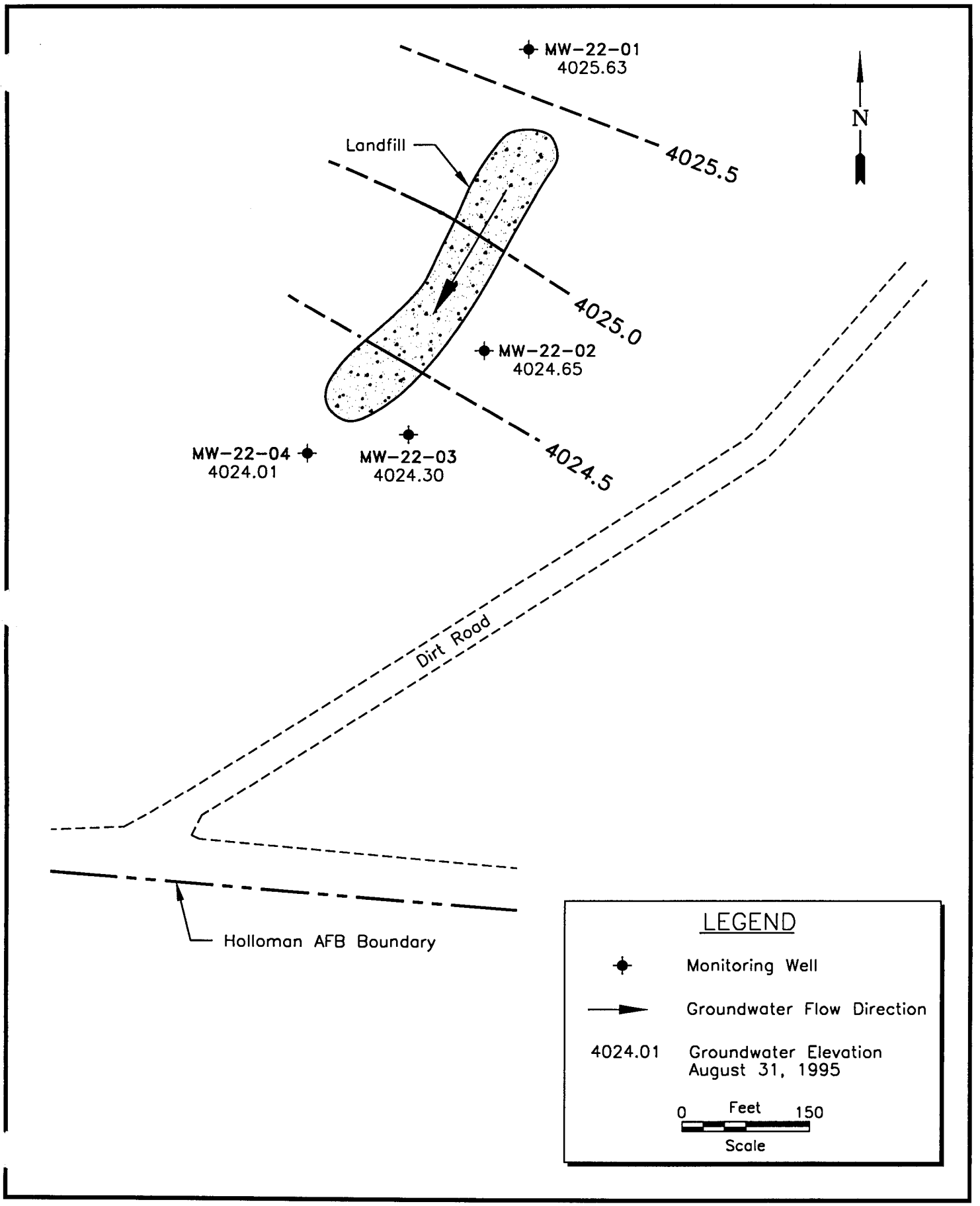
2201-GCL

Figure 3-7. Groundwater Contour Map, August 28, 1995
Site LF-19, Golf Course Landfill



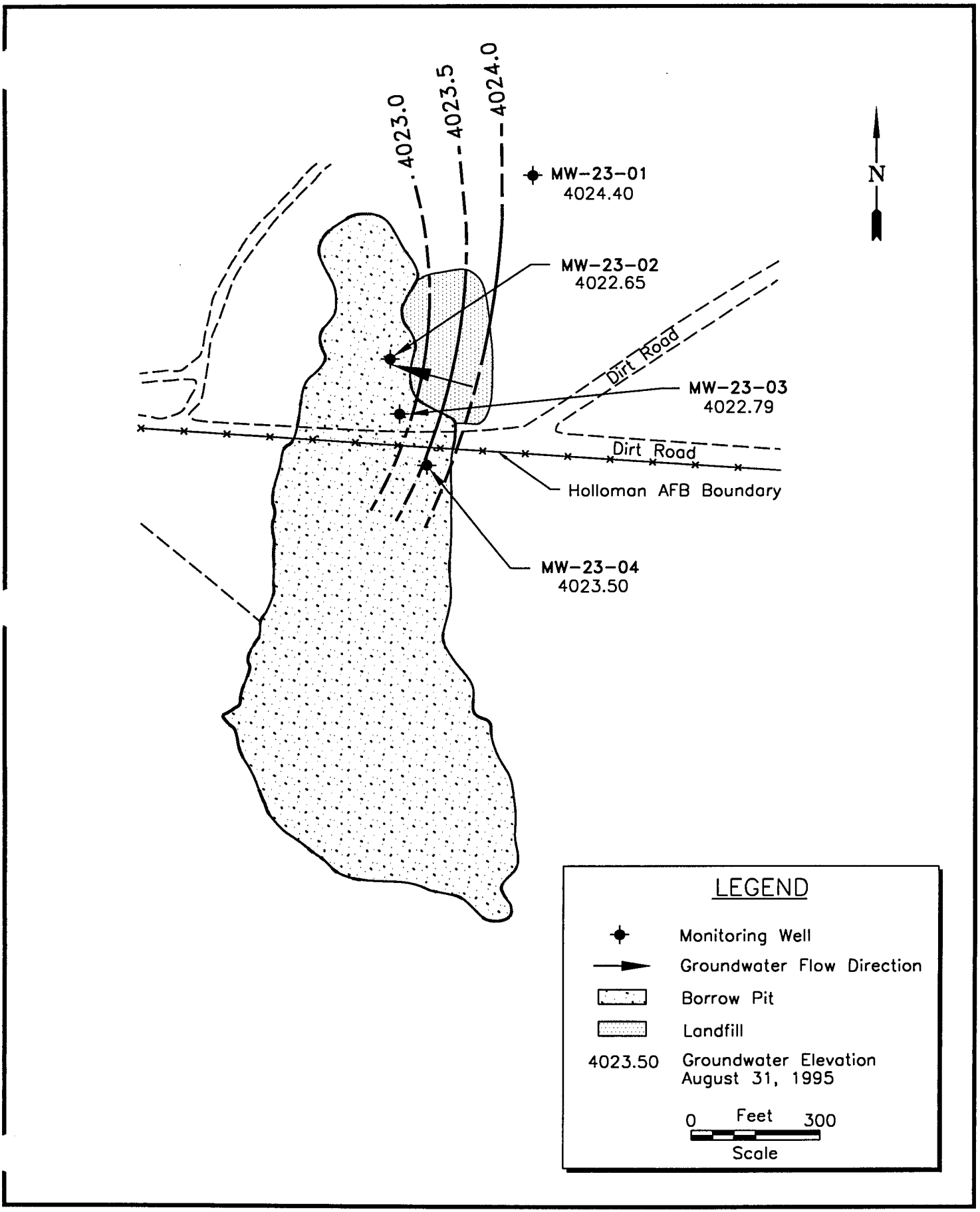
2201-WAL

Figure 3-9. Groundwater Contour Map, August 28, 1995
Site LF-21, West Area Landfill No. 2



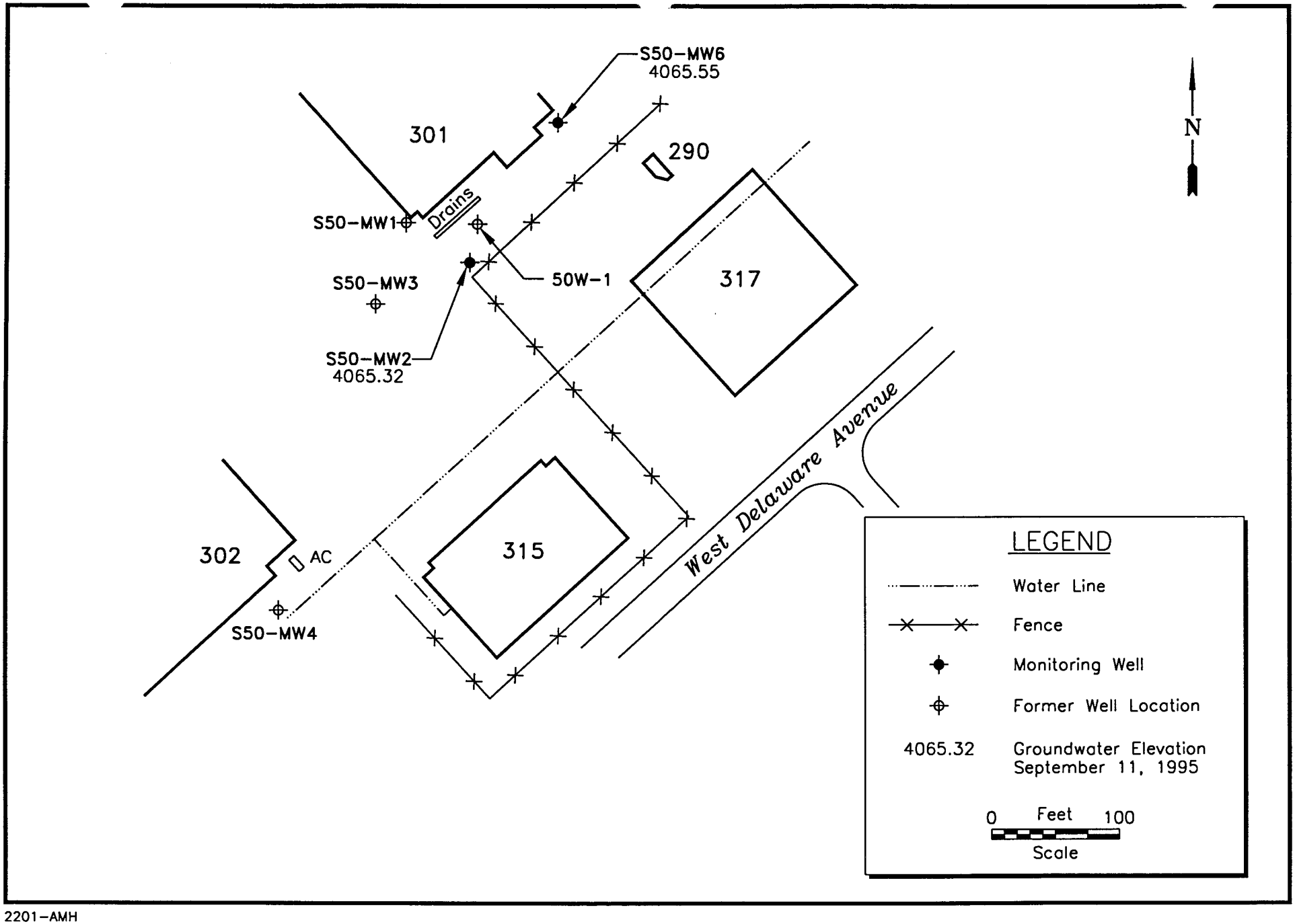
2201WAL1

Figure 3-11. Groundwater Contour Map, August 31, 1995
Site LF-22, West Area Landfill No. 1



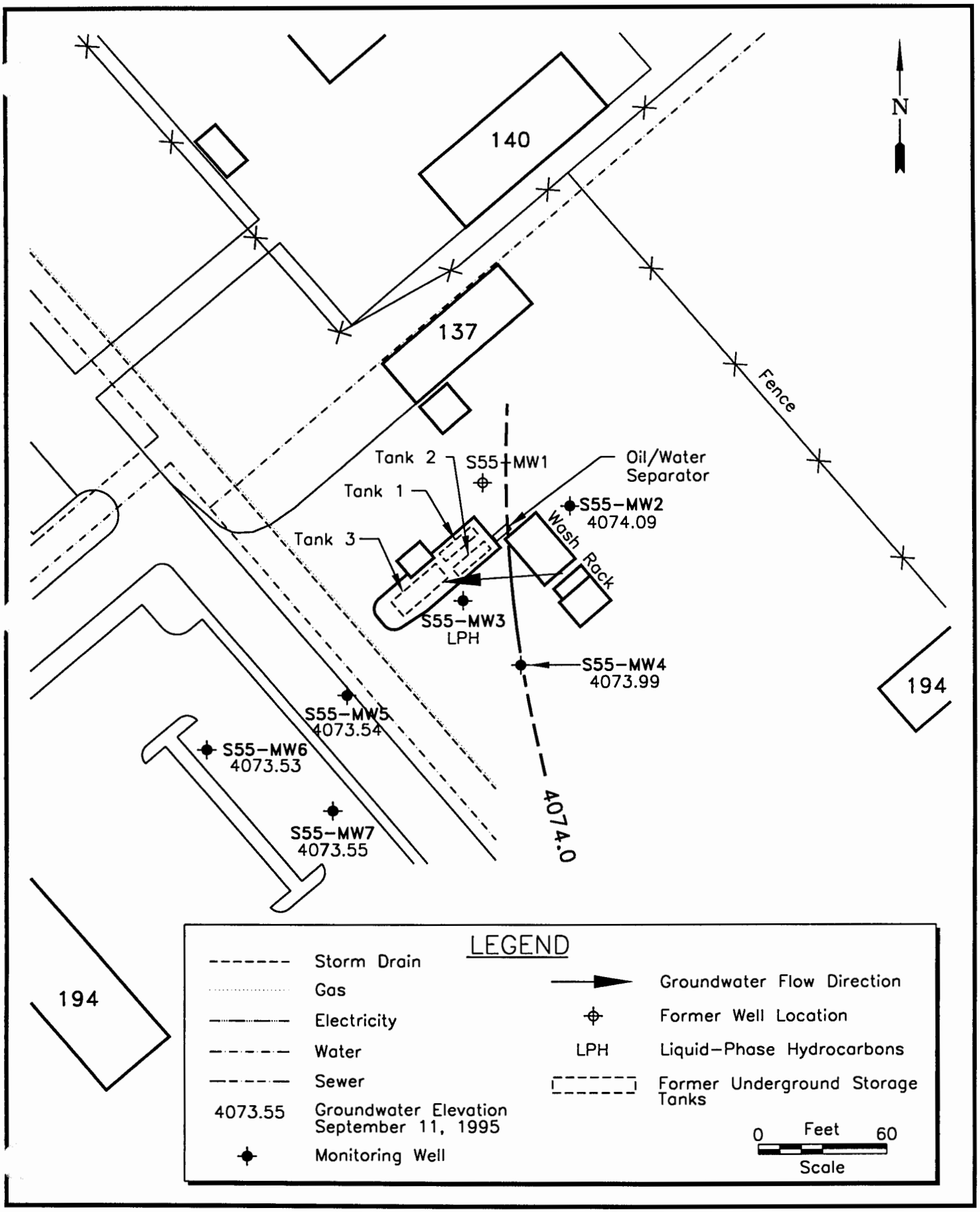
2201-LF

Figure 3-13. Groundwater Contour Map, August 31, 1995
Site LF-23, MOBBS Landfill



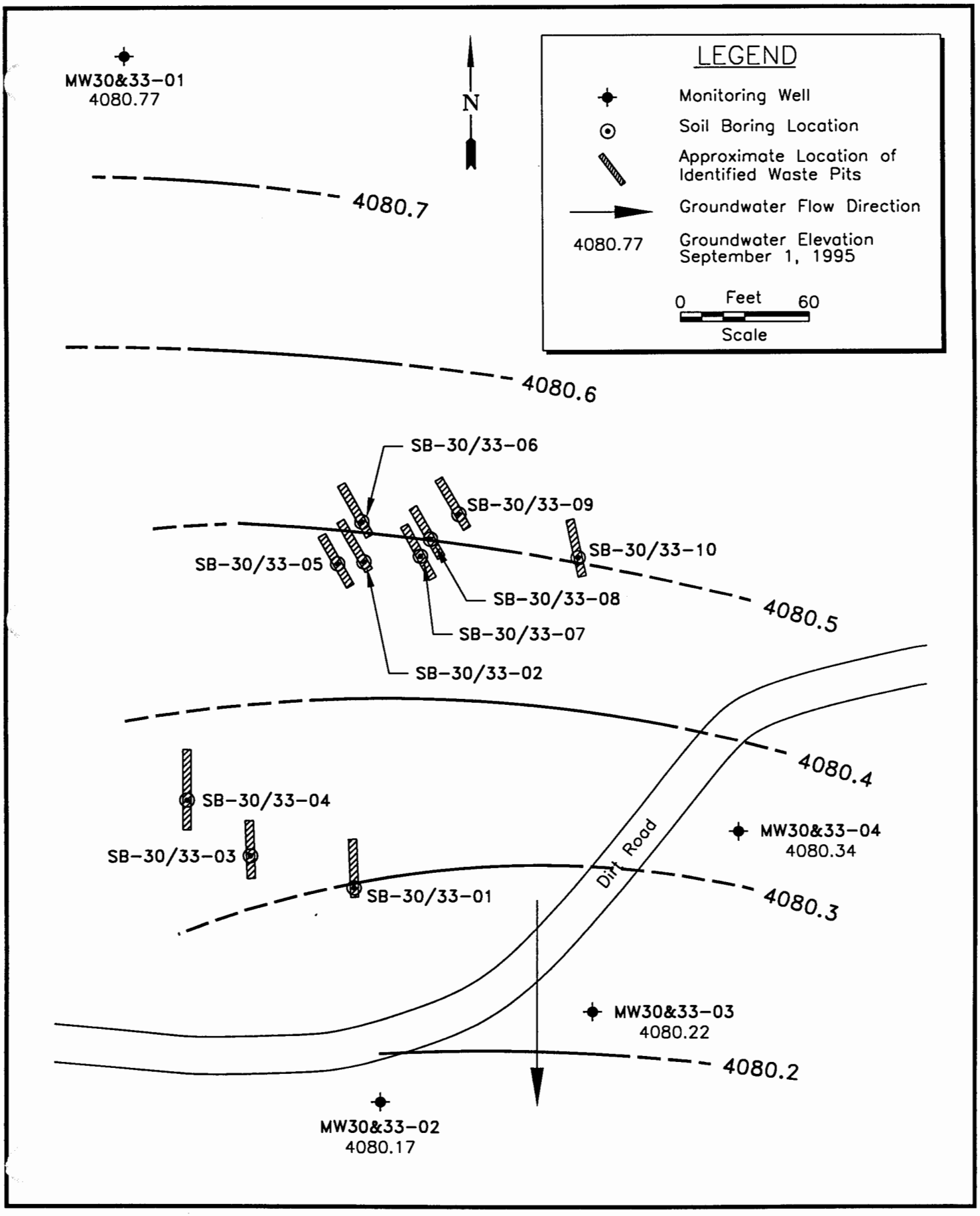
2201-AMH

Figure 3-15. Groundwater Elevation Map, September 11, 1995
Site OT-44, Building 301, Aircraft Maintenance Hangar



2201-MGS

Figure 3-19. Groundwater Contour Map, September 11, 1995
Site SS-48, Military Gas Station



2201-SPX

Figure 3-21. Groundwater Contour Map, September 1, 1995
Site DP-30 And SD-33, Grease Trap Disposal Pits

FINAL

QUALITY ASSURANCE PROJECT PLAN
LONG TERM GROUNDWATER MONITORING PROGRAM
HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

U.S. Army Corps of Engineers
Omaha District
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LIST OF ACRONYMS/ABBREVIATIONS

AA	Atomic Absorption
AFB	Air Force Base
BFB	4-Bromofluorobenzene
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CCC	Calibration Check Compound
CCV	Continuing Calibration Verification
CVAA	Cold Vapor Atomic Absorption
DFTPP	Decafluorotriphenylphosphine
DPT	Dichloro-diphenyl-trichloroethane
DQCR	daily quality control reports
DQO	data quality objectives
DRO	Diesel Range Organics
ECD	electron capture detector
EPA	Environmental Protection Agency
FEC	Foothill Engineering Consultants, Inc.
FID	flame ionization detector (
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption
GRO	Gasoline Range Organics
ICPES	Inductively Coupled Plasma Emission Spectroscopy
ICP	Inductively-Coupled Argon Plasma
ICV	Initial Calibration Verification
IDW	Investigative Derived Waste
LCS	Laboratory Control Sample
LTM	Long-Term Monitoring program
MRL	Missouri River Laboratory
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NMED	New Mexico Environmental Department
ppb	Parts per Billion
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation & Recovery Act
RF	Response Factor
RL	Reporting Limit
RPD	Relative percent Difference
RSD	Relative Standard Deviation

LIST OF ACRONYMS/ABBREVIATIONS (continued)

SOP	Standard Operating Procedure
SPCC	System Performance Check Compound
SQCSR	Sample Quality Control Summary Report
SSHP	Site Safety and Health Plan
TAL	Target Analyte List
TIC	Tentatively Identified Compounds
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
USACE	United States Army Corps of Engineers
VOC	volatile organic compounds

1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) has been prepared to support the Long-Term Monitoring (LTM) program at Holloman Air Force Base (AFB), New Mexico. The QAPP, which is part of a work plan that includes a Field Sampling Plan (FSP), provides guidance to FEC field personnel and the contract analytical laboratory, specifying field and analytical quality assurance and quality control (QA/QC) procedures to be implemented for this sampling effort. The FSP is comprised of groundwater sampling procedures and site-specific long-term monitoring sampling plans.

The purpose of the QAPP is to ensure that data collected during LTM activities are of adequate quality for meeting the requirements of annual groundwater monitoring and sampling, as required by the United States Environmental Protection Agency (EPA) and the New Mexico Environmental Department (NMED). Sampling and analysis protocol will also meet applicable requirements for closure of hazardous waste sites. The QAPP describes procedures which will be used to document and report precision, accuracy and completeness of data generated from LTM activities.

This QAPP addresses the quality assurance elements specified in the "*General Chemistry Supplement to the Scope of Services,*" United States Army Corps of Engineers (USACE), Omaha District, October 1996.

For the 1997 sampling effort, FEC has prepared a work plan (FSP, Site Safety and Health Plan [SSHP], and QAPP) by providing an addendum to Section 3.0 of the existing FSP and addressing site-specific requirements and QA/QC requirements in this QAPP and SSHP. The work plan addresses tasks to be performed at the following sites:

LF-01	Main Base Landfill
LF-10	Old Main Base Landfill
SD-08	Refuse Collection Truck Washrack
LF-19	Golf Course Landfill
LF-21	West Area Landfill No.2
LF-22	West Area Landfill No.1
LF-23	MOBBS Landfill

OT-44	Building 301 Aircraft Maintenance Area
SS-48	Military Gas Station - Building 137
SS-56	West Ramp Fuel Spill
DP-30 & SD-33	Grease Trap Disposal Pits
SS-02 & SS-05	POL Spill Sites
SS-46	JP-4 Spill Site
OT-16	Existing Entomology Shop Area
SS-17	BX Service Station
SS-39	Missile Fuel Spill Area
LF-29	Former Army Landfill

The QAPP is organized in the following manner:

Section 1.0 - Introduction
Section 2.0 - Project Organization and Functional Area Responsibilities
Section 3.0 - Data Quality Objectives
Section 4.0 - Field Activities
Section 5.0 - Laboratory Analytical Procedures
Section 6.0 - Quality Assurance Reporting
Section 7.0 - Quality Assurance Audits

2.0 PROJECT ORGANIZATION AND FUNCTIONAL AREA RESPONSIBILITIES

The project team for the Holloman AFB Long-Term Monitoring program will be comprised of a project manager, field team leader, and several staff geologists/scientists. FEC will subcontract with Analytica Environmental Laboratories for completing sample analysis. The roles and responsibilities of these personnel are discussed below.

2.1 Roles and Responsibilities

The FEC project manager will be responsible for organizing and directing the technical activities of the project and for reporting the results of these activities. The FEC project manager will have overall responsibility, authority, and accountability for completing project activities. The project manager will maintain daily interaction with field personnel throughout sampling activities.

Specifically, the project manager will be responsible for:

- Establishing technical objectives, reviewing and modifying the work plans in accordance with USACE specifications
- Responding to work plan revisions
- Ensuring that all contractual requirements are met for each task
- Ensuring that project budget and schedules are met
- Ensuring the technical quality of reports, memoranda, and other communications pertinent to project activities
- Maintaining contact with the USACE technical manager and providing information regarding all aspects of the project, including progress, problems encountered, and recommended solutions
- Ensuring that required staffing and technical expertise are provided

The FEC field team leader will be responsible for execution of sampling activities.

The responsibilities of the field team leader include:

- Daily coordination of field personnel
- Communication with the project manager regarding technical problems, scheduling and budget
- Coordination of daily QC activities required as part of the internal QC system

The field team leader will be responsible for all on-site activities, including sample collection and chain of custody. The field team leader will also be responsible for completing daily quality control reports. Staff geologists/ scientists will assist the field team leader with all sample collection activities.

2.2 Subcontractor Qualifications

Analytica Environmental Laboratories (ANALYTICA) in Broomfield, Colorado, will serve as the analytical laboratory for this project. ANALYTICA's qualifications include current USACE validation. ANALYTICA will provide data deliverables consisting of sample results, case narratives, surrogate spike percent recoveries, blank results, instrument tuning and calibration summaries, matrix spike/matrix spike duplicate (MS/MSD) and control sample percent recoveries. Sample analyses will be performed according to SW-846 methodologies.

2.3 USACE Missouri River Laboratory

The USACE Missouri River Laboratory (MRL) will serve as the QA laboratory for the sampling event. MRL will analyze QA split samples submitted by FEC, perform a review of reported analytical data, and assess the quality of data generated by the contract laboratory.

3.0 DATA QUALITY OBJECTIVES

To support the overall project objectives, chemical data quality objectives (DQOs) have been established. The chemical DQOs for this sampling effort include:

- Collecting samples as specified in the USACE Scope of Services and Field Sampling Plan. As part of the LTM, monitoring wells at 18 different sites will be sampled semi-annually to obtain data which may be used for site closure.
- Ensuring data comparability through the use of standard and approved analytical methods and sample collection procedures
- Generating data comparable to the formerly-defined EPA Level IV data
- Obtaining analytical results with known and acceptable precision and accuracy
- Achieving 95 percent data completeness for valid analytical results representing each matrix-method combination (minimum acceptable completeness will be 90 percent)

Data representativeness is a function of sampling strategy and will be achieved using the sampling procedures detailed in the Field Sampling Plan and USACE Scope of Services (SOS), dated October, 1996. Potential for sample contamination will be minimized by the use of decontamination procedures specified in the FSP (Volume I of the Work Plan). Data comparability will be achieved using standard methods and standard units of measure as specified in the methods. Analytical bias will be monitored by using QC samples and applying the QC criteria specified in the corresponding method. Analytical bias and precision in site-specific matrices/ samples will be evaluated through analysis of matrix spike samples, field duplicates, and split samples.

Project specific QA/QC samples will be collected as specified in the USACE SOS. QA/QC samples consist of site-specific MS/MSD samples, trip blanks, field duplicates, and split samples. MS/MSD samples will be collected at a frequency of 5 percent (1 per twenty samples). Trip blanks will be submitted with each sample cooler containing samples for VOC analysis. Field duplicates and split samples will be collected at a frequency of 10 percent (1 per every 10 samples). QA/QC samples will be analyzed for the same parameters as their corresponding field samples. Trip blanks will be analyzed for volatile organic compounds (VOCs) only.

Field/equipment blanks will not be generated as part of the QA/QC protocol for this sampling effort as dedicated, disposable sampling equipment will be used to collect samples at each location.

To ensure that DQOs are met, QA/QC efforts will be applied to provide a means for ongoing control and evaluation of measurement data quality throughout the course of project activities (i.e., analytical system capability). QA/QC acceptance windows for precision and accuracy, have been established and are presented in Section 5.

3.1 Analytical Capability

The ability of an analytical system to produce data of acceptable quality is assessed in terms of accuracy and precision. Indicators of acceptable precision and accuracy can be measured by evaluating system QC data (e.g., initial and continuing calibration, laboratory control sample [LCS] analysis, method matrix spikes [MS], and matrix spike duplicates [MSD]). Analytical system performance and sensitivity is documented in the way of routine method detection limit studies and control charts.

For this sampling effort, the goal for data completeness is 95 percent for each analytical method performed. Completeness is defined as the ratio of valid data to total data generated during the course of project activities. Data will be considered valid if they meet the acceptance criteria for precision, accuracy, and reporting limits specified in this QAPP.

3.1.1 *Method Reporting Limits*

Method reporting limits (RLs) for each analytical method are presented in Tables 3-1 through 3-7. RLs achieved at the time of analysis may vary slightly from those listed in Tables 3-1 through 3-7 due to sample dilutions which may be necessary. In general, dilutions will be performed only as directed in each representative method.

Reporting limits achieved for all analytes will be compared to Federal Drinking Water Standards Maximum Contaminant Levels (MCL). The laboratory will also report down to its method detection limits for all analytes to achieve the lowest possible detections.

Reporting limits listed in Tables 3-1 through 3-7 are derived from MDL studies at Analytica and are 3-5 times the MDL.

3.1.2 *Precision and Accuracy*

Precision and accuracy objectives for each analytical method, as applicable, are presented in Tables 3-8 through 3-14. Precision, which will be calculated from MS/MSD and control sample duplicate analyses, is expressed in terms of relative percent difference (RPD). RPDs will be evaluated against precision objectives listed in Tables 3-8 through 3-14. Accuracy will be measured in terms of percent recovery values for surrogate compounds, MS/MSD samples, and laboratory control samples. percent recoveries reflect the total analytical error for a given measurement, expressed as a percentage of the true spike value. Recovery values will be compared with accuracy objectives contained in the tables.

Criteria for accuracy and precision specified in the tables may not be achievable in all analyses due to variability in sample matrix. When precision and accuracy objectives are not met, rationale for the variance will be provided. The percent recovery between true and measured concentrations of LCS may be compared with accuracy objectives in Tables 3-8 through 3-14. The contract analytical laboratory will be responsible for applying all QA/QC procedures specified by SW-846 for each applicable method of analysis.

3.2 Data Quality Calculations

Precision and accuracy are important indicators of measurement data quality. Precision is a measure of variability associated with a measurement system. Accuracy expresses the degree to which a measured value agrees with the true value for a given parameter. Accuracy includes elements of both bias and precision. This section provides instructions for calculating data quality in terms of precision and accuracy.

For this project, precision will be assessed by evaluating the results of MS/MSD and control sample analyses. As applicable, acceptance criteria are listed in Tables 3-8 through 3-14. The relative percent difference (RPD) will be used to estimate precision for duplicate analyses and is calculated by:

$$RPD = \frac{X_1 - X_2}{(X_1 + X_2)/2} \; x \; 100$$

For this project, accuracy of the measurement data will be assessed by evaluating the results of percent recovery and comparing them to acceptable limits presented in Tables 3-8 through 3-14. percent recovery is calculated as the measured value of the spiked sample less the measured value of the sample divided by the actual value of the spike (multiplied by 100 to obtain a percentage).

4.0 FIELD ACTIVITIES

Protocol for field activities have been established for this sampling effort. Details pertaining to field activities, including well purging, sample numbering, sample collection and handling, chain-of-custody, and management of IDW, are presented in the Field Sampling Plan (Volume I, SAP).

5.0 LABORATORY ANALYTICAL PROCEDURES

5.1 Analytical Methods

The analytical methods and procedures that will be used to prepare and analyze samples are discussed in this section. Chemical analyses of groundwater samples will be performed according to methods contained in the following publications:

- SW-846, Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd Edition, U.S. EPA, Office of Solid Waste and Emergency Response, Update I, II, IIA, IIB, March 1995
- EPA, Methods for Chemical Analysis of Water and Wastes, EPA Publication No. 600/4-79-020, March 1983

Analytical methods and corresponding parameters are identified in Table 5-1.

5.1.1 *Volatile Organic Compounds--SW-846 Method 8260A*

Groundwater samples will be analyzed for volatile organic compounds by SW-846 Method 8260A. Samples will be prepared following SW-846 Method 5030, purge and trap. The presence and concentration of purgeable organic compounds will be determined by SW-846 Method 8260A using a capillary column. This method uses a purge-and trap GC/MS technique. An inert gas is passed through water to transfer the purgeable organic compounds from the liquid to the vapor phase. The vapor is then swept through a sorbent trap that is heated and backflushed with inert gas to desorb the organic compounds onto the GC capillary column. The VOCs are then separated and detection is achieved with a mass spectrometer.

5.1.2 *Semivolatile Organic Compounds--SW-846 Method 8270B*

Groundwater samples will be analyzed for semivolatile organic compounds by SW-846 Method 8270B. The samples will be extracted using SW-846 Method 3510. Method 8270B is a GC/MS technique used for determining a specific list of semivolatile basic, neutral, and acidic organic compounds that are soluble in methylene chloride and capable of being eluted as sharp peaks from a capillary column with a slightly polar liquid phase.

5.1.3 *Organochlorine Pesticides and Polychlorinated Biphenyls -- SW-846 Method 8080A*

Groundwater samples will be analyzed for organochlorine pesticides and polychlorinated biphenyls (PCBs) by SW-846 Method 8080A. Groundwater samples are prepared with a separatory funnel liquid-liquid extraction (3510A). Sample extracts are injected into a gas chromatograph and analytes are separated onto a capillary column. Detection is achieved by an electron capture detector (ECD). Because interferences may affect method sensitivity, extract cleanup techniques may be necessary to reduce interferences.

5.1.4 *Chlorinated Herbicides -- SW-846 Method 8150B*

Groundwater samples will be analyzed for chlorinated herbicides by SW-846 Method 8150B. Samples are extracted and converted to their methyl esters using a diazomethane as the derivating agent. The esters are analyzed by GC employing an ECD. Results are reported as the acid equivalent. Interferences may affect method sensitivity and derivitization efficiency.

5.1.5 *Target Analyte List (TAL) Metals -- SW-846 Method 6010A/7000-series*

Groundwater samples will be analyzed for total and dissolved concentrations of Target Analyte List Metals by SW-846 Method 6010A and methods of the SW-846 7000-series. Samples will be prepared using SW-846 Method 3010A. Samples for dissolved metal analyses will be filtered in the field and preserved with nitric acid. After preparation (acid digestion), samples will be analyzed by Inductively-Coupled Argon Plasma (ICP) Spectroscopy (SW-846 6010A) and various furnace atomic absorption methods (SW-846 7000-series).

Following acid digestion, metal concentrations will be determined by Method 6010A, which allows the simultaneous or sequential measurement of elements using ICP. Under this method, element-emitted light optical spectrometry is measured. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific atomic-line emission spectra are produced, which are then dispersed by a grating spectrometer and monitored for intensity by photomultiplier tubes.

5.1.6 *Arsenic by GFAA -- SW-846 Method 7060*

Groundwater samples will be analyzed for dissolved and total concentrations of arsenic using SW-846 Method 7060. Samples collected for dissolved analysis by GFAA will be filtered in the field and immediately preserved with nitric acid. After acid digestion, samples will be analyzed by graphite furnace atomic absorption. The sample aliquot is placed in a graphite tube in the furnace. The sample is then evaporated, charred, and atomized. Radiation from a given excited element is passed through the vapor containing ground-state atoms of arsenic. The intensity of radiation decreases in proportion to the amount of ground-state atoms present. A monochromator isolates the characteristic radiation from the hollow cathode tube or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

5.1.7 *Lead by GFAA -- SW-846 Method 7421*

Groundwater samples will be analyzed for dissolved and total concentrations of lead using SW-846 Method 7421. Samples for dissolved metal analysis by GFAA will be filtered in the field and preserved with nitric acid. After digestion, samples will be analyzed by graphite furnace atomic absorption. The sample aliquot is placed in a graphite tube in the furnace. The sample is then evaporated, charred, and atomized. Radiation from a given excited element is passed through the vapor containing ground-state atoms of lead. The intensity of radiation decreases in proportion to the amount of ground-state atoms present. A monochromator isolates the characteristic radiation from the hollow cathode tube or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

5.1.8 *Mercury by CVAA -- SW-846 Method 7470*

Groundwater samples will be analyzed for dissolved and total concentrations of mercury using cold vapor atomic absorption (CVAA), SW-846 Method 7470. Samples collected for dissolved metal analysis via CVAA will be filtered in the field and preserved with nitric acid. Under this methodology, mercury is reduces to its elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an atomic absorption spectrometer for detection and measurement.

5.1.9 *Selenium by GFAA -- SW-846 Method 7740*

Groundwater samples will be analyzed for dissolved and total concentrations of selenium using SW-846 Method 7740. Samples collected for dissolved metal analysis by GFAA will be filtered in the field and preserved with nitric acid. After acid digestion, the sample aliquot is placed in a graphite tube in the furnace. The sample is then evaporated, charred, and atomized. Radiation from a given excited element is passed through the vapor containing ground-state atoms of selenium. The intensity of radiation decreases in proportion to the amount of ground-state atoms present. A monochromator isolates the characteristic radiation from the hollow cathode tube or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

5.1.10 *Thallium by GFAA -- SW-846 Method 7841*

Groundwater samples will be analyzed for dissolved and total concentrations of thallium using SW-846 Method 7841. Samples collected for dissolved metal analysis by GFAA will be filtered in the field and preserved with nitric acid. After acid digestion, the sample aliquot is placed in a graphite tube in the furnace. The sample is then evaporated, charred, and atomized. Radiation from a given excited element is passed through the vapor containing ground-state atoms of selenium. The intensity of radiation decreases in proportion to the amount of ground-state atoms present. A monochromator isolates the characteristic radiation from the hollow cathode tube or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

5.2 Calibration Procedures

Documented calibration procedures are necessary to provide consistency in preparing equipment for specific analytical measurements. Established calibration procedures then provide a mechanism for ensuring that measurements made with a specific type of equipment are comparable. Calibration requirements for each analytical method used for this project are briefly discussed in the following subsections and are summarized in Table 5-2.

5.2.1 *Volatile Organic Compounds -- SW-846 Method 8260A*

Samples will be analyzed for volatile organic compounds by GC/MS following SW-846 Method 8260A, 3rd edition. Analyte identification and quantitation will be performed using response factors (RFs) and retention times generated from a five-point calibration curve, daily RF updates, and instrument-specific mass spectra. A minimum of three of the following internal standards will be used: 1,4-difluorobenzene; chlorobenzene; fluorobenzene; pentafluorobenzene; and 1,4-dichlorobenzene.

Tentatively identified compounds (TICs) are identified only when an acceptable match (as defined by the qualitative identity criteria of the method) is obtained between the unknown spectra and the library spectra. The TIC is then quantitated using the total ion current and a RF of 1.0, with respect to the closest eluting internal standard free of interferences.

The mass spectrometer will be tuned daily to give an acceptable spectrum for bromofluorobenzene. Relative abundance criteria for bromofluorobenzene are given in SW-846.

As required by the method, system performance will be verified initially and after every 12 hours to ensure a minimum average RF of 0.3 (0.25 for bromoform) for the following system performance check compounds (SPCCs): chloromethane; 1,1-dichloroethane; 1,1,2,2-tetrachloroethane; chlorobenzene; and bromoform. A five-point calibration, used for generating RFs, will be performed initially. The relative standard deviation (RSD) must be less than 30 percent for the five RFs calculated for each of the following calibration check compounds (CCCs): 1,1-dichloroethene; chloroform; 1,2-dichloropropane; toluene; vinyl chloride; and ethylbenzene.

A continuing (every 12 hours) calibration check will be performed, containing five SPCCs and six CCCs as well as the other target analytes of interest. A RF will be calculated for all analytes and the CCCs and SPCCs will be evaluated for acceptability against the method criteria.

5.2.2 *Semivolatile Organic Compounds -- SW-846 Method 8270B*

Samples will be analyzed for semivolatile organic compounds by GC/MS following SW-846 Method 8270B, 3rd edition. All samples are prepared following extraction procedures outlined in SW-846, 3rd edition. Qualitative identification is performed using method criteria for retention time and referenced spectra matches of sample and calibration analyte peaks. Quantitation is performed using the internal standard technique and updated response factors every 12 hours that are verified against a five point initial calibration mean RF per method criteria. The six internal standards used are 1,4-dichlorobenzene, naphthalene, acenaphthene:phenanthrene, chrysene, and perylene. The mass spectrometer is tuned every 12 hours to give an acceptable spectrum for decafluorotriphenylphsphine (DFTPP); DFTPP ion abundance criteria are specified in SW-846 Method 8270B.

System performance is verified initially and every 12 hours to ensure a minimum average response factor of 0.050 for the following SPCC: n-nitroso-di-n-propylamine; hexachlorocyclopentadiene; 2,4-dichlorophenol; and 4-nitrophenol. A five-point calibration, used for generating response factors, is performed initially. The variability for specific ion response factors for Method 8270A CCCs must be less than 30 percent RSD. The CCCs are phenol, 1,4-dichlorobenzene, 2-nitrophennol, 2,4-dichlorophenol, hexachlorobutadiene, 4-chloro-3-methylphenol, acenaphthene, 2,4,6-trichlorophenol, n-nitro-di-n-phenylamine, pentachlorophenol, fluoranthene, di-n-octylphthalate, and benzo(a)pyrene.

A continuous calibration check is performed every 12 hours. This check consists of a single concentration of the CCCs, SPCCs, and other compounds of interest from which a RF is calculated. The single-point RF for each CCC must be within 30 percent difference of the average five-point RF and the SPCCs must have a minimum response of $\geq$ 0.05; otherwise corrective action must be taken and/or a new five-point calibration must be generated.

5.2.3 *Organochlorine Pesticides and PCBs -- SW-846 Method 8080A*

Initial calibration is performed by the external standard technique as described in SW-846. A five-point calibration is used for generating response factors (RF). The RSD must be

less than 20 percent in order to use the mean RF for quantitation and presume linearity through the origin, otherwise a calibration curve must be used. IC is required after instrument repair, column change or failure of ICV or CCV. An ICV consisting of a mid-range standard is analyzed after the calibration to verify the calibration. The CCV is analyzed daily before analysis starts and thereafter at a 10 percent frequency. The CCV must be within 15 percent of the average multipoint RF or within 15 percent of the daily initial CCV for ongoing verification.

On a daily basis the dichloro-diphenyl-trichloroethane (DDT) and endrin degradation is checked. If degradation of either DDT and endrin exceeds 20 percent, corrective action is taken before proceeding with analysis of the CCV.

5.2.4 *Chlorinated Herbicides -- SW-846 Method 8150B*

Initial calibration is performed by the external standard technique as described in SW-846. Method 8000A, a five-point calibration with methyl esters of the target analytes, is used for generating RFs. The RSD must be less than 20 percent in order to use the mean RF for quantitation and presume linearity though the origin, otherwise a calibration curve must be used. IC is required after instrument repair, column change or failure of ICV or CCV. An ICV consisting of a mid-range standard is analyzed after the calibration to verify the calibration. The CCV is analyzed daily before analysis starts and thereafter at a 10 percent frequency. The CCV must be within 15 percent of the average multipoint RF or within 15 percent of the daily initial CCV for ongoing verification.

5.2.5 *Metals by ICPES -- SW-846 Method 6010A*

SW-846 Method 6010A is used to measure elements by ICPES. Detailed calibration procedures for ICPES systems are described in SW-846, 3rd edition. A response factor (RF) is calculated daily for each metal on the basis of two determinations of a calibration standard and calibration blank. Following calibration, a high-level calibration check sample is reanalyzed; agreement between the measured value and the expected value must be within 5 percent for the analyses to proceed. Calibration is verified by analyzing a QC check standard which is prepared independently of calibration standards, at a frequency of every 10 samples. Agreement within 10 percent of the expected value is required for all target

analytes; otherwise, the system must be recalibrated. When a calibration check does not agree with the expected value (±10 percent), the samples that have been analyzed since the last calibration check was made will be reanalyzed.

5.2.6 *Metals by GFAA -- SW-846 Methods 7060, 7421, and 7740*

SW-846 Methods 7060, 7421, and 7740 are GFAA techniques for determination of arsenic, lead, and selenium, respectively. The calibration procedures for the graphite furnace systems are described in the respective SW-846, 3rd edition methods. A multipoint calibration curve is generated daily for each element using a calibration blank and three up-scale standards. The correlation coefficient for the linear regression equation must exceed 0.995 to be acceptable. Calibration will be verified every 10 samples by analyzing a QC check sample and calibration blank. Agreement within ± 20 percent of the expected value is required; otherwise, a new calibration curve must be generated.

5.2.7 *Mercury by CVAA -- SW-846 Methods 7470*

SW-846 Method 7470 is a CVAA technique for determination of mercury in water samples. The calibration procedures for the CVAA system are described in the respective SW-846, 3rd edition methods. A multipoint calibration curve is generated daily using a calibration blank and three up-scale standards. The correlation coefficient for the linear regression equation must exceed 0.995 to be acceptable. Calibration will be verified every 10 samples by analyzing a QC check sample and calibration blank. Agreement within ±15 percent of the expected value is required; otherwise, a new calibration curve must be generated.

5.3 Preventive Maintenance

The primary objective of preventive maintenance is to help ensure the timely and effective completion of a measurement effort (i.e., method of analysis). A preventive maintenance program is designed to minimize the down-time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. Effective preventive maintenance requires addressing three primary areas: maintenance responsibilities; maintenance schedules for major/critical instrumentation and apparatus; and inventory of critical spare parts. Each of these items is discussed in the following sections.

5.3.1 *Maintenance Responsibilities*

Maintenance responsibilities for analytical instrumentation and equipment are assigned to the appropriate laboratory managers. Responsibilities include establishing maintenance procedures and schedules for each major instrument or piece of equipment. Responsibilities for specific items may be delegated to laboratory personnel (i.e., analysts), although the laboratory managers retain responsibility for ensuring adherence to prescribed maintenance protocol.

For field instruments and equipment, such as pH and specific conductivity meters, water-level meters, thermometers, real-time monitoring instrumentation, and organic vapor analysis instrumentation, the FEC Field Team Leader will assume maintenance responsibilities, ensuring that available equipment is functional and ready for use.

5.3.2 *Maintenance Schedules*

To maximize the effectiveness of a preventive maintenance program, maintenance schedules for all major analytical instruments are followed. At the contract laboratory, schedules are established for all routine maintenance activities. Schedules are subject to change when conditions warrant. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Field testing equipment (e.g., pH meters) will be inspected prior to use and serviced or replaced as necessary. Schedules for maintenance of field equipment is based on manufacturers' recommendations. During field sampling activities, all equipment maintenance will be documented in a field logbook and on an appropriate field form.

5.3.3 *Spare Parts*

The contract analytical laboratory shall maintain an adequate inventory of spare parts to minimize equipment down time. The inventory should include parts that are subject to frequent failure, those which have limited useful lifetimes, and those which cannot be obtained promptly should failure occur. The appropriate laboratory managers will be responsible for maintaining an adequate inventory of necessary spare parts. For field equipment, the FEC Field Team Leader will have appropriate phone numbers of equipment

vendors to ensure that replacement parts or instrumentation can be received within 24 hours of instrument failure.

5.4 Internal Quality Control

Internal QC procedures associated with analytical methods involve measuring percent recoveries and relative percent differences (as applicable) of matrix spike analyses, surrogate spike recoveries, and laboratory control sample recoveries. The analytical methods to be used for analysis of groundwater samples collected during this sampling effort require the measurement system to initially satisfy specific criteria for calibration linearity, reference material recovery, and freedom from contamination. Results of control samples, indicate which corrective actions are necessary to correct out-of-control conditions. Internal QC samples to be analyzed with project samples are discussed below.

5.4.1 *Method Blank*

A method blank is an aliquot of reagent water carried through the entire analytical process, just as the actual sample is. The purpose of the method blank analysis is to monitor and control laboratory sources of contamination. At a minimum, one laboratory method blank will be analyzed daily for volatile organic analyses and each preparatory batch will have a method blank analyzed for semivolatile analyses and inorganic analyses. Ideally, method blanks should not have detectable concentrations of contaminants present. In the event that contaminants are detected in the method blanks, corrective action will consist of reanalyzing the blank and associated samples. After reanalysis, any analytes found in the method blank will be flagged in associated samples.

5.4.2 *Matrix Spike/Matrix Spike Duplicate*

MS/MSD-analyses will be conducted on site-specific field samples. These samples will be designated as MS/MSD samples by FEC field personnel collecting the samples. MS/MSD samples will be analyzed for the same parameters as the corresponding field sample. MS/MSD sample collection is addressed in the FSP (Volume I). Sufficient sample volume will be submitted to the contract analytical laboratory to allow for MS/MSD analyses of the appropriate parameters.

Matrix spike (MS) samples are analyzed for both organic and inorganic analyses. An MS for inorganic analyses is an aliquot of a field sample spiked with known concentrations of reference materials and taken through the entire preparation and analytical procedures. An MS for organic analyses is an extra field sample spiked with known concentrations of reference materials and taken through the entire preparation and analytical procedures. The MS allows the laboratory to assess the efficiency of extraction/digestion, accuracy of the analysis, and possible matrix effects. Site-specific MS samples will be collected in the field and provided to the contract laboratory for analysis. MS analyses will be performed on a 5 percent frequency for each batch as required by SW-846.

If method accuracy or precision, as demonstrated with matrix spikes, actual samples, or laboratory duplicates, fall outside acceptable limits, a quality control sample will be analyzed immediately. If the analytical system is shown to be within acceptance criteria, an investigation shall be initiated and the sample in question will be re-analyzed (if required to verify that the problem is reproducible and hence related to the sample). If the analytical system is found to be at fault, the problem will be corrected and all samples affected will be re-analyzed.

The matrix spike duplicate (MSD) is a second aliquot of the matrix spike sample that is also spiked with known concentrations of reference material. Method precision for the matrix can be estimated by calculating the relative percent differences between the recoveries of the spiking compounds in the MS and MSD. MSD analyses will be performed on a 5 percent frequency for each batch.

5.4.3 *Laboratory Duplicate Samples*

Laboratory duplicate samples will be analyzed for inorganic analyses to provide a measure precision. Results of duplicate analysis provides a measure of method variability (i.e., total variability from imprecision in both sample collection and analytical procedures).

5.4.4 *Laboratory Control Sample*

A laboratory control sample (LCS), or method blank spike sample, is a sample having known concentrations of reference materials spiked into an aliquot of deionized water. The

LCS is subjected to the processes of sample preparation and analysis. The purpose of an LCS analysis is to determine if out-of-control conditions associated with the analytical system exist. LCS data also provide an indication of whether failure to meet QC acceptance criteria is due to matrix interference in the sample.

5.4.5 *Surrogate Compounds*

Surrogate compounds are added to all samples that will undergo organic analysis. Surrogate compounds are organic compounds that are similar to analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples, and spiked samples prior to extraction. percent recoveries are calculated and reported for each surrogate compound. Surrogate spike percent recoveries are used to assess method accuracy for individual samples.

5.5 Corrective Action

An important part of the QA/QC program for this sampling effort includes implementation of corrective action when appropriate. In the process of performing methods of analysis, the contract laboratory may encounter "out-of-control" conditions that require corrective actions. Examples of out-of-control conditions at the laboratory are:

- Detection of any compounds of interest in a method blank at concentrations equal to or greater than the reporting limit (or required detection limit)
- Failure to meet the acceptance criteria for recovery of any compound of interest in a QC sample
- Exceeding the acceptance criteria for matrix spike recovery and subsequent failure to meet the acceptance criteria for a laboratory control sample (QC check sample) for the same parameter(s). Any parameter that fails the matrix spike test but passes the QC check sample test will be flagged as suspect for the parameter due to matrix effects

When an out-of-control situation is encountered, efforts will be undertaken to determine the appropriate corrective action. Corrective actions for routine QC checks are outlined in laboratory standard operating procedures for each given analysis. General procedures related to corrective actions are described below.

During the course of the project, it will be the responsibility of the laboratory staff and FEC project manager to ensure that analytical procedures are followed as specified and that data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem(s). Laboratory analysts and/or supervisors will initiate corrective action in the event that QC results exceed acceptance criteria specified in Tables 3-8 through 3-14. Corrective action may also be initiated upon identification of other problems. Corrective action may also be initiated by the laboratory QA officer if data problems or other anomalies are noted during data review. Within 24 hours of the identification of a QC problem that may compromise data quality, the USACE project manager or chemist will be verbally notified.

During the course of the field investigation, the FEC project manager will be responsible for notifying the USACE technical manager of situations that may affect data quality and nonconforming items or activities which would initiate the corrective action process. Monthly progress reports will include nonconfirmation notices of all circumstances associated with any corrective actions taken.

The contract laboratory project manager will be responsible for ensuring that all QA/QC procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem. Problems requiring major corrective action will be documented and the FEC Project Manager informed. Laboratory personnel will initiate corrective action when QC results exceed acceptability limits or other problems or potential problems are identified.

5.6 Data Reduction, Validation and Documentation

Analytical data generated by the contract laboratory will be reviewed for accuracy and completeness. Data will undergo reduction and review by the laboratory, and FEC will apply data validation guidelines for the purpose of evaluating data quality and usability. An analytical data package, consisting of sample results and internal QC data (equivalent to EPA Level IV), will be submitted to USACE for QA review by USACE personnel.

5.6.1 *Data Reduction, Validation, and Reporting by the Laboratory*

The process by which sample concentrations are calculated will adhere to procedures specified by the analytical method. Data reduction involves taking instrument responses or other raw data and calculating concentrations for each target analyte. Data validation by the laboratory involves examining the analytical systems to verify that they are operating properly and that QA/QC objectives have been met. Data will be reviewed and validated by the analyst and/or laboratory project manager. Data will be validated for conformance with method specifications including, calibration, duplicate analyses, blank analyses, spike recoveries, data calculations, and frequency of QC sample analyses.

The QC data presented by the contract laboratory will provide a basis for assessing the accuracy and precision of analytical data.

5.6.2 *FEC Data Review and Validation*

Upon receipt of analytical data from the contract laboratory, FEC will perform an independent review of the data to ensure that analytical results received from the laboratory are valid and meet the QA objectives. Exceedences and nonconformances with QC acceptance limits will be evaluated based on EPA Functional Guidelines for Reviewing Data and qualifications made to corresponding sample results will be discussed.

6.0 QUALITY ASSURANCE REPORTING

QA/QC activities performed during the course of the project will be documented on appropriate forms and in the field logbook. Daily quality control reports, monthly progress reports, confirmation notices, and a sample quality control summary report will be generated to document various QA/QC activities related to the project.

6.1 Daily Quality Control Reports

Throughout the course of project activities, daily quality control reports (DQCRs) will be maintained as a measure of QA/QC. The DQCRs will be submitted to the USACE TM weekly. The DQCRs address and summarize the following: weather conditions; activities and work performed; field instrument calibration; unscheduled maintenance activities; problems encountered and corrective actions taken; health and safety issues; and any deviations from the approved work plan.

6.2 Monthly Progress Reports

FEC will submit monthly progress reports to the USACE TM, indicating the work performed, and any problems encountered during the period.

6.3 Confirmation Notices

During project activities, FEC will record all discussions, verbal directions, and telephone conversations related to the sampling effort. The confirmation notices will be submitted weekly to the USACE TM.

6.4 Sample Quality Control Summary Report

At the conclusion of the sampling phase, FEC will submit a draft and draft final sample quality control summary report (SQCSR) that details the QA/QC findings relative to sample collection procedures and analytical operations. The SQCSR will contain a discussion of data validity and usability based on the results of QC analyses.

6.5 QAPP Revisions

After review of the QAPP by the USACE, modifications and revisions to the document will be made based on suggestions and comments provide by USACE. Once the QAPP has been approved by USACE, it will serve as a working document that contains the QA/QC objectives for the sampling effort.

7.0 QUALITY ASSURANCE AUDITS

QA audits may include both internal and external audits of field and laboratory activities. Formal audits of field activities will not be performed for this sampling effort. However, FEC will monitor field activities by following a checklist that delineates relevant field activities. FEC will document all observations and findings in the field logbook.

At Analytica, internal audits are conducted by the laboratory QA Officer and external audits are performed by various agencies to ensure that analytical systems are properly functioning.

FEC will conduct an on-site qualitative review of the various aspects of the sampling program, observing and documenting all aspects of the sampling effort. FEC will monitor and document information pertaining to:

- Field instrument calibration procedures
- Completeness of field forms, logbook entries, and other reporting requirements
- Sample custody procedures
- Field QC procedures

As a way of auditing data quality, FEC will evaluate data quality indicators. Reviewing data quality indicators (precision, accuracy, completeness, comparability) provides information necessary to characterize data quality. Specifically, this type of review addresses:

- Adequacy of data recording and transfer
- Precision and bias of resultant data
- Adequacy of data calculation, generation, and processing
- Documentation of procedures
- Identification of data quality indicators to inform users of data limitations and applicability

TABLES

Table 3-1. Method Reporting Limits - Analytica, Inc. SW-846 8260A - Volatile Organic Compounds

Analyte	Reporting Limit	Units
Dichlorodifluoromethane	10	µg/L
Chloromethane	10	µg/L
Vinyl Chloride	2.0	µg/L
Bromomethane	10	µg/L
Chloroethane	10	µg/L
Trichlorofluoromethane	10	µg/L
1,1-Dichloroethene	5.0	µg/L
Trichlorotrifluoroethane	3.0	µg/L
Methylene Chloride	10	µg/L
trans-1,2-Dichloroethene	3.0	µg/L
1,1-Dichloroethane	5.0	µg/L
2,2-Dichloropropane	5.0	µg/L
cis-1,2-Dichloroethene	3.0	µg/L
Bromochloromethane	5.0	µg/L
Chloroform	3.0	µg/L
1,1,1-Trichloroethane	5.0	µg/L
Carbon Tetrachloride	10	µg/L
1,1-Dichloropropene	5.0	µg/L
Benzene	1.0	µg/L
1,2-Dichloroethane	5.0	µg/L
Trichloroethene	3.0	µg/L
1,2-Dichloropropane	3.0	µg/L
Dibromomethane	3.0	µg/L
Bromodichloromethane	3.0	µg/L
cis-1,3-Dichloropropene	3.0	µg/L
Toluene	1.0	µg/L
trans-1,3-Dichloropropene	5.0	µg/L
1,1,2-Trichloroethane	3.0	µg/L
Tetrachloroethene	3.0	µg/L
1,3-Dichloropropane	3.0	µg/L
Dibromochloromethane	3.0	µg/L
1,2-Dibromoethane	3.0	µg/L
Chlorobenzene	3.0	µg/L
Ethylbenzene	1.0	µg/L
1,1,1,2-Tetrachloroethane	3.0	µg/L
m,p-Xylenes	1.0	µg/L
o-Xylene	1.0	µg/L
Styrene	3.0	µg/L

Table 3-1. Method Reporting Limits - Analytica, Inc. SW-846 8260A - Volatile Organic Compounds (continued)

Analyte	Reporting Limit	Units
Bromoform	5.0	µg/L
Isopropylbenzene	2.0	µg/L
Bromobenzene	3.0	µg/L
n-Propylbenzene	5.0	µg/L
1,1,2,2-Tetrachloroethane	5.0	µg/L
1,2,3-Trichloropropane	3.0	µg/L
2-Chlorotoluene	1.0	µg/L
1,3,5-Trimethylbenzene	5.0	µg/L
4-Chlorotoluene	1.0	µg/L
tert-Butylbenzene	5.0	µg/L
1,2,4-Trimethylbenzene	5.0	µg/L
sec-Butylbenzene	5.0	µg/L
4-Isopropyltoluene	5.0	µg/L
1,3-Dichlorobenzene	2.0	µg/L
1,4-Dichlorobenzene	2.0	µg/L
n-Butylbenzene	5.0	µg/L
1,2-Dichlorobenzene	5.0	µg/L
1,2-Dibromo-3-chloropropan	10	µg/L
1,2,4-Trichlorobenzene	5.0	µg/L
Hexachlorobutadiene	5.0	µg/L
Napthalene	5.0	µg/L
1,2,3-Trichlorobenzene	5.0	µg/L
Acetone	50	µg/L
Acrylonitrile	10	µg/L
2-Butanone	50	µg/L
Carbon Disulfide	5.0	µg/L
trans-1,4-Dichloro-2-buten	10	µg/L
2-Chloroethyl Vinyl Ether	10	µg/L
2-Hexanone	20	µg/L
Iodomethane	5.0	µg/L
4-Methyl-2-pentanone	20	µg/L
Vinyl Acetate	5.0	µg/L
tert-Butyl methyl ether	5.0	µg/L
1,2-Dichloroethane-d4	5.0	µg/L
Toluene d-8	5.0	µg/L
p-Bromofluorobenzene	5.0	µg/L

Table 3-2. Method Reporting Limits - Analytica, Inc. SW-846 8270B - Semivolatile Organic Compounds

Analyte	Reporting Limit	Units
Phenol	10	µg/L
bis(2-Chloroethyl) ether	10	µg/L
2-Chlorophenol	10	µg/L
1,3-Dichlorobenzene	10	µg/L
1,4-Dichlorobenzene	10	µg/L
Benzyl alcohol	20	µg/L
1,2-Dichlorobenzene	10	µg/L
2-Methylphenol	10	µg/L
bis(2-Chloroisopropyl) eth	10	µg/L
4-Methylphenol	10	µg/L
n-Nitroso-di-n-propylamine	10	µg/L
Hexachloroethane	10	µg/L
Nitrobenzene	10	µg/L
Isophorone	10	µg/L
2-Nitrophenol	10	µg/L
2,4-Dimethylphenol	10	µg/L
Benzoic acid	50	µg/L
bis(2-Chloroethoxy)methane	10	µg/L
2,4-Dichlorophenol	10	µg/L
1,2,4-Trichlorobenzene	10	µg/L
Naphthalene	10	µg/L
4-Chloroaniline	10	µg/L
Hexachlorobutadiene	10	µg/L
4-Chloro-3-methylphenol	10	µg/L
2-Methylnaphthalene	10	µg/L
Hexachlorocyclopentadiene	10	µg/L
2,4,6-Trichlorophenol	10	µg/L
2,4,5-Trichlorophenol	50	µg/L
2-Chloronaphthalene	10	µg/L
2-Nitroaniline	50	µg/L
Dimethylphthalate	10	µg/L
Acenaphthylene	10	µg/L
3-Nitroaniline	50	µg/L
Acenaphthene	10	µg/L
2,4-Dinitrophenol	50	µg/L
4-Nitrophenol	50	µg/L
Dibenzofuran	10	µg/L
2,6-Dinitrotoluene	10	µg/L
2,4-Dinitrotoluene	10	µg/L
Diethylphthalate	10	µg/L

Table 3-2. Method Reporting Limits - Analytica, Inc. Sw-846 8270B - Semivolatile Organic Compounds (continued)

Analyte	Reporting Limit	Units
4-Chlorophenyl-phenylether	10	µg/L
Fluorene	10	µg/L
4-Nitroaniline	10	µg/L
4,6-Dinitro-2-methylphenol	50	µg/L
n-Nitrosodiphenylamine	10	µg/L
4-Bromophenyl-phenylether	10	µg/L
Hexachlorobenzene	10	µg/L
Pentachlorophenol	50	µg/L
Phenanthrene	10	µg/L
Anthracene	10	µg/L
Di-n-butylphthalate	10	µg/L
Fluoranthene	10	µg/L
Pyrene	10	µg/L
Butylbenzylphthalate	10	µg/L
3,3'-Dichlorobenzidine	20	µg/L
Benzo(a)Anthracene	10	µg/L
Chrysene	10	µg/L
Bis(2-Ethylhexyl)phthalate	10	µg/L
Di-n-octylphthalate	10	µg/L
Benzo(b)fluoranthene	10	µg/L
Benzo(k)fluoranthene	10	µg/L
Benzo(a)pyrene	10	µg/L
Indeno(1,2,3-cd)pyrene	10	µg/L
Dibenz(a,h)anthracene	10	µg/L
Benzo(g,h,i)perylene	10	µg/L

Table 3-3. Method Reporting Limits - Analytica, Inc. SW-846 6010A - Metals

Analyte	Reporting Limit	Units
Aluminum	0.050	mg/L
Antimony	0.050	mg/L
Arsenic	0.050	mg/L
Barium	0.01	mg/L
Beryllium	0.001	mg/L
Boron	0.05	mg/L
Cadmium	0.005	mg/L
Calcium	0.10	mg/L
Chromium	0.01	mg/L
Cobalt	0.010	mg/L
Copper	0.010	mg/L
Iron	0.05	mg/L
Lead	0.05	mg/L
Magnesium	0.10	mg/L
Manganese	0.01	mg/L
Molybdenum	0.005	mg/L
Nickel	0.010	mg/L
Potassium	1.0	mg/L
Selenium	0.10	mg/L
Silicon	0.50	mg/L
Silver	0.005	mg/L
Sodium	3.0	mg/L
Strontium	0.05	mg/L
Tin	0.05	mg/L
Titanium	0.05	mg/L
Vanadium	0.010	mg/L
Zinc	0.010	mg/L
Thallium	0.10	mg/L

Table 3-4. Method Reporting Limits - Analytica, Inc. SW-846 7000-Series - Metals

Analyte	Reporting Limit	Units
Arsenic	0.002	mg/L
Lead	0.001	mg/L
Mercury (Cold Vapor)	0.0002	mg/L
Selenium	0.002	mg/L
Thallium	0.001	mg/L

Table 3-5. Method Reporting Limits - Analytica, Inc. SW-846 8080A - Pesticides/PCBs

Analyte	Reporting Limit	Units
Aldrin	0.050	µg/L
alpha-BHC	0.050	µg/L
beta-BHC	0.050	µg/L
delta-BHC	0.050	µg/L
gamma-BHC (Lindane)	0.050	µg/L
alpha-Chlordane	0.050	µg/L
gamma-Chlordane	0.050	µg/L
4,4'-DDD	0.10	µg/L
4,4'-DDE	0.10	µg/L
4,4'-DDT	0.10	µg/L
Dieldrin	0.10	µg/L
Endosulfan I	0.050	µg/L
Endosulfan II	0.10	µg/L
Endosulfan Sulfate	0.10	µg/L
Endrin	0.10	µg/L
Endrin Aldehyde	0.10	µg/L
Heptachlor	0.050	µg/L
Heptachlor Epoxide	0.050	µg/L
4,4'-Methoxychlor	0.50	µg/L
Toxaphene	5.0	µg/L
Aroclor-1016	1.0	µg/L
Aroclor-1221	2.0	µg/L
Aroclor-1232	1.0	µg/L
Aroclor-1242	1.0	µg/L
Aroclor-1248	1.0	µg/L
Aroclor-1254	1.0	µg/L
Aroclor-1260	1.0	µg/L

Table 3-6. Method Reporting Limits - Analytica, Inc. SW-846 8150B - Herbicides

Analyte	Reporting Limit	Units
2,4-D	4.0	µg/L
2,4-DB	4.0	µg/L
2,4,5-T	0.40	µg/L
Silvex (2,4,5-TP)	0.40	µg/L
Dalapon	10	µg/L
Dicamba	0.40	µg/L
Dichlorprop	4.0	µg/L
Dinoseb	2.0	µg/L
MCPA	500	µg/L
MCPP	500	µg/L

Table 3-7. Quality Control Acceptance Limits - Analytica, Inc. SW-846 8260A - Volatile Organic Compounds

Analyte	Control Limits Percent	Type
1,2-Dichloroethane-d4	80 - 120	SS
Toluene d-8	88 - 110	SS
p-Bromofluorobenzene	86 - 115	SS
1,1-Dichloroethene	61 - 145	MS
Benzene	76 - 127	MS
Trichloroethene	71 - 120	MS
Toluene	76 - 125	MS
Chlorobenzene	75 - 130	MS

MS = Matrix spike
SS = Surrogate Spike

Table 3-8. Quality Control Acceptance Limits - Analytica, Inc. SW-846 8270B - Semivolatile Organic Compounds

Analyte	Control Limits Percent	Type
2-Fluorophenol	21 - 100	SS
d5-Phenol	10 - 94	SS
d5-Nitrobenzene	35 - 114	SS
2-Fluorobiphenyl	43 - 116	SS
2,4,6-Tribromophenol	10 - 123	SS
d14-Terphenyl	33 - 141	SS
Phenol	12 - 89	MS
2-Chlorophenol	27 - 123	MS
1,4-Dichlorobenzene	36 - 97	MS
n-Nitroso-di-n-propylamine	41 - 116	MS
1,2,4-Trichlorobenzene	39 - 98	MS
4-Chloro-3-methylphenol	23 - 97	MS
Acenaphthene	46 - 118	MS
4-Nitrophenol	10 - 80	MS
2,4-Dinitrotoluene	24 - 96	MS
Pentachlorophenol	9 - 103	MS
Pyrene	26 - 127	MS

MS = Matrix spike
SS = Surrogate Spike

Table 3-9. Quality Control Acceptance Limits - Analytica, Inc. SW-846 8080A - Pesticides/PCBs

Analyte	Control Limits Percent	Type
Decachlorobiphenyl	21 - 105	SS
Tetrachloro-m-Xylene	33 - 105	SS
Aldrin	40 - 120	MS
gamma-BHC (Lindane)	56 - 123	MS
4,4'-DDT	38 - 127	MS
Dieldrin	52 - 126	MS
Endrin	56 - 121	MS
Heptachlor	40 - 131	MS

MS = Matrix spike
SS = Surrogate Spike

Table 3-10. Quality Control Acceptance Limits - Analytica, Inc. SW-846 8150B - Herbicides

Analyte	Control Limits Percent	Type
DCPAA	20 - 100	SS
2,4-D	20 - 100	MS
2,4-DB	20 - 100	MS
2,4,5-T	20 - 100	MS
Silvex (2,4,5-TP)	20 - 100	MS
Dalapon	20 - 100	MS
Dicamba	20 - 100	MS
Dichlorprop	20 - 100	MS
Dinoseb	20 - 100	MS
MCPA	20 - 100	MS
MCPP	20 - 100	MS

MS = Matrix spike
SS = Surrogate Spike

Table 3-11. Quality Control Acceptance Limits - Analytica, Inc. SW-846 6010A - Metals

Analyte	Control Limits percent
Aluminum	20 - 120
Antimony	20 - 120
Arsenic	20 - 120
Barium	20 - 120
Beryllium	20 - 120
Boron	20 - 120
Cadmium	20 - 120
Calcium	20 - 120
Chromium	20 - 120
Cobalt	20 - 120
Copper	20 - 120
Iron	20 - 120
Lead	20 - 120
Magnesium	20 - 120
Manganese	20 - 120
Molybdenum	20 - 120
Nickel	20 - 120
Potassium	20 - 120
Selenium	20 - 120
Silicon	20 - 120
Silver	20 - 120
Sodium	20 - 120
Strontium	20 - 120
Tin	20 - 120
Titanium	20 - 120
Vanadium	20 - 120
Zinc	20 - 120
Thallium	20 - 120

MS = Matrix spike
SS = Surrogate Spike

Table 3-12. Quality Control Acceptance Limits SW-846 6010A - Metals

Analyte	Control Limits percent
Arsenic	80 - 120
Lead	80 - 120
Mercury (Cold Vapor)	80 - 120
Selenium	80 - 120
Thallium	80 - 120

MS = Matrix spike
SS = Surrogate Spike

Table 5-1. Analytical Methods

Parameter	SW-846 Method
VOCs	8260A
SVOCs	8270B
Chlorinated Herbicides	8150B
Pesticides/PCBs	8080A
Dissolved TAL Metals	6010A/7000-series
Total TAL Metals	6010A/7000-series
Total Lead	7421
Dissolved Lead	7421

Table 5-2. Summary of Calibration Procedures

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SW-846:6010A	Metals (ICPES)	Mixed Calibration Standards (2 Concentrations)	Daily, and 10 percent	Measured value ± 10 percent of true value for element of interest	1) Repeat calibration
SW-846:7060 SW-846:7421 SW-846:7471 SW-846:7740 SW-846:7841	Metals: Arsenic (AA) Lead Mercury Selenium Thallium	Multipoint calibration (minimum of three concentrations)	Daily prior to analyses	r^3 0.995	1) Repeat test 2) Take corrective action 3) Repeat calibration and test
		Calibration Blank	10 percent, or minimum of one per batch	<MRL	1) Clean system 2) Reanalyze
SW-846:8260A	Volatile Organic Compounds	Check of Mass Spectral Ion Intensities Using BFB	Daily prior to sample analyses or every 12 hours	Refer to Method 8260 Table 4	1) Retune instrument 2) Repeat BFB analyses
		Multipoint Calibration (5-point calibration at 20-200 ppb range)	Initial calibration and as required by calibration check	RSD<30 percent for average RF for CCCs and all SPCCs meet minimum RF criteria	1) Repeat calibration
		System Performance Check Compounds (SPCC) Calibration Check Compounds (CCC)	Every 12 hours	Minimum RF Criteria for SPCCs percent Difference <25 percent for CCCs	1) Evaluate system 2) Repeat test 3) Recalibrate if repeat fails
SW-846:8270B	Semi-volatile Organic Compounds	Check of Mass Spectral Ion Intensities Using DFTPP	Daily and prior to sample analysis in every 12 hr. period	Refer to Method 8270 Table 3	1) Retune instrument 2) Repeat DFTPP analysis
		5-Point Calibration at 20-160 ppb Range	Initial and as required by daily check.	RF variability for specific CCC compounds <30 percent RSD	Repeat calibration
	Semi-volatile Organic Compounds	Calibration Verification for Calibration Check Compounds (CCC)	Every 12 hours	Single-point RF for each CCC within 30 percent of average multipoint RF	1) Evaluate system 2) Correct problems 3) Repeat test 4) Recalibrate if fails
		System Performance Check Compounds (SPCC)	Every 12 hours	RF > 0.05 for all SPCCs	1) Evaluate system 2) Correct problems 3) Repeat test 4) Recalibrate if fails

Table 5-2. Summary of Calibration Procedures (continued)

Analytical Method	Parameter	Quality Control Check	Frequency	Acceptance Criteria	Corrective Action
SW-846:8080A	Organochlorine Pesticides and PCBs	Check Endrin & DDT Degradation	Daily prior to sample analysis	Degradation must be <20 percent,Refer to Method 8080 section 7.4.5	1) Retune instrument 2) Repeat DFTPP analysis
		5-Point Calibration	Initial and as required by daily check.	RSD for all RFs must be <20 percent if mean RF used for quant.	1) Repeat calibration or use a calibration curve for quant.
		Continuing Calibration Verification (CCV)	Daily and at 10 percent of all client sample	CCV recoveries must be within 15 percent of the predicted response	1) Evaluate system 2) Correct problems 3) Repeat test 4) Recalibrate if fails
SW-846:8150A	Chlorinated Herbicides	5-Point Calibration	Initial and as required by daily check	RSD for all RFs must be <20 percent if mean RF used for quant.	1) Repeat calibration or use a calibration curve for quant.
		Initial Calibration Verification (ICV)	After initial calibration	ICV recoveries must be within 15 percent of the predicted response	1) Repeat calibration verification 2) Recalibrate if ICV fails
		Continuing Calibration Verification (CCV)	Daily prior to sample analysis and at 10 percent of client samples	CCV recoveries must be within 15 percent of the predicted response	1) Evaluate system 2) Correct problems 3) Repeat test 4) Recalibrate if fails

AA = Atomic Absorption
BFB = 4-Bromofluorobenzene
BTEX = Benzene, Toluene, Ethylbenzene, and Xylenes
CCC = Calibration Check Compound
CCV = Continuing Calibration Verification
CPES = Inductively Emission Spectroscopy Coupled Plasma
DFTPP = Decafluorotriphenylphosphine
DPT = Dichloro-diphenyl-trichloroethane
EPA = Environmental Protection Agency
MRL = Method Reporting Limit
PPB = Parts per Billion
RF = Response Factor
RL = Reporting Limit
RPD = Relative percent Difference
RSD = Relative Standard Deviation
SOP = Standard Operating Procedure
SPCC = System Performance Check Compound
SW = Solid Waste

FINAL

SITE SAFETY AND HEALTH PLAN ADDENDUM

LONG TERM GROUNDWATER MONITORING PROGRAM

HOLLOMAN AIR FORCE BASE, NEW MEXICO

Prepared for:

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July 1997

SITE SAFETY AND HEALTH PLAN ADDENDUM
HOLLOMAN AIR FORCE BASE, NEW MEXICO

July 1997

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SITE SAFETY AND HEALTH PLAN AGREEMENT FORM

I have read, understood and agreed with the information set forth in this Health and Safety Plan (and attachments) and discussed in the Personnel Health and Safety briefing.

Name (print)	Signature	Organization	Date

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LIST OF ATTACHMENTS

Attachment

A Field Standard Operating Procedures

LIST OF ACRONYMS/ABBREVIATIONS

μg/L	Micrograms Per Liter
AFB	Air Force Base
AVGAS	Aviation Gasoline
bgs	Below Ground Surface
DCA	1,2-Dichloroethane
EPA	United States Environmental Protection Agency
FEC	Foothill Engineering Consultants, Inc.
FSP	Field Sampling Plan
JP-4	Jet Propellant 4
LTM	Long-Term Monitoring
NMED	New Mexico Environmental Department
PA/SI	Preliminary Assessment/Site Investigation
PCB	Polychlorinated Biphenyl
POL	Petroleum, Oils, Lubricants
ppb	Parts Per Billion
ppm	Parts Per Million
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SOP	Standard Operating Procedure
SSHP	Site Safety and Health Plan
SSO	Site Safety Officer
SVE	Soil Vapor Extraction
SVOC	Semivolatile Organic Compound
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

This document will constitute an Addendum to the Site Safety and Health Plan (SSHP) developed for the Long-Term Groundwater Monitoring Program at Holloman Air Force Base (AFB), New Mexico developed by Ebasco Services and Groundwater Technology Government Services in July 1995. As such, only sections of the 1995 SSHP which require revision to incorporate changes to the scope of work covered during this investigation will be included in this Addendum. Sections which are not included in this Addendum have not been changed from the 1995 SSHP, and the contents of those sections may be found in the 1995 SSHP. Foothill Engineering Consultants, Inc. (FEC) field personnel will use both this Addendum and a copy of the 1995 SSHP while performing site activities under this investigation.

1.1 Modifications to the 1995 SSHP

References to Groundwater Technology and/or Ebasco Services found in the 1995 SSHP will be replaced with references to FEC. Additional, section-specific modifications are given below, according to section number, table number, or page number.

The scope of work for this project includes the installation of four groundwater monitoring wells. Health and safety-related information for groundwater monitoring well installation (such as drilling hazards, mitigation of drilling hazards, and personal protective equipment requirements) will be discussed in an additional section, Section 18.0, which is included in this Addendum.

1.2 Modifications to Section 1.0 of the 1995 SSHP

Subsection 1.1, page 1-1. FEC will perform environmental services for the United States Army Corps of Engineers, Omaha District, Contract Number DACW45-94-D-0031. The purpose of this SSHP Addendum is to provide FEC field personnel and other visitors with an understanding of the potential chemical, physical, and related hazards that exist or may arise while the groundwater sampling and monitoring well installation tasks are being performed.

Table 1-1 has been modified as shown below.

TABLE 1-1. OVERVIEW OF PROJECT SCOPE, HAZARDS AND LEVELS OF PROTECTION

Scope	Collection of Groundwater Samples and Groundwater Monitoring Well Installation
HAZARD SUMMARY • Chemical • Physical • Biological • Other (Radiological, etc.)	 Low (Volatile and Semivolatile Organic Compounds, Pesticides/Herbicides, Fuels, Metals, and Polychlorinated Biphenyls in groundwater) Moderate (drilling) to none Moderate (cactus spines, insects, and rattlesnakes) None anticipated
LEVELS OF PROTECTION	Level D/Level C Upgrade Contingency
CLIENT OR OWNER	United States Army Corps of Engineers, Omaha District
SITE NAME	LF-01, SD-08, LF-10, LF-19, LF-21, LF-22, LF-23, LF-29, DP-30/SD-33, OT-16, OT-44, SS-02/SS-05, SS-17, SS-39, SS-46, SS-48, SS-56, Holloman AFB. At SS-46, three of the four wells to be sampled will be installed and developed prior to sampling. At SS-56, one of the four wells to be sampled will be installed and developed prior to sampling.
SITE ADDRESS	Holloman AFB, New Mexico
PROJECT NUMBER	96-332
PROJECT MANAGER	Mark Bergman
DATE(S) OF WORK	August-September 1997
SITE SIZE	Seventeen sites within approximately 10 square miles
SITE TOPOGRAPHY	Relatively flat
SITE WEATHER	Mostly sunny, temperature in the high 70s to low 100s (late summer)
SITE DESCRIPTION/HISTORY	Holloman AFB is located in south-central New Mexico, approximately five miles southwest of the city of Alamogordo. FEC has been contracted to collect groundwater samples at 18 sites, and install and develop groundwater monitoring wells at two of the above-listed sites.

Subsection 1.3, page 1-3. The scope of work under this investigation consists of groundwater sampling at the original 11 sites, and drilling, installing, developing, and sampling four new groundwater monitoring wells at two site locations (SS-46 & SS-56). Groundwater will be sampled from existing wells at an additional five sites (LF-29, OT-16, SS-02 & 05, SS-17, and SS-39).

Subsection 1.4. Site information for the additional five sites not previously discussed in the 1995 SSHP, and for SS-56, is given below.

1.4.13 SS-02 & SS-05

These two petroleum, oil, and lubricant (POL) sites are located within the POL compound in the eastern portion of the main base area. Figure 3-13 of the Field Sampling Plan (FSP) is a map of the site with monitoring well locations. The two sites are being remediated together, and for the purpose of this project are considered one site. From the early 1960s to the late 1970s, the former 25,000 gallon fuel tanks were periodically over-filled at Site SS-02. JP-4 and aviation gasoline (AVGAS) spills occurred throughout the unlined bermed area. The amount of fuel spilled is unknown. The tanks were removed in 1987, but the saddle tanks were left in place and covered with soil.

At Site SS-05 approximately 30,000 gallons of JP-4 fuel was spilled in 1978 when a drain valve for a 4-inch fuel line was accidentally left open. The fuel line was used for filling the former 25,000 gallon tanks with JP-4 fuel. Interviews with POL personnel indicated the 30,000 gallon spill accumulated primarily in the southeast corner of the former unlined bermed area with fuel draining through the berm drain valve to a low spot southeast of the berm. Base personnel also indicated that approximately 28,500 gallons of fuel was recovered, with the remaining fuel seeping into the gravel base of the POL storage area. An estimated 1,500 gallons was released and no interim remedial action was performed.

The preliminary assessment/site investigation (PA/SI) for site SS-05 was completed in 1988. The remedial investigation (RI) was completed in June 1992. Sixteen soil borings were drilled and eight monitoring wells were installed during the RI. Total petroleum hydrocarbon (TPH) values up to 17,500 parts per million (ppm) were detected in soil obtained from the soil borings. Benzene was detected in the soil at maximum concentrations of 48 ppm. Benzene was also detected in groundwater samples, with a maximum concentration of 2.9 ppm. A soil vapor extraction (SVE) system was constructed

and became operational in April 1995. As of March 1996, the SVE has removed an estimated 17,000 pounds of TPH. The system is scheduled to run through 1998. The primary risk driver for this site is the connection between the contaminated non-potable groundwater and the adjacent arroyo which has been designated as a Water of the United States.

A Decision Document was signed in September 1995 by the installation commander and NMED, conditionally closing SS-02 & SS-05 based on contaminant level reduction to 1,000 ppm TPH through the operation of the SVE system. In addition, United States Environmental Protection Agency (EPA) Region VI requires that SS-02 & SS-05 undergo long-term monitoring (LTM) for a period of ten years to ensure that no further migration of contaminants is occurring. The document describes past site use, current conditions, and investigation results, and provides recommendations for LTM.

During site investigations, eight groundwater monitoring wells were installed at the site. All wells are operable and accessible for groundwater sampling. LTM will be performed on four of the eight monitoring wells at the site. The wells to be sampled will include MW-02 & 05-03, MW-02 & 05-05, MW-02 & 05-06 and MW-02 & 05-08. The wells will be sampled and analyzed for volatile organic compounds (VOCs) and field parameters of pH, temperature and specific conductivity.

1.4.14 SS-46

SS-46 is a 25,000 gallon JP-4 underground waste fuel tank which was installed in 1978 without containment. The tank is located on the southeast side of Taxiway 4 (Figure 3-14 of the FSP). There are no permanent structures at Site SS-46. The entire site is covered by a concrete hardstand. Waste fuel was stored in the tank and analyzed by the fuels laboratory at the base for eventual disposition. An RI was conducted at the site in 1988, which included the installation of four monitoring wells. TPH, benzene, chlorobenzene and toluene were detected in groundwater samples. A baseline risk assessment conducted at the site determined that the site posed no threat and a site closeout/no further action was recommended. The tank was taken out of service in 1989 and was removed as part of a 1995 tank removal project coordinated by the base. During the tank removal and building construction, the four monitoring wells were removed.

A Decision Document was signed by the installation commander in September of 1991. The NMED has agreed to sign the Decision Document if periodic groundwater monitoring was initiated. The document describes past site use, current conditions, and investigation results, and provides recommendations for LTM.

During this investigation, three groundwater monitoring wells will be installed, developed and sampled. All wells will be operable and accessible for groundwater sampling. LTM sampling will be conducted on MW-46-01, MW-46-02 and MW-46-03. The groundwater samples will be analyzed for total and dissolved lead, VOCs, and TPH. Field parameters of pH, temperature and specific conductivity will be obtained.

1.4.15 OT-16

The site is located at Building 21 at the southeastern portion of the main base area (Figure 3-15 of the FSP). Rinse water from washing of pesticide mixing equipment was discharged to a septic tank leach field located in back of the building from 1977 to 1980. Diesel fuel, used to solubilize pesticides, may also have been discharged to this leach field. From 1980 to 1988, rinse water was discharged into a pit/boring on the northwest side of the building. A pesticide holding tank is located on the southwest side of Building 21; however, spills were not reported or documented at the tank.

A PA/SI conducted in 1983 identified this site as a potential source of pesticide and fuel contamination. The Phase I RI was completed in 1992. 4,4-DDT (12.0 ppm), alpha-BHC (0.2 ppm), delta-BHC (6.5 ppm) and methyl parathion (1.5 ppm) were detected in the surface soils, indicating that a release had occurred. Several pesticides, including DDD (10 ppm), DDE (6.1 ppm), DDT (36 ppm), aldrin (1.7 ppm), chlordane (34 ppm), heptachlor (770 ppm), and gamma-BHC (2.8 ppm) were detected. Organochlorine pesticides and VOCs detected in all four monitoring wells included benzene (0.0023 ppm), dieldrin (1.5 ppm), trichloroethene (4.2 ppm), alpha-BHC (1.5 ppm), and gamma-BHC (1 ppm). The investigation to delineate soil and groundwater contamination detected the polychlorinated biphenyl (PCB) 1260 at 639 ppm, TPH (10,300 ppm) and heptachlor epoxide (386 ppm) in soils and heptachlor epoxide (0.315 ppm) and gamma-BHC (0.372 ppm) in groundwater. The RI concluded that no action is necessary to protect human health and the environment.

A Decision Document is anticipated to be signed by September 1997 conditionally closing the site based on attainment of less than 1,000 ppm TPH in the soils at OT-16 through the excavation and removal of contaminated soils. Although PCB levels at OT-16 do not pose a risk to human health or the environment, PCB-contaminated soil were removed concurrently with TPH-contaminated soils in 1997. In addition, EPA Region VI requires that OT-16 undergo LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

During site investigations, four groundwater monitoring wells (118-MW1601, 118-MW1602, 118-MW1603, and 118-MW1604) were installed at the site. All wells are operable and accessible for groundwater sampling. LTM will be performed on the four monitoring wells at the site. The wells will be sampled and analyzed for VOCs, organochlorine pesticides; and field parameters of pH, temperature and specific conductivity.

1.4.16 SS-17

The site is located on First Street in the main portion of the Base and approximately 2,500 feet from the main gate (Figure 3-16 of the FSP). Site SS-17 is an 8-acre site with numerous buildings, including the service station, convenience store, car wash and several residences. The service station has been in its present location since the early 1950s. The base hospital is located about 420 feet to the northeast of the service station; an elementary school is located 600 feet to the northwest of the service station; and base residential housing is located 200 feet to the southeast of the service station. The site contamination extends under adjacent properties.

Discrepancies in the gasoline storage inventories led to the discovery of leaking underground fuel lines. In 1981, test borings were drilled to assess the extent of contamination. Gasoline thicknesses up to 4 feet were found in monitoring wells. Two recovery wells were installed. An RI completed in 1984 included the installation of 15 monitoring wells and 14 test holes at SS-17. From the information obtained through the installation of the monitoring wells and test holes, it was estimated that 71,000 gallons of free-phase product (gasoline) remained. In January 1987, recovery operations resumed using three recovery wells and two recovery trenches. Changes recommended in the 1988

Technical Report were implemented in 1989, which included installing more recovery wells. These operations recovered a total of 42,000 gallons of free product at SS-17.

A remedial investigation/feasibility study was completed in 1990 and 1991. The five underground storage tanks (USTs) at the site were removed and replaced with above-ground tanks in February 1992. In July 1993, a 30-day SVE pilot test was conducted on a small area of the site. Soil samples obtained from soil borings completed prior to the pilot test contained TPH (8,340 ppm) and benzene (53.6 ppm). TPH concentrations in the subsurface soils were reduced by 48% and benzene concentrations were reduced by 70% through the SVE system. In late 1994, a leak from a pipe under a dispenser island was detected. An estimated 4,000 gallons of product was released from this leak. Construction and operation of a full scale SVE/bioremediation system began in September 1995. As of June 1997, 45,000 pounds of TPH have been removed.

A Decision Document was signed in September 1996, conditionally closing SS-17 based on attainment of less than 1,000 ppm TPH via SVE. In addition, NMED requires that SS-17 undergo LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

During the RIs, 20 groundwater monitoring wells were installed at the site. However, due to construction activities the total number of monitoring wells is now less than 20. All wells are operable and accessible for groundwater sampling. LTM will be performed on four of the wells at the site. Sampling will be conducted on W-4, TH-22, MW-BX-01 and MW-BX-02. The wells will be sampled and analyzed for VOCs and field parameters of pH, temperature and specific conductivity.

1.4.18 SS-39

The site is located approximately 3.5 miles northwest of the main Base area near Building 1176 (Figure 3-17 of the FSP). The site consists of two outfall areas located downstream from oxidizer and propellant spill drain pipes, and drainage troughs and sumps located near Building 1176. Facilities at SS-39 were used for fueling, detanking and routine maintenance of test sleds. Fuels used at the track included unsymmetrical dimethylhydrazine, aniline, JP-4, inhibited red fuming nitric acid, inhibited white fuming nitric acid, liquid oxygen, miscellaneous jet and solid rocket propellants, and dyes. Solvents, such as trichloroethane, were commonly used during sled maintenance activities.

During a PA conducted in 1983, SS-39 was identified as a source of potential soil and groundwater contamination. An RI was completed in 1992. Results of the RI indicated arsenic (28 ppm), beryllium (0.58 ppm), lead (1,300 ppm) and trichlorethene (TCE, 95 ppm) in soils and TCE (0.24 ppm), carbon tetrachloride (0.0058 ppm) and lead (0.019 ppm) in groundwater near Building 1176. A second RI, completed in 1994, delineated soil and groundwater contamination. TCE concentrations in 15 groundwater samples ranged from 2.76 ppm directly east of the site to 0.028 ppm 200 feet south of the site (downgradient). The RIs and the associated risk assessment indicated that no further action is necessary to protect human health or the environment.

A Decision Document is anticipated to be signed by September 1997 with a recommendation for LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

During the RIs, four groundwater monitoring wells were installed at SS-39. All wells are operable and accessible for groundwater sampling. LTM will be performed on the four monitoring wells. Sampling will be conducted on MW-39-01, MW-39-02, MW-39-03, and MW-39-04. The wells will be sampled for VOCs, and field parameters of pH, temperature, and specific conductivity.

1.4.19 LF-29

The site occupies approximately three acres in the North Base area and is located approximately 300 feet north of Building 1001 (Figure 3-18 of the FSP). The site is surrounded by a small (3-foot high) earthen berm that extends 400 feet north-south and 350 feet east-west.

From the early 1950s to 1975, the Army disposed of spent munitions and missiles at the site. Materials were also dumped outside the berm, roughly 200 feet south of the landfill border. These materials appear to be primarily construction debris.

During an RI, four monitor wells were installed at the site. Groundwater samples were collected and analyzed for VOCs, total metals, organophosphorus pesticides, organochlorine pesticides, polychlorinated biphenyls (PCBs), explosives, chlorinated herbicides, anions, and total dissolved solids. The only VOC detected was chloroform, which was detected in groundwater samples from monitoring wells MW-29-03 (22 μg/L)

and MW-29-04 (5 μg/L). 4,4'-DDD was detected at a concentration of 0.028 μg/L in monitoring well MW-29-03. With the exception of lead, all inorganic compounds were detected within the range of concentrations present in base-wide upgradient monitoring wells. Lead was detected at a concentration of 2 μg/L in monitoring well MW-29-02.

A quantitative risk assessment was conducted for LF-29 as part of the RI. It concluded that the site does not pose an unacceptable risk to human health or the environment; however, EPA Region IV requested more characterization be carried out.

During a Phase II RFI, three monitoring wells were installed downgradient and one well was installed upgradient of the site to provide adequate flow path coverage. No inorganic compounds were detected above background ranges in the groundwater samples obtained from these three wells. Delta-BHC concentrations were detected below the reporting limit in the monitoring wells. Several other organochlorine pesticide and chlorinated herbicides were detected below reporting limits in monitoring well MW-29-05.

Chloroform was detected in five out of seven groundwater samples, but was not detected in the associated method blanks. With the exception of the sample from monitoring well MW-29-03, all concentrations were below reporting limits. From the time of the RI in 1991 to the Phase II RFI in 1994, the chloroform concentration detected in monitor well MW-29-03 decreased from 22 to 11 μg/L. 1,2-Dichloroethane (DCA) concentrations (ranging from 0.82 to 9.3 μg/L) were detected in groundwater samples from three monitoring wells (MW-29-02, MW-29-06, and MW-29-08) downgradient of the site. However, a DCA concentration of 350 μg/L was measured in the groundwater sample obtained from upgradient monitoring well MW-29-05. With the exception of the upgradient well MW-29-05, benzene concentrations were detected below the reporting limit in each monitoring well. A benzene concentration of 3,100 μg/L was detected in monitoring well MW-29-05.

The site was approved for NFA by NMED in June 1997, however, NMED is recommending LTM for a period of ten years to ensure that no further migration of contaminants is occurring.

During the RI, eight groundwater monitoring wells (MW-29-01 through MW-29-08) were installed at the Landfill. All wells are operable and accessible for groundwater sampling. LTM will be performed on four of the monitoring wells. Sampling will be conducted on

MW-29-02, 06, 07, and 08. The wells will be sampled and analyzed for VOCs, SVOCs, and field parameters of pH, temperature, and specific conductivity.

1.14.20 SS-56

The West Ramp Fuel Spill Site (SS-56) is located west of the north/south runway (Figure A-1 of the FSP). The west ramp is a concrete pad approximately 2,100 feet by 600 feet that was formerly used for parking and maintenance of airplanes. During 1991, a subsurface investigation was conducted at the site to evaluate possible subsurface fuel contamination associated with past practices and fuel spills. No specific details were provided concerning the historical spill on the ramp. The field investigation consisted of installing and sampling six monitoring wells (WCC-1 through WCC-6) and drilling and sampling 14 borings or test holes (TH-1 through TH-14) (Woodward-Clyde Consultants, April 1991). Groundwater was encountered at the site between 1.5 to 5 feet below grade. No water level measurements were collected after drilling, no top of casing elevations are available and, therefore, site-specific groundwater flow direction is not available at this site.

Groundwater samples were analyzed for BTEX, metals, and TPH. Results of the groundwater analyses revealed that no TPH was detected and BTEX levels were near or below the limit of quantification. Chromium and mercury were detected in two of the six water samples.

All soil samples were analyzed for same parameters as the groundwater samples. In addition, soil samples were tested using the Toxicity Characteristic Leaching Procedure (TCLP) analyses for VOCs, semivolatiles (SVOC), metals, and pesticides/herbicides. Results of the soil analyses revealed TPH concentrations greater than 100 mg/kg to 290 mg/kg were present in three of the 38 samples analyzed. Results of the metals analyses revealed lead concentrations above 150 mg/kg present in a single sample (WCC-1 at 2 feet bgs, 2,400 mg/kg). Lead was not detected when this sample was reanalyzed. All remaining analyses conducted on the soil samples (including the remaining metals, BTEX, VOCs, SVOCs, and pesticides/herbicides) indicated concentrations near or below the limit of quantification (Woodward-Clyde Consultants, April 1991). Subsequent to the investigation conducted in 1991, ten buildings were installed in the west ramp area.

A Decision Document has been prepared for the West Ramp Fuel Spill Site; however, acceptance by the NMED of this document has not yet been obtained. The scope of work

for the LTM was derived from the results of the previous investigations conducted at the site (Woodward, Clyde Consultants, April 1991).

The LTM will be conducted on three of the existing six wells. An additional well will be installed, developed, and sampled as part of the LTM tasks. The wells will be sampled for VOCs, dissolved lead, and field parameters of pH, temperature, and specific conductivity.

1.3 Modifications to Section 2.0 of the 1995 SSHP

Subsection 2.1, page 2-1. On-site personnel for FEC are:

Name	Project Title/Assigned Role	Phone Number
Claude Murray	Field Team Leader	Work: (303) 278-0622
John Wong	Site Safety and Health Officer/Competent Person	Work: (303) 278-0622
John Wong	First Aid Personnel	Work: (303) 278-0622

Other FEC project personnel are:

Name	Project Title/Assigned Role	Phone Number
Mark Bergman	Project Manager	Work: (303) 278-0622
Ralph Sansone	Project Geologist	Work: (303) 278-0622
Ian Broussard	Project Geologist	Work: (303) 278-0622

Subsection 2.2.

- All references to Groundwater Technology in this subsection are replaced with references to FEC.
- The responsibilities listed under *Site Managers and Task Supervisors* are the responsibility of FEC's Field Team Leader.

1.4 Modifications to Section 3.0 of the 1995 SSHP

Table 3-1. Information regarding the following site locations is included in addition to the information presented in Table 3-1 of the 1995 SSHP.

Table 3-1. Chemicals of Concern in Groundwater (continued)

Site	Chemicals of Concern	Maximum Concentration
SS-02/SS-05	Volatile organic compounds	2.9 ppm (benzene)
SS-46	Volatile organic compounds TPH Lead	Below NMED action levels (TPH, benzene, chlorobenzene, toluene)
OT-16	Volatile organic compounds Pesticides	0.0023 ppm (benzene) 4.2 ppm (trichloroethene) 1.5 ppm (dieldrin) 1.5 ppm (α-BHC) 1.0 ppm (γ-BHC) 0.315 ppm (heptachlor epoxide)
SS-17	Volatile organic compounds	Concentrations unknown (free product found during initial investigation)
SS-39	Volatile organic compounds Metals	0.005 ppm (carbon tetrachloride) 0.019 ppm (lead)
LF-29	Volatile organic compounds Semivolatile organic compounds Metals	5-22 ppb (chloroform) 0.028 ppb (4,4'-DDD) 0.82-350 ppb (1,2-dichloroethane) 3,100 ppb (benzene)

1.5 Modifications to Section 4.0 of the 1995 SSHP

Subsection 4.4, page 4-3. Personnel authorized to perform work during this investigation include:

1. Mark Bergman, Project Manager
2. Claude Murray, Field Team Leader
3. John Wong, SHSO/Project Scientist
4. Ralph Sansone, Project Geologist
5. Ian Broussard, Project Geologist
6. Additional FEC personnel
7. Regulatory agency personnel
8. USACE personnel
9. Holloman AFB personnel.

1.6 Modifications to Section 6.0 of the 1995 SSHP

Subsection 6.2, page 6-1. Medical/technical advisors include:

Robert Strode, CIH,
Canyon Environmental Consultants, Golden, CO 303/642-3583

Linda Burdzinski, CHMM, Environmental Scientist,
FEC, Golden, CO 303/278-0622

The Western Center
Consulting Medical Facility 303/239-6060

1.7 Modifications to Section 7.0 of the 1995 SSHP

Table 7-1. Add sites SS-02/SS-05, SS-17, SS-46, and OT-16 to the list of sites where benzene is the chemical of concern (the first non-shaded row of Table 7-1).

Modify the required action and action level for benzene as described below:

(PID Reading)	Action (Protective Equipment)
Background (BG) to 0.5 ppm	Level D
>0.5 ppm to 5 ppm above BG for more than 5 minutes	Sample ambient air with colorimetric indicator tubes specific for benzene. If benzene is not detected, assume the other compounds listed in Table 7-1 are present. Continue air-monitoring working in Level D protection. If benzene is detected at any concentration, upgrade to Level C protection. Don air purifying respirators with organic vapor cartridges.
>5 ppm to 25 ppm above BG	If benzene is not detected, assume the other compounds listed in Table 7-1 are present. Continue air-monitoring working in Level D protection. If benzene is detected at any concentration, upgrade to Level C protection. Don air purifying respirators with organic vapor cartridges.
>25 ppm to 50 ppm above BG	If benzene is not detected, upgrade to Level C protection. Don air purifying respirators with organic vapor cartridges. Level C work may continue as long as PID readings are under 50 ppm for persons wearing full face respirators.
>50 ppm above BG	Stop work immediately.

Consider the following information for site SS-39:

Chemical of concern: Carbon tetrachloride

Vapor Pressure	Ionization Potential	OSHA PEL	ACGIH TLV
91.3 mm Hg	11.47 eV	TWA = 2 ppm Ceiling = 200 ppm	TWA = 5 ppm STEL = 10 ppm

As carbon tetrachloride cannot be detected using a PID equipped with a 10.2 eV lamp, detector tubes for carbon tetrachloride will be used upon opening the well, when bailing the well, and when collecting the samples. The following actions will be taken depending upon the concentrations of carbon tetrachloride detected in the detector tube:

Detector Tube Reading	Action
1 ppm or less	Continue working
1 ppm - 2 ppm	Upgrade to Level C
2 ppm or greater	Leave area and reassess project scope

If carbon tetrachloride is not detected in the detector tubes, the actions indicated in Table 7-1 for all other areas will apply. The PID will be used in conjunction with the detector tubes.

1.8 Modifications to Section 15.0 of the 1995 SSHP

Subsection 15.2, page 15-4. The following information is given for Subsection 15.2.

Contaminants of Concern: VOCs, Semivolatile Organic Compounds, Pesticides, Metals, and TPH in Groundwater

Minimum Level of Protection: Modified Level D

Do not endanger your life. Survey the situation before taking any action.

FEC Office Telephone	(303) 278-0622
FEC Office Address	350 Indiana Street, Suite 415 Golden, CO 80401 FAX: (303) 278-0624
Telephone Located at:	Phone On-Site

IN THE EVENT OF ANY EMERGENCY,
CONTACT THE PROJECT MANAGER OR SSHO

EMERGENCY PHONE NUMBERS

Ambulance (Base): 9-911
Fire Dept. (Base): 7228
Base Hospital: 833rd Medical Group Hospital (505) 479-7171

Project Manager: Mark Bergman	(303) 278-0622
Field Team Leader: Claude Murray	(303) 278-0622
FEC Health and Safety: Linda Burdzinski	(303) 278-0622
Base POC: Warren Neff	(505) 475-5395
Poison Control:	(800) 432-6866
National Response Center:	(800) 424-8802
Chemtrec:	(800) 424-9300

Civilian Hospital: Gerald Champion Memorial Hospital (505) 439-2100

Table 15-2. Directions to the hospital from the following sites are included in addition to the information given in Table 15-2 of the 1995 SSHP. Figure 1 provides a general map to the hospital.

SS-02/SS-05. Go north out of the site and left onto Delaware Avenue. Proceed southwest on Delaware Avenue and turn left onto 1st Avenue. The hospital is approximately five blocks south on the left side of the street.

SS-46. Go south from the site to Delaware Avenue. Turn left or east onto Delaware Avenue, and turn right onto 1st Avenue. The hospital is approximately five blocks south on the left side of the street.

OT-16. Go south from the site and cross Santa Drive into the hospital entrance.

SS-17. Go east from the site across 1st Avenue into the hospital entrance.

SS-39. Go southeast from the site on the unnamed road. Continue south and loop onto Kelly Road. Go right onto 49 GR, and then right onto 1st Avenue. The hospital is approximately two blocks south on the left side of the street.

LF-29. Go west from the site onto the unpaved road and proceed south. Turn left onto the periphery road and continue east. Turn right onto Sabre Road, and proceed until the road loops into Delaware Avenue heading southwest. Turn left on 1st Avenue. The hospital is approximately five blocks south on the left side of the street.

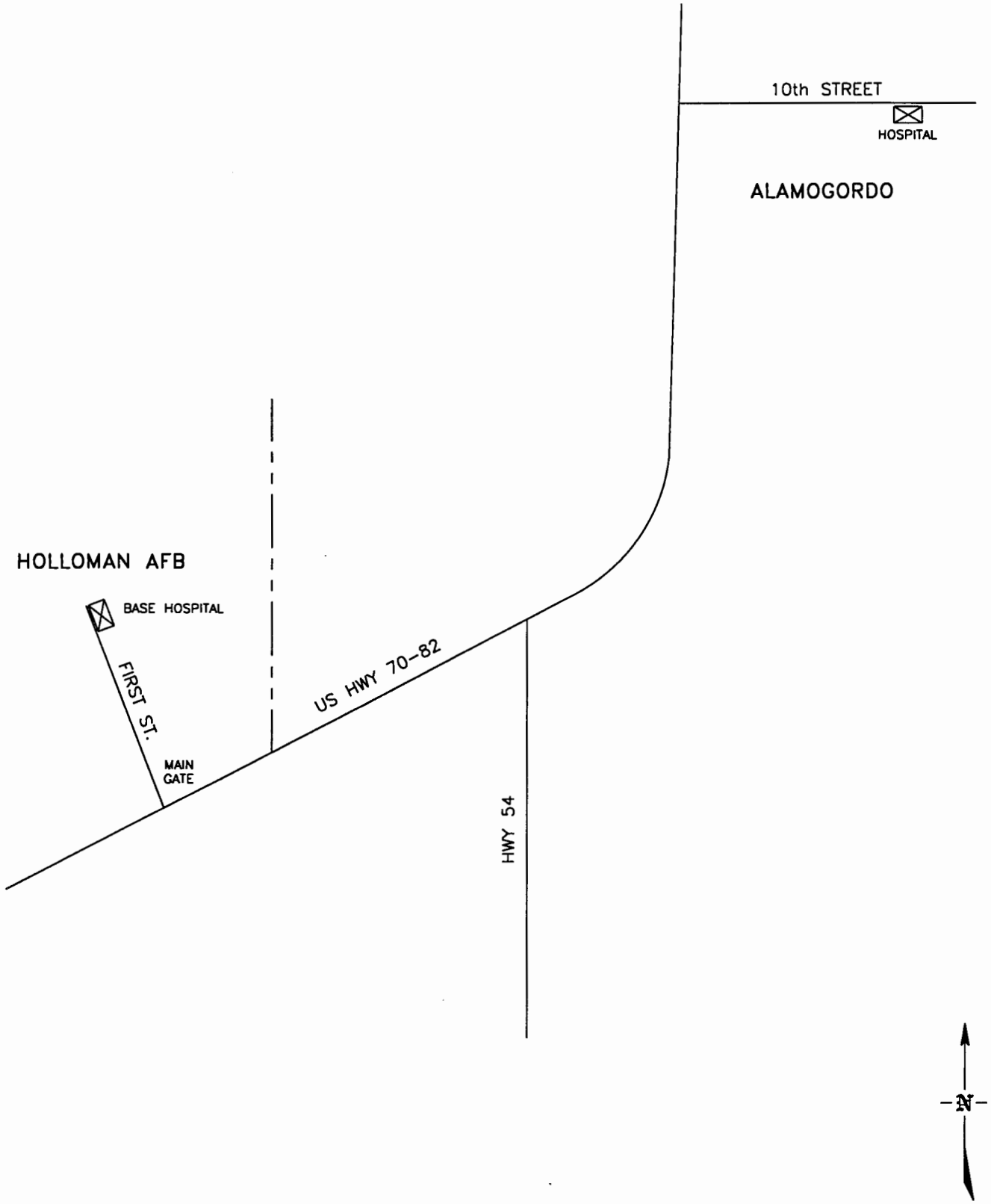

FIGURE 1 ROUTE TO BASE AND CIVILIAN HOSPITALS HOLLOMAN AIR FORCE BASE, NEW MEXICO	DATE: 7/97	SCALE: NTS	DRAWN BY: SHN

97-317\FIGURE1.DWG 7/16/97 (R13)

2.0 ADDITION OF THE NEW SECTION 18.0

Section 18.0 Drilling Safety. The scope of services for this project includes the installation of four groundwater monitoring wells, three at Site S-46 and one at Site SS-56. This section discusses the health and safety information regarding the installation and development of groundwater monitoring wells.

Hazards associated with operating a drill rig include slip, trip and fall hazards, hazards associated with using hand tools, heavy lifting hazards, and hazards associated with breakage of wire line hoists, wire rope and hoisting hardware.

These physical hazards will be addressed by the use of safe work practices and are discussed the standard operating procedure (SOP) for drilling safety provided in Attachment A. To avoid hazards associated with working around a drill rig, field personnel will use the techniques and information contained in the SOP for drilling safety.

During drilling and well development activities, only the personnel conducting the tasks and providing oversight will be allowed in the work area. The work area will be defined as a 50-foot radius around any site activities.

The work area will be delineated with flagging, and entry into this area will be controlled by the Site Safety Officer (SSO). Site visitors will check in with the SSO, who will brief them on the contents of this plan. Site visitors will not be allowed into the work areas.

The drill rig and associated drilling equipment (augers, shovels, etc.) will be decontaminated after the installation of each well and prior to installing the next well. Each operator performing decontamination activities shall wear, as a minimum, the following personnel protection equipment. Additional equipment may be required if chemical or other hazards are present.

- Hands - Nitrile gloves
- Feet - Steel-toed boots
- Eyes/Face - Face shield and/or safety glasses
- Head - Hard hat

Decontamination personnel will be instructed in the hazards associated with using high-pressure spray washers for decontamination of drilling equipment.

Work around drilling rigs entails lifting and moving heavy objects. To avoid hazards associated with improper lifting, personnel will utilize proper lifting techniques such as bending the knees, lifting by using the leg muscles, and carrying the load close to the body. Personnel will assess the load to be lifted to determine whether assistance is necessary. Additional information regarding lifting of heavy objects is found in the SOP for lifting (Attachment A).

To avoid noise hazards while operating equipment such as the drill rig, field personnel will use the techniques and information provided in the SOP for noise prevention (Attachment A). In addition, hearing protection will be donned when two people engaged in normal conversation cannot hear each other standing at a distance of three feet from each other.

ATTACHMENT A

Field Standard Operating Procedures

DRILLING SAFETY GUIDE

All local, state and federal regulations or restrictions, currently in effect take precedence over the recommendations and suggestions which follow. Government regulations will vary from country to country and state to state.

SAFETY SUPERVISOR

Every drill crew should have a designated safety supervisor. The safety supervisor should have the authority to enforce safety on the drilling site. A rig worker's first safety responsibility is to listen to the safety directions of the safety supervisor. The safety supervisor for the drill crew will in most cases be the drill rig operator.

- The safety supervisor should consider the "responsibility" for safety and the "authority" to enforce safety to be a matter of first importance.
- The safety supervisor should be the leader in using proper personal safety gear and set an example in following the rules that are being enforced on others.
- The safety supervisor should enforce the use of proper personal protective safety equipment and take appropriate corrective action when proper personal protective safety equipment is not being used.
- The safety supervisor should understand that proper maintenance of tools and equipment and general "housekeeping" on the drill rig will provide the environment to promote and enforce safety.
- Before drilling is started with a particular drill, the safety supervisor must be assured that the operator (who may be the safety supervisor) has had adequate training and is thoroughly familiar with the drill rig, its controls, and its capabilities.
- The safety supervisor should inspect the drill rig at least daily for structural damage, loose bolts and nuts, proper tension in chain drives, loose or missing guards or protective covers, fluid leaks, damaged hoses, damaged pressure gauges, or damaged pressure relief valves.
- The safety supervisor should check and test all safety devices such as emergency shut-down switches at least daily and preferably at the start of a drilling shift. Drilling should not be permitted until all emergency shut-down and warning systems are working correctly. Do not wire around, bypass, or remove an emergency device.
- The safety supervisor should check that all gauges, warning lights, and control levers are functioning properly and listen for unusual sounds on each starting of an engine.

- The safety supervisor should assure that all new drill rig workers are informed of safe operating practices on and around the drill rig and should provide each new drill rig worker with a copy of the company's drilling operations safety manual, and when appropriate, the drill rig manufacturer's operations and maintenance manual. The safety supervisor should assure that each new employee reads and understands the safety manual.
- The safety supervisor should carefully instruct a new worker in drilling safety and observe the new worker's progress towards understanding safe operating practices.
- The safety supervisor should observe the mental, emotional and physical capability of each worker to perform the assigned work in a proper and safe manner. The safety supervisor should dismiss any worker from the drill site whose mental and physical capabilities might cause injury to the worker or coworkers.
- The safety supervisor should assure that there is a first-aid kit on each drill rig and a fire extinguisher on each drill rig and on each additional vehicle and assure that they are properly maintained.
- The safety supervisor (as many crew members as possible) should be well-trained and capable of using first-aid kits, fire extinguishers, and all other safety devices and equipment.
- The safety supervisor should maintain a list of addresses and telephone numbers of emergency assistance units (ambulance services, police, hospitals, etc.) and inform other members of the drill crew of the existence and location of this list.

INDIVIDUAL PROTECTIVE EQUIPMENT

For most geotechnical, mineral, and/or groundwater drilling projects, individual protective equipment should include a safety hat, safety shoes, safety glasses and close-fitting gloves and clothing. The clothing of the individual drill rig worker is not generally considered protective equipment; however, the clothing should be close-fitting but comfortable, without loose ends, straps, draw strings or belts, or otherwise unfastened parts that might catch on some rotating component of the drill rig. Rings and jewelry should not be worn during a work shift.

- Safety Head Gear. Safety hats (hard hats) should be worn by every one working or visiting at or near a drilling site. All safety hats should meet the requirements of ANSI Z89.1. All safety hats should be kept clean and in good repair with the headband and crown straps properly adjusted for the individual drill rig worker or visitor.
- Safety Shoes or Boots. Safety shoes or boots should be worn by all drilling personnel and all visitors to the drill site that observe drilling operations within close

proximity of the drill rig. All safety shoes or boots should meet the requirements of ANSI Z4.1.1.

- Gloves. All drilling personnel should wear gloves for protection against cuts and abrasion which could occur while handling wire rope or cable and form contact with sharp edges and burrs on drill rods and other drilling or sampling tools. All gloves should be close-fitting and not have large cuffs or loose ties which can catch on rotating components 9f the drill rig.
- Safety Glasses. All drilling personnel should wear safety glasses. All safety glasses should meet the requirements of ANSI Z87.1
- Other Protective Equipment. For some drilling operation, the environment or regulations may dictate that other protective equipment be used. The requirement for such equipment must be determined jointly by the management of the drilling organization and the safety supervisor. Such equipment might include face or ear protection or reflective clothing. Each drill rig worker should wear noise-reducing ear protectors when appropriate. When drilling is performed in chemically or radiologically contaminated ground, special protective equipment and clothing may and probably will be required. The design and composition of the protective equipment and clothing should be determined as a joint effort of management and the client who requests the drilling services.

HOUSEKEEPING ON AND AROUND THE DRILL RIG

The first requirement for safe field operations is that the safety supervisor understands and fulfills the responsibility for maintenance and "housekeeping" on and around the drill rig.

- Suitable storage locations should be provided for all tools, materials, and supplies so that they can be conveniently and safely handled without hitting or falling on a member of the drill crew or a visitor.
- Avoid storing or transporting tools, materials, or supplies within or on the mast of the drill rig.
- Pipe, drill rods, casing, augers, and similar drilling tools should be orderly stacked on racks or sills to prevent spreading, rolling or sliding.
- Penetration or other driving hammers should be placed at a safe location on the ground or be secured to prevent movement when not in use.
- Work areas, platforms, walkways, scaffolding and other accessways should be kept free of materials, debris and obstructions, and substances such as ice, grease, or oil that could cause a surface to become slick or otherwise hazardous.
- Keep all controls, control linkages, warning and operation lights, and lenses free of oil, grease or ice.

- Do not store gasoline in any portable container other than a non-sparking, red container with a flame arrester in the fill spout, and having the word "gasoline" easily visible.

MAINTENANCE SAFETY

Good maintenance will make drilling operations safer. Also, maintenance should be performed safely.

- Wear safety glasses when performing maintenance on a drill rig or on drilling tools.
- Shut down the drill rig engine to make repairs or adjustments to a drill rig or to lubricate fittings (except repairs or adjustments that can only be made with the engine running). Take precautions to prevent accidental staring of an engine during maintenance by removing or tagging the ignition key.
- Always block the wheels or lower the leveling jacks or both and set hand brakes before working under a drill rig.
- When possible and appropriate, release all pressure on the hydraulic systems, the drilling fluid system and the air pressure systems of the drill rig prior to performing maintenance. In other words, reduce the drill rig and operating systems to a "zero energy state" before performing maintenance. Use extreme caution when opening drain plugs and radiator caps and other pressurized plugs and caps.
- Do not touch an engine or the exhaust system of an engine following its operation until the engine and exhaust system have had adequate time to cool.
- Never weld or cut on or near a fuel tank.
- Do not use gasoline or other volatile or flammable liquids as cleaning agents on or around a drill rig.
- Follow the manufacturer's recommendations for applying the proper quantity and quality of lubricants, hydraulic oils and/or coolants.
- Replace all caps, filler plugs, protective guards or panels, and high pressure hose clamps and chains or cables that have been removed for maintenance before returning the drill rig to service.

SAFE USE OF HAND TOOLS

There are almost an infinite number of hand tools that can be used on or around a drill rig and in repair shops and more than an equal number of instructions for proper use. "Use the tool for its intended purpose" is the most important rule. The following are a few specific and some general suggestions which apply to safe use of several hand tools that are often used on and around drill rigs.

- When a tool becomes damaged, either repair it before using it again or get rid of it.
- When using a hammer any kind of hammer for any purpose, wear safety glasses and require all others around you to wear safety glasses.
- When using a chisel, any kind of chisel, for any purpose wear safety glasses and require all others around you to wear safety glasses.
- Keep all tools cleaned and orderly stored when not in use.
- Use wrenches on nuts - don't use pliers on nuts.
- Use screwdrivers with blades that fit the screw slot.
- When using a wrench on a tight nut - first use some penetrating oil, use the largest wrench available that fits the nut, when possible pull on the wrench handle rather than push, and apply force to the wrench with both hands when possible and with both feet firmly placed. Don't push or pull with one or both feet on the drill rig or the side of a mud pit or some other blocking-off device. Always assume that you may lose your footing - check the place where you may fall for sharp objects.
- Keep all pie wrenches clean and in good repair. The jaws of pipe wrenches should be wire-brushed frequently to prevent an accumulation of dirt and grease which would otherwise build up and cause wrenches to slip.
- Never us pipe wrenches in place of a rod holding device.
- Replace hook and heel jaws when they become visibly worn.
- When breaking tool joints on the ground or on a drilling platform, position your hands so that your fingers will not be smashed between the wrench handle and the ground or the platform, should the wrench slip or the joint suddenly let go.

CLEARING THE WORK AREA

Prior to drilling, adequate site clearing and leveling should be performed to accommodate the drill rig and supplies and provide a safe working area. Drilling should not commence when tree limbs, unstable ground, or site obstructions cause unsafe tool handling conditions.

START UP

- All drill rig personnel and visitor should be instructed to "stand clear" of the drill rig immediately prior to and during starting of an engine.
- Make sure all gear boxes are in neutral, all hoist levers are disengaged, all hydraulic levers are in the correct nonactuating positions and the cathead rope is not on the cathead before starting a drill rig engine.

- Start all engines according to the manufacturer's manual.

SAFETY DURING DRILLING OPERATIONS

Safety requires the attention and cooperation of every worker and site visitor.

- Do not drive the drill rig form hole to hole with the mast in the raised position.
- Before raising the mast, look up to check for overhead obstructions (refer to the section on overhead and buried utilities).
- Before raising the mast, all drill rig personnel (with the exception of the operator) and visitors should be cleared form the areas immediately to the rear and the sides of the mast. All drill rig personnel and visitors should be informed that the mast is being raised prior to raising it.
- Before the mast of a drill rig is raised and drilling is started, the drill rig must be first leveled and stabilized with leveling jacks and/or solid cribbing. The drill rig should be reveled if it settles after initial set-up. Lower the mast only when the leveling jacks are down and do not raise the leveling jack pads until the mast is lowered completely.
- Before starting drilling, secure and/or lock the mast if required according to the manufacturer's recommendations.
- The operator of a drill rig should only operate a drill rig from the position of the controls. If the operator or the drill rig must leave the area of the controls, the operator should shift the transmission controlling the rotary drive into neutral and place the lead control lever in neutral. The operator should shut down the drill engine before leaving the vicinity of the drill.
- Throwing or dropping tools should not be permitted. All tools should be carefully passed by hand between personnel or a hoist line should be used.
- Do not consume alcoholic beverages or other depressants or chemical stimulants prior to starting work on a drill rig or while on the job.
- If it is necessary to drill within an enclosed area, make certain that exhaust fumes are conducted out of the area. Exhaust fumes can be toxic and some cannot be detected by smell.
- Clean mud and grease from boots before mounting a drill platform and use hand holds and railings. Watch for slippery ground when dismounting from the platform.
- During freezing weather, do not touch any metal parts of the drill rig with exposed flesh. Freezing of moist skin to metal can occur almost instantaneously.
- All air and water lines and pumps should be drained when not in use if freezing weather is expected.

- All unattended boreholes must be adequately covered or otherwise protected to prevent drill rig personnel, site visitors, or animals from stepping or falling into the hole. All open boreholes should be covered, protected, or backfilled adequately and according to local or state regulations on completion of the drilling project.
- "Horsing around" within the vicinity of the drill rig and tool and supply storage areas should never be allowed, even when the drill rig is shut down.
- When using a ladder on a drill rig, face the ladder and grasp either the side rails or the rungs with both hands while ascending or descending. Do not attempt to use one or both hands to carry a tool while on a ladder. Use a hoist line and a tool "bucket" or a safety hook to raise or lower hand tools.
- Before lifting any object without using a hoist make sure that the load is within your personal lifting capacity. If it is too heavy, ask for assistance.
- Before lifting a relatively heavy object, approach the object by bending at the knees, keeping your back vertical and unarched while obtaining a firm footing. Grasp the object firmly with both hands and stand slowly and squarely while keeping your back vertical and unarched. In other words, perform the lifting with the muscles in your legs, not with the muscles in your lower back.
- If a heavy object must be moved some distance without the aid of machinery, keep your back straight and unarched. Change directions by moving your feet, not by twisting your body.
- Move heavy objects with the aid of hand carts whenever possible.
- Drilling operations should be terminated during an electrical storm and the complete crew should move safety away from the drill rig.

OVERHEAD AND BURIED UTILITIES

The use of a drill rig on a site or project within the vicinity of electrical power lines and other utilities requires that special precautions be taken by both supervisors and members of the exploration crew. Electricity can shock, it can burn, and it can cause death.

- Overhead and buried utilities should be located, noted, and emphasized on all boring location plans and boring assignment sheets.
- When overhead electrical power lines exist at or near a drilling site or project, consider all wires to be alive and dangerous.
- Watch for sagging power lines before entering a site. Do not lift power lines to gain entrance. Call the utility and ask them to lift or raise the lines or de-energize them.
- Before raising the mast on a site in the vicinity of power lines, walk completely around the drill rig. Determine what the minimum distance from any point on the

drill rig to the nearest power line will be when the mast is raised and/or being raised. do not raise the mast or operate the drill rig if this distance is less than 20 feet, or if known, the minimum clearance stipulated by federal, state and local regulations.

- Keep in mind that both hoist lines and overhead power lines can be moved toward each other by the wind.
- In order to avoid contact with power lines, only move the drill rig with the mast down.
- If there are any questions whatever concerning the safety of drilling on sites in the vicinity of overhead power lines, call the power company. The power company will provide expert advice at the drilling site as a public service and at no cost.

Underground electricity is as dangerous as overhead electricity. Be aware and always suspect the existence of underground utilities such as electrical power, gas, petroleum, telephone, sewer and water. As for assistance if a sign warning of underground utilities is located on a site boundary. Do not assume that underground utilities are located on or near the boundary or property line under the sign. Call the utility and check it out. The underground utilities may be a considerable distance away form the warning sign.

Always contact the owners of utility lines or the nearest underground utility location service before drilling. Determine jointly with utility personnel the precise location of underground utility lines, mark and flag the locations, and determine jointly with utility personnel what specific precautions must be taken to assure safety.

SAFE USE OF WIRE LINE HOISTS, WIRE ROPE, AND HOISTING HARDWARE

The use of wire line hoists, wire rope and hoisting hardware should be as stipulated by the American Iron and Steel Institute's *Wire Rope Users Manual.*

- All wire ropes and fittings should be visually inspected during use and thoroughly inspected at least once a week for abrasion, broken wires, wear, reduction in rope diameter, reduction in wire diameter, fatigue, corrosion, damage from heat, jamming, crushing, bird caging, kinking, core protrusion, and damage to lifting hardware. Wire ropes should be replaced when inspection indicates excessive damage. All wire ropes which have not been used for a period of a month or more should be thoroughly inspected before being returned to service.
- End fittings and connections consist of spliced eyes and various manufactured devices. All manufactured end fittings and connections should be installed

according to the manufacturer's instructions and loaded according to the manufacturer's specifications.

- If a ball-bearing type hoisting swivel is used to hoist drill rods, swivel bearings should be inspected and lubricated daily to assure that the swivel freely rotates under load.
- If a rod-slipping device is used to hoist drill rods, do not drill through or rotate drill rods through the slipping device, do not hoist more than 1 foot of the drill rod column above the top of the mast, do not hoist a rod column with loose tool joints, and do not make up, tighten, or loosen tool joints while the rod column is being supported by a rod-slipping device. If drill rods should slip back into the borehole, do not attempt to break the fall of the rods with your hands or by tensioning the slipping device.
- Most sheaves on exploration drill rigs are stationary with a single part line. The number of parts of line should not ever by increased without first consulting with the manufacturer of the drill rig.
- Wire ropes must be property matched with each sheave - if the rope is too large, the sheave will pinch the wire rope - if the rope is too small, it will groove the sheave. Once the sheave is grooved, it will severely pinch and damage larger-sized wire ropes.

The following procedures and precautions must be understood and implemented for safe use of wire ropes and rigging hardware.

- Use tool handling hoists only for vertical lifting of tools (except when angle hole drilling). Do not use tool handling hoists to pull on objects away from the drill rig; however, drills may be moved using the main hoist if the wire rope is spooled through proper sheaves according to the manufacturer's recommendations.
- When stuck tools or similar loads cannot be raised with a hoist, disconnect the hoist line and connect the stuck tools directly to the feed mechanism of the drill. do not use hydraulic leveling jacks for added pull to the hoist line or the feed mechanism of the drill.
- When attempting to pull out a mired down vehicle or drill rig carrier, only use a winch on the front or rear of the vehicle and stay as far away as possible fro the wire rope. Do not attempt to use tool hoists to pull out a mired down vehicle or drill rig carrier.
- Minimize shock loading of a wire rope - apply loads smoothly and steadily.
- Avoid sudden loading in cold weather.
- Never use frozen ropes.

- Protect wire rope form sharp corners or edges.
- Replace faulty guides and rollers.
- Replace worn sheaves or worn sheave bearings.
- Replace damaged safety latches on safety hooks before using.
- Know the safe working load of the equipment and tackle being used. Never exceed this limit.
- Clutches and brakes of hoists should be periodically inspected and tested.
- Know and do not exceed the rated capacity of hooks, rings, links, swivels, shackles and other lifting aids.
- Always wear gloves when handling wire ropes.
- Do not guide wire rope on hoist drums with your hands.
- Following the installation of a new wire rope, first lift a light load to allow the wire rope to adjust.
- Never carry out any hoisting operations when the weather conditions are such that hazards to personnel, the public, or property are created.
- Never leave a load suspended in the air when the hoist is unattended.
- Keep your hands away from hoists, wire rope, hoisting hoods, sheaves, and pinch points as slack is being taken up and when the load is being hoisted
- Never hoist the load over the head, body or feet of any personnel.
- Never use a hoist line to "ride" up the mast of a drill rig.
- Replacement wire ropes should conform to the drill rig manufacturer's specifications.

SAFE USE OF CATHEAD AND ROPE HOISTS

The following safety procedures should be employed when using a cathead hoist.

- Keep the cathead clean and free of rust and oil and/or grease. The cathead should be cleaned with a wire brush if it becomes rusty.
- Check the cathead periodically, when the engine is not running, for rope wear grooves. If a rope groove forms to a depth greater than 1/8 in. (3 mm), the cathead should be replaced.
- Always use a clean, dry, sound rope. A wet or oily rope may "grab" the cathead and cause drill tools or other items to be rapidly hoisted to the top of the mast.

- Should the rope "grab" the cathead or otherwise become tangled in the drum, release the rope and sound an appropriate alarm for all personnel to rapidly back away and stay clear. The operator should also back away and stay clear. If the rope "grabs" the cathead, and tools are hoisted to the sheaves at the top of the mast, the rope will often break, releasing the tools. If the rope does not break, stay clear of the drill rig until the operator cautiously returns to turn off the drill rig engine and appropriate action is taken to release the tools. The operator should keep careful watch on the suspended tools and should quickly back away after turning off the engine.
- The rope should always be protected from contact with all chemicals. Chemicals can cause deterioration of the rope that may not be visibly detectable.
- Never wrap the rope from the cathead (or any other rope, wire rope or cable on the drill rig) around a hand, wrist, arm, feet, ankle, leg or any other part of your body.
- Always maintain a minimum of 18 inches of clearance between the operating hand and the cathead drum when driving samplers, casing, or other tools with the cathead and rope method. Be aware that the rope advances toward the cathead with each hammer blow as the sampler or other drilling tool advances into the ground.
- Never operate a cathead (or perform any other task around a drill rig) with loose unbuttoned or otherwise unfastened clothing or when wearing gloves with large cuffs or loose straps or lacings.
- Do not use a rope that is any longer than necessary. A rope that is too long can form a ground loop or otherwise become entangled with the operator's legs.
- Do not use more rope wraps than are required to hoist a load.
- Do not leave a cathead unattended with the rope wrapped on the drum.
- Position all other hoist lines to prevent contact with the operating cathead rope.
- When using the cathead and rope for driving or back-driving, make sure that all threaded connections are tight and stay as far away as possible from the hammer impact point.
- The cathead operator must be able to operate the cathead standing on a level surface with good, firm footing conditions without distraction or disturbance.

SAFE USE OF AUGERS

The following general procedures should be used when starting a boring with continuous flights or hollowstem augers:

- Prepare to start an auger boring with the drill rig level, the clutch or hydraulic rotation control disengaged, the transmission in low gear and the engine running at low RPM.
- Apply an adequate amount of down pressure prior to rotation to seat the auger head below the ground surface.
- Look at the auger head while slowly engaging the clutch or rotation control and starting rotation. Stay clear of the auger.
- Slowly rotate the auger and auger head while continuing to apply down pressure. Keep one hand on the clutch or the rotation control at all times until the auger has penetrated about one foot or more below ground surface.
- If the auger head slides out of alignment, disengage the clutch or hydraulic rotation control and repeat the hole starting process.
- An auger guide can facilitate the starting of a straight hole through hard ground or a pavement.
- The operator and tool handler should establish a system of responsibility for the series of various activities required for auger drilling, such as connecting and disconnecting auger sections, and inserting and removing the auger fork. The operator must assure that the tool handler is well away from the auger column and that the auger fork is removed before starting rotation.
- Only use the manufacturer's recommended method of securing the auger to the power coupling. Do not touch the coupling or the auger with your hands, a wrench or any other tools during rotation.
- Whenever possible, use tool hoists to handle auger sections.
- Never place hands or fingers under the bottom of an auger section when hoisting the auger over the top of the auger section in the ground or other hard surfaces such as the drill rig platform.
- Never allow feet to get under the auger section that is being hoisted.
- When rotating augers, stay clear of the rotating auger and other rotating components of the drill rig. Never reach behind or around a rotating auger for any reason whatever.
- Use a long-handled shovel to move auger cuttings away from the auger. Never use your hands or feet to move cuttings away from the auger.
- Do not attempt to remove earth from rotating augers. Augers should be cleaned only when the drill rig is in neutral and the augers are stopped from rotating.

SAFETY DURING ROTARY AND CORE DRILLING

Rotary drilling tools should be safety checked prior to drilling:

- Water swivels and hoisting plugs should be lubricated and checked for "frozen" bearings before use.
- Drill rig chuck jaws should be checked periodically and replaced when necessary.
- The capacities of hoists and sheaves should be checked against the anticipated weight to the drill rod string plus other expected hoisting leads.

Some precautions that should be taken for safe rotary or care drilling involve chucking joint break, hoisting and lowering of drill rods:

- Only the operator of the drill rig should brake or set a manual chuck so that rotation of the chuck will not occur prior to removing the wrench from the chuck.
- Drill rods should not be braked during lowering into the hole with drill rod chuck jaws.
- Drill rods should not be help or lowered into the hole with pipe wrenches.
- If a string of drill rods are accidentally or inadvertently released into the hole, do not attempt to grab the falling rods with your hands or a wrench.
- In the event of a plugged bid or other circulation blockage, the high pressure in the piping and hose between the pump and the obstruction should be released or bled down before breaking the first tool joint.
- When drill rods are hoisted from the hole, they should be cleaned for safe handling with a rubber or other suitable rod wiper. Do not use your hands to clean fluids from drill rods.
- If work must progress over a portable drilling fluid (mud) pit, do not attempt to stand on narrow sides or cross members. The mud pit should be equipped with rough surfaced, fitted cover panels of adequate strength to hold drill rig personnel.
- Drill rods should not be lifted and leaned unsecured against the mast. Either provide some method of securing the upper ends of the drill rod sections for safe vertical storage or lay the rods down.

SAFETY DURING TRAVEL

The individual who transports a drill rig on and off a drilling site should:

- Be properly licensed and should only operate the vehicle according to federal, state, and local regulations.

- Know the traveling height (overhead clearance), width, length and weight of the drill rig with carrier and know highway and bridge lead, width and overhead limits, making sure these limits are not exceeded with an adequate margin.
- Never move a drill rig unless the vehicle brakes are in sound working order.
- Allow for most overhang when cornering or approaching other vehicles or structures.
- Be aware that the canopies of service stations and motels are often too low for a drill rig mast to clear with the mast in the travel position.
- Watch out for low hanging electrical lines, particularly at the entrances to drilling sites or restaurants, motels or other commercial sites.
- Never travel on a street, road, or highway with the mast (derrick) of the drill rig in the raised or partially raised position.
- Remove all ignition keys when a drill rig is left unattended.

LOADING AND UNLOADING

When loading and unloading a drill rig on a trailer or a truck:

- Use ramps of adequate design that are solid and substantial enough to bear the weight of the drill rig with carrier-including tooling.
- Load and unload on level ground.
- Use the assistance of someone on the ground as a guide.
- Check the brakes on the drill rig carrier before approaching loading ramps.
- Distribute the weight of the drill rig, carrier and tools on the trailer so that the center of weight is approximately on the center line of the trailer and so that some of the trailer load is transferred to the hitch of the pulling vehicle. Refer to the trailer manufacturer's weight distribution recommendations.
- The drill rig and tools should be secured to the hauling vehicle with ties, chains and/or load binders of adequate capacity.

OFF-ROAD MOVEMENT

The following safety suggestions relate to off-road movement:

- Before moving a drill rig, first walk the route of travel, inspecting for depressions, stumps, gullies, ruts and similar obstacles.
- Always check the brakes of a drill rig carrier before traveling, particularly on rough, uneven or hilly ground.

- Check the complete drive train of a carrier at least weekly for loose or damaged belts, nuts, studs, shafts, and mountings.
- Discharge all passengers before moving a drill rig on rough or hill terrain.
- Engage the front axle (for 4 x 4, and 6 x 6, etc. vehicles or carriers) when traveling off highway on hilly terrain.
- Use caution when traveling side-hill. Conservatively evaluate side-hill capability of drill rigs, because the arbitrary addition of drilling tools may raise the center of mass. When possible, travel directly uphill or downhill. Increase tire pressure before traveling in hilly terrain (do not exceed rated tire pressure).
- Attempt to cross obstacles such as small logs and small erosion channels or ditches squarely, no at an angle.
- Use the assistance of someone on the ground as a guide when lateral or overhead clearance is close.
- After the drill has been moved to a new drilling site, set all brakes and/or locks. When grades are steep, block the wheels.
- Never travel off-road with the mast (derrick) of the drill rig in the raised or partially raised position.

DRILL RIG UTILIZATION

Do not attempt to exceed manufacturers' ratings of speed, force, torque, pressure, flow, etc. Only use the drill rig and tools for the purposes which they are intended and designed.

DRILL RIG ALTERATIONS

Alternations to a drill rig or drilling tools should only be made by qualified personnel and only after consultation of the manufacturer.