3.0 RFI-PHASE II FIELD INVESTIGATION

The RFI-Phase II field program conducted at the Group 2 SWMUs was designed to characterize the environmental setting, define the nature and extent of the sources of contamination, and identify actual and potential receptors. Data obtained under previous investigations were used to plan the RFI-Phase II field program and were incorporated into the contamination assessment. It should be noted, however, that the human and ecological risk assessments made use of RFI-Phase II data only, since interest in comparing data collected under the same field program is paramount in these evaluations.

The RFI-Phase II field program was conducted in accordance with the USATHAMA (1990) Quality Assurance Program and the USATHAMA Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports (USATHAMA 1987). The field program included the following activities:

- Ecological investigations
- Air quality monitoring
- Unexploded ordnance locating and explosive risk determination
- Chemical agent monitoring
- Soil gas sampling
- Surface water sampling
- Soil sampling
- Well installation and well development
- Groundwater sampling
- Aquifer testing

3.1 ECOLOGICAL INVESTIGATIONS

Ecological investigations at the Group 2 SWMUs included vegetation mapping and key species identification to identify potential ecological receptors and their ranges. The area of investigation was broadened to include all of TEAD-S to account for mobile species, which use areas beyond the SWMU boundaries. Vegetation mapping for these SWMUs was conducted during site-wide mapping activities in summer 1993. Key species were identified by combining field observations, including bird and small mammal surveys, from spring, summer, and fall field efforts in 1993 with data presented in previous investigations (EBASCO 1993a and 1994, Rust 1994), and from unpublished lists developed by Rust and UDOW wildlife coordinators.

3.1.1 Vegetation Mapping

A vegetation map was prepared for TEAD-S that includes the Group 2 SWMUs as well as the surrounding areas (Plate 3). This map provides a basis for characterizing wildlife habitat, analyzing potential contaminant migration pathways, and identifying potential receptors. Initially, the investigation included a review of the following existing vegetation and soil mapping data:

- SCS soil maps and range site maps—Particular reference was made to the "Soil and Range Survey of the Tooele Army Depot" (SCS, no date)
- BLM ecological site mapping information—Areas in proximity to TEAD-S were investigated and mapped as part of the Tooele Grazing Draft Environmental Impact Statement (BLM 1983)
- U.S. Forest Service, Vegetation and Environmental Features of Forest and Range Ecosystems (Garrison et al. 1977)—Descriptions of sagebrush and desert shrub ecosystems were compared to areas in proximity to TEAD-S

The classification schemes, which are based on assessments of potential vegetation, employed in these existing maps emphasize range management requirements. These schemes do not necessarily reflect man-made disturbances and natural disturbance regimes that create various successional stages of the potential climax vegetation. To better reflect actual conditions, field biologists developed a vegetation map of TEAD-S using a modified classification system related to broad ecological requirements (i.e., habitats).

To create the map, observational field surveys were conducted. From strategic topographic highs, vegetation types that were apparent from each location were identified. When numerous or small-sized plants were present, their species were individually identified. Generally, contacts between vegetation types were transitional, but could be identified on aerial photographs with ground-truthing as needed. The boundaries between habitat areas were drawn directly on color infrared aerial photographs taken in June 1987. The mapped boundaries were digitized and transferred onto the base map using an AutoCADD system (Plate 3).

3.1.2 Key Species Identification

The key species list was compiled by combining data from the RFI-Phase II report for known releases units (Rust 1994) and the ecological risk assessment of the Group 1 SWMUs (EBASCO 1994) with new field data acquired during the seasonal field work in 1993. This new field work included raptor and small bird surveys in March 1993, vegetation and general wildlife surveys in June 1993, and small mammal trapping and bird surveys in August and September 1993. All species present in the valley were considered to be potential receptors. The surveys were performed both along transects inside the SWMUs and in adjacent areas to effectively inventory more mobile species. Species were identified and their habitat usage was recorded on field data sheets and later combined with data from the previously conducted surveys. The new field data included information on large and small mammal, raptor, and small bird populations. The resultant species list is provided in Appendix G.

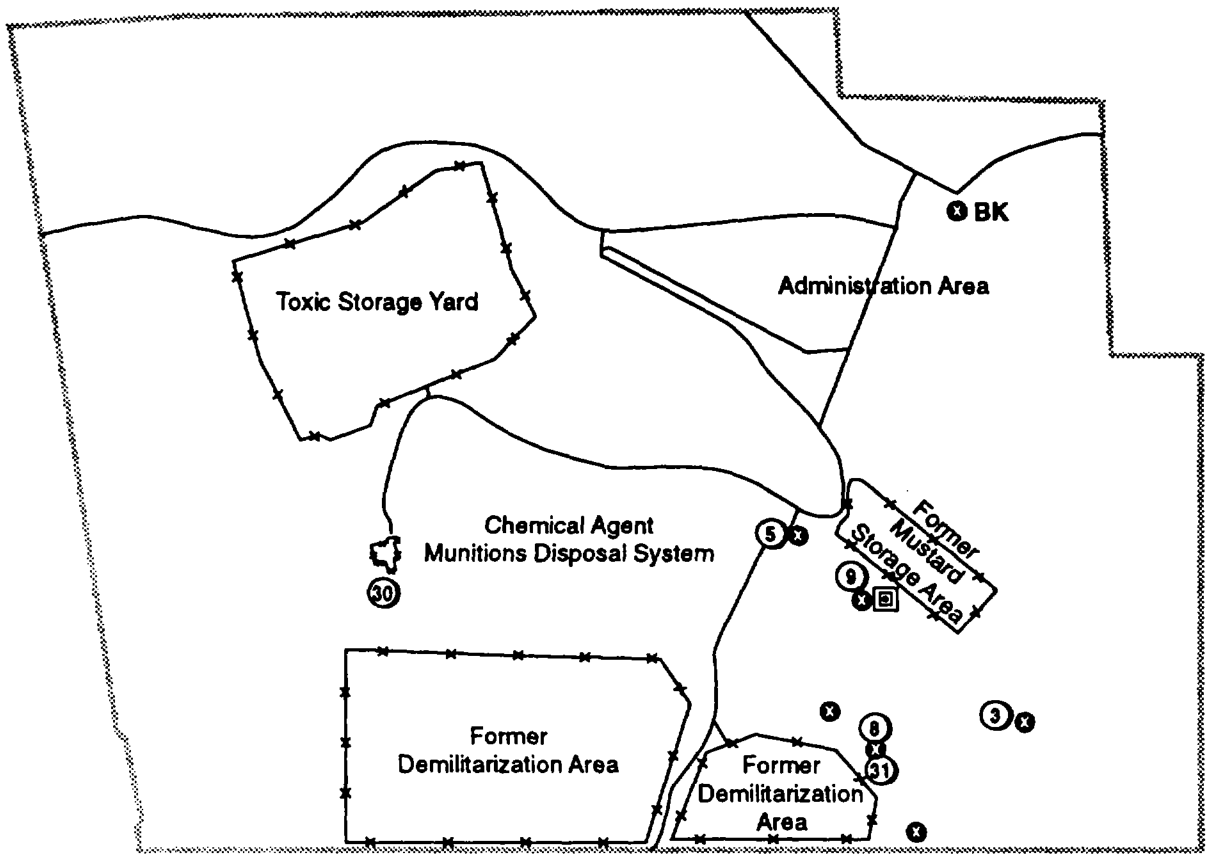
Considerable qualitative data on the flora and fauna of Rush Valley is available in the published literature (SCS, no date; BLM 1988; UDOW 1993). These literature sources were used to review the adequacy of the compiled species list, as were discussions with BLM biologists and state wildlife coordinators to re-affirm the adequacy of the species identified. The results of this effort are described in detail in Sections 6.2.2 and 6.2.3, which describe the determination of potentially exposed biota.

3.2 AIR QUALITY MONITORING

Air quality monitoring was conducted at TEAD-S between September 11 and October 3, 1993 to support the evaluation of the air exposure pathway in the human health risk assessment of SWMUs 3, 5, 8, 9, and 31. Six air quality sampling locations (including one background site) and one meteorological monitoring site were selected (Figure 3.2-1). Sample site BK was located north (upwind) of the five SWMUs in accordance with the anticipated prevailing wind directions to evaluate ambient background levels at TEAD-S. Sites at the SWMUs were located south-southeast (downwind) of the main operational areas at each SWMU also in accordance with the anticipated prevailing wind direction. Figure 3.2-2 shows the air monitoring station at SWMU 3 downwind from the operational area at the gravel pad. Actual wind directions observed during the monitoring program were very close to the projected wind directions. Figure 3.2-3 shows the composite windrose compiled from each of the 24-hour monitoring periods.

Target analytes monitored included total suspended particulates (TSP), metals (aluminum, arsenic, barium, chromium, lead, magnesium, nickel, sodium, and zinc), VOCs, and semivolatile organic compounds (SVOCs). VOC and SVOC target compounds were selected using the results of previous soil studies conducted at Tooele as well as standard chemical analyte lists. The list of target analytes and the detection limit for each chemical are shown in Table 3.2-1.

The objective of the air quality monitoring was to select days or events when meteorological conditions would be most favorable for sampling higher contaminant levels (i.e., worst-case conditions). These conditions included warm daytime temperatures and nighttime inversions for sampling VOCs and SVOCs, and moderate to strong winds for sampling metals, which are generally transported with dust particles. Strong-wind events were also selected for sampling SVOCs since these compounds can also adhere to dust particles. For the most part, these conditions were met for the selected sampling days. The prevailing wind during the monitoring period was from the north-northwest (Figure 3.2-3). All wind directions and various wind speeds, however, were represented on individual sampling days, as is shown in the daily windroses (Appendix I).



Solid Waste Management Units

3. Decon Pad/Disposal Pit (Southeast of Area 2)
5. Building 600 Foundation, Drainage Pond, and Ditch
8. Surveillance Test Site
9. Old Area 2 (including Mustard Holding and Pit Areas)
30. CAMDS Landfill
31. Demilitarization Area (Northeast of SWMU 1)

Legend

⊗	Air Monitoring Station
⊡	Meteorological Station
(31)	Group 2 SWMUs
——	Paved Road
×—×—×	Fence
········	Tooele Army Depot - South Area Boundary

N

0 6000 ft.

Scale

T3G2 9.16.94 jb

Source:

NUS Corporation 1987
EBASCO Field Measurement

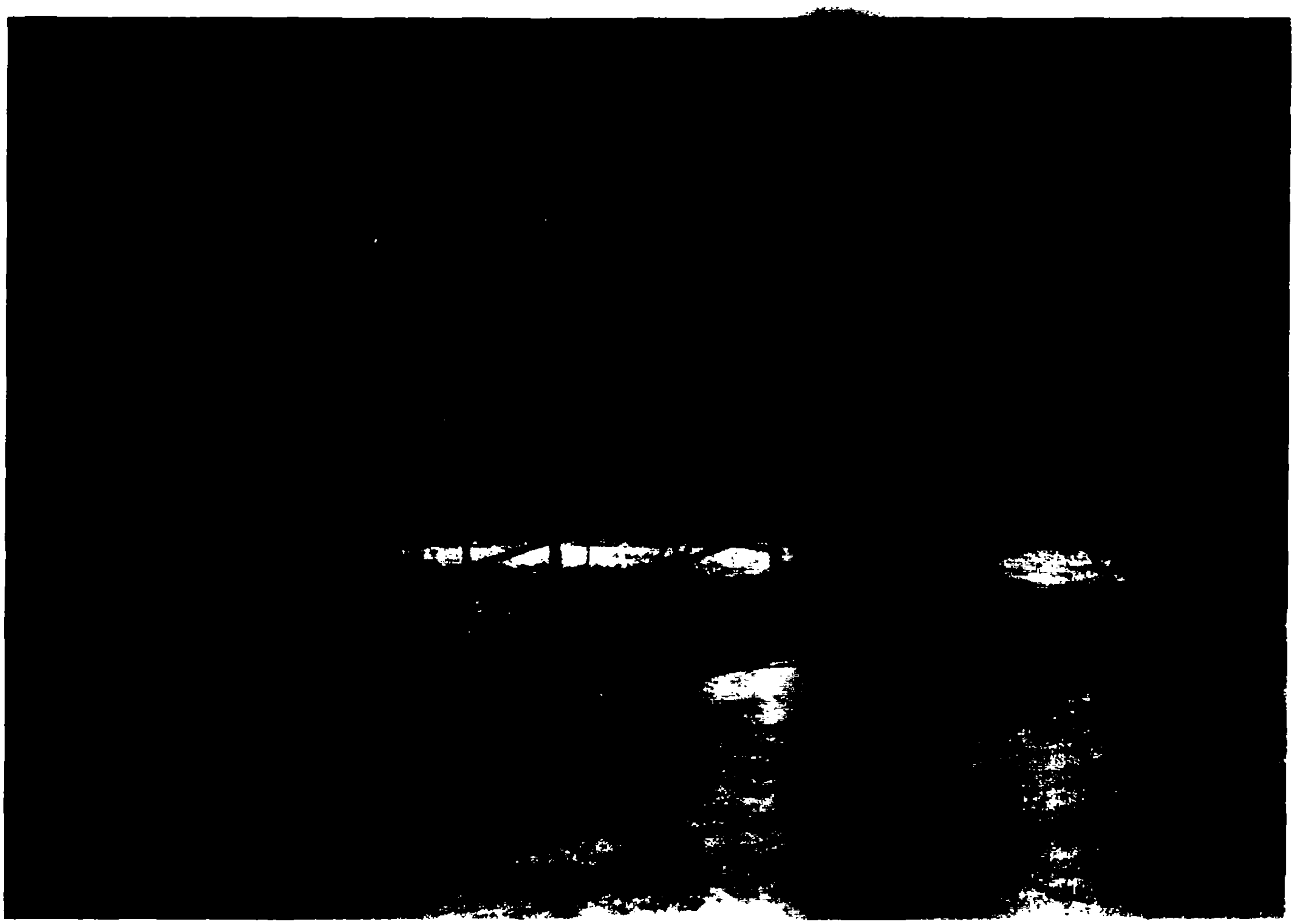
Figure 3.2-1

Location of Air Monitoring and Meteorological Stations

Tooele Army Depot - South Area
Prepared by: Ebasco Services Incorporated

EBASCO

Recycled Paper

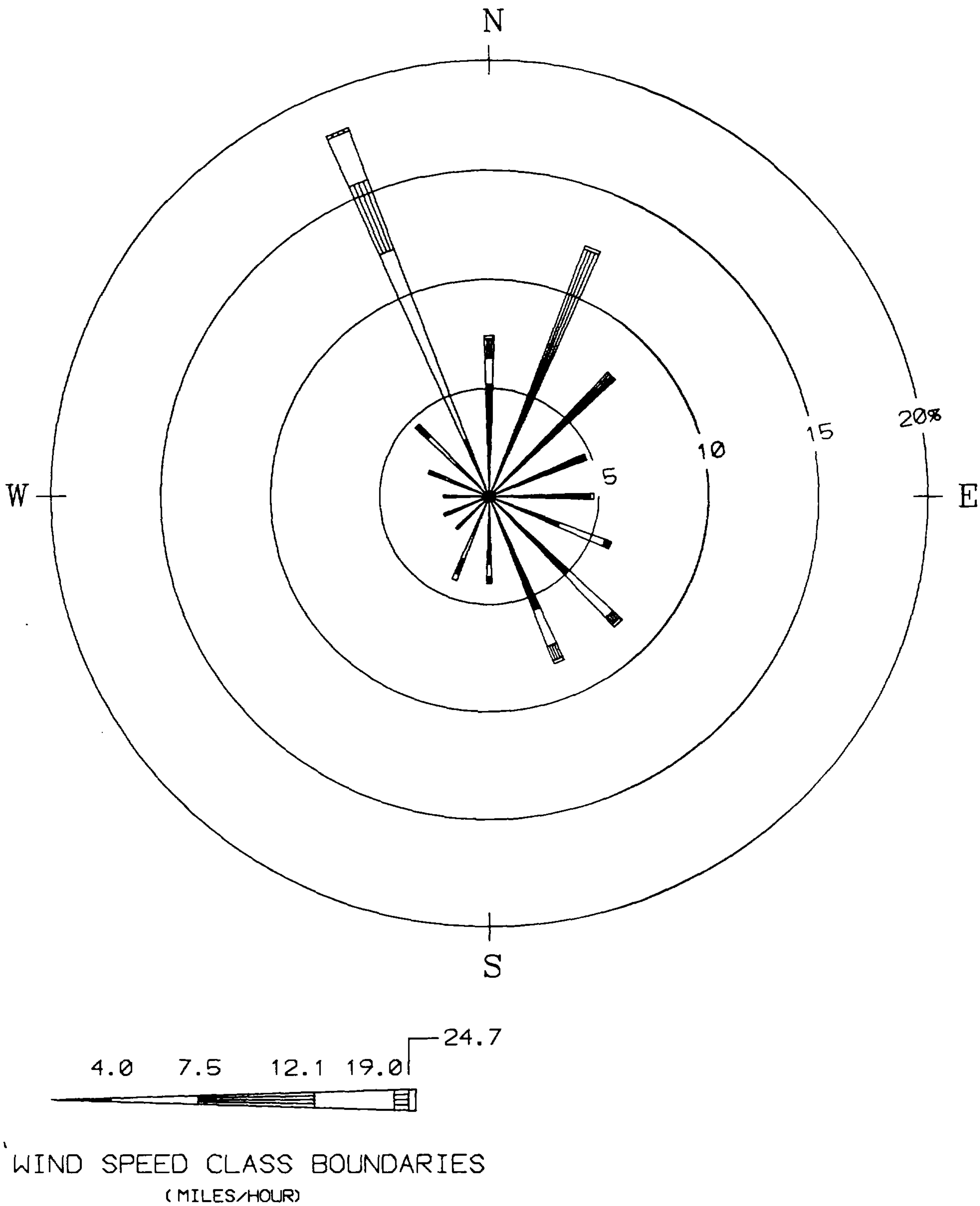


Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.2-2

Typical Air Monitoring Station at SWMU 3.

Prepared by:
Ebasco Services Incorporated



Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.2-3

Composite Windrose for TEAD-S
September 5, 1993 - October 3, 1993

Prepared by:
Ebasco Services Incorporated

Table 3.2-1 • Analyte List and Detection Limits, Page 1 of 7

Compound	Air Samples	[illegible]	Water Samples
Volatiles	µg/m³	[illegible]	µg/l
Chloromethane	NA	8.8	3.2
Bromomethane	NA	[illegible]	5.8
Vinyl Chloride	0.13	6.2	2.6 e
Chloroethane	NA	[illegible]	1.9
Methylene Chloride	0.35	***6****	2.3
Acetone	NA	[illegible]	13
Carbon Disulfide	NA	4.4	0.5
1,1-Dichloroethene	0.2	[illegible]	0.5
1,1-Dichloroethane	NA	2.3	0.68
1,2-Dichloroethene (Total)	NA	[illegible]	0.5
Chloroform	0.124	0.87	0.5
1,2-Dichloroethane	NA	[illegible]	0.5
2-Butanone (MEK)	NA	70	6.4
1,1,1-Trichloroethane	0.55	[illegible]	0.5
Carbon Tetrachloride	0.16	***3.5***	0.58
Vinyl Acetate	NA	[illegible]	8.3
Bromodichloromethane	NA	2.9	0.59
1,2-Dichloropropane	NA	[illegible]	0.5
cis-1,3-Dichloropropene	NA	3.2	0.58
Trichloroethene	0.55	[illegible]	0.5
Dibromochloromethane	NA	3.1	0.67
1,1,2-Trichloroethane	NA	[illegible]	1.2
Benzene	0.08	1.5	0.5
trans-1,3-Dichloropropene	NA	[illegible]	0.7
Bromoform	NA	***3.45***	2.6
4-Methyl-2-pentanone	0.41	[illegible]	3

T3G2 9.9.94.jb

NA - Not analyzed
$\mu g/m^3$ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
e - Value estimated below 10 µg/l

* - Lowest USAEC reporting limit is greater than SW-846 detection limit

Note: Values in ***bold italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection Limits, Page 2 of 7

Compound	Air Samples	Soil Samples	Water Samples
Volatiles *(continued)*	**µg/m³**	**µg/kg**	**µg/l**
2-Hexanone	NA	32	3.6
Tetrachloroethene	0.69	0.81	1.6
Toluene	0.38	0.78	0.5
1,1,2,2-Tetrachlorethane	0.7	2.4	0.51
Chlorobenzene	NA	0.86	0.5
Ethylbenzene	0.44	1.7	0.5
Styrene	NA	2.6	0.5
Xylenes (Total)	0.44	1.5	0.84
1,2-Dibromoethane	NA	TIC	TIC
Benzyl Chloride	NA	TIC	TIC
1,2- Dichlorobenzene	NA	0.2	10
1,3- Dichlorobenzene	NA	0.14	10
1,4-Dichlorobenzene	NA	0.2	10
BNAs	**µg/m³**	**µg/kg**	**µg/l**
Phenol	NA	110	9.2
bis (2-Chloroethyl) ether	NA	33	1.9
2-Chlorophenol	2	60	0.99
1,3-Dichlorbenzene	NA	130	1.7
1,4-Dichlorobenzene	NA	98	1.7
Benzyl alcohol	2	190	0.72
1,2-Dichlorobenzene	NA	110	1.7
2-Methylphenol	2	29	3.9
bis (2-Chloroisopropyl) ether	NA	200	5.3
4-Methylphenol	2	240	0.52
N-Nitroso-di-n-propylamine	NA	TIC	TIC

T3G2 9.9.94.jb

NA - Not analyzed
µg/m³ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
* - Lowest USAEC reporting limit is greater than SW-846 detection limit
Note: Values in ***bold Italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection [illegible], Page 3 of 7

Compound	Air Samples	[illegible]	Water Samples
BNAs *(continued)*	µg/m³	[illegible]	µg/l
Hexachloroethane	NA	150	1.5
Nitrobenzene	NA	[illegible]	0.5
Isophorone	NA	33	4.8
2-Nitrophenol	NA	[illegible]	3.7
2,4-Dimethylphenol	2	***345***	5.8
Benzoic acid	NA	[illegible]	***6.5***
bis (2-Chloroethoxy) methane	NA	59	1.5
2,4-Dichlorophenol	NA	[illegible]	2.9
1,2,4-Trichlorobenzene	NA	40	1.8
Naphthalene	1	[illegible]	0.5
4-Chloroaniline	NA	810	7.3
Hexachlorobutadiene	NA	[illegible]	3.4
3-Methyl-4-Chlorophenol	NA	TIC	TIC
2-Methylnapthalene	1	[illegible]	1.7
Hexachlorocyclopentadiene	NA	***3100****	8.6
2,4,6-Trichlorophenol	2	[illegible]	4.2
2,4,5-Trichlorophenol	2	100	5.2
2-Chloronaphthalene	NA	[illegible]	0.5
2-Nitroaniline	NA	62	4.3
Dimethylphthalate	1	[illegible]	1.5
Acenaphthylene	1	33	0.5
2,6-Dinitrotoluene	2	[illegible]	0.79
3-Nitroaniline	NA	450	4.9
Acenaphthene	1	[illegible]	1.7
2,4-Dinitrophenol	2	1200	21

T3G2 9.9.94.jb

NA - Not analyzed
µg/m³ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
* - Lowest USAEC reporting limit is greater than SW-846 detection limit
Note: Values in ***bold Italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection Limits, Page 4 of 7

Compound	Air Samples	Soil Samples	Water Samples
BNAs *(continued)*	**µg/m³**	**µg/kg**	**µg/l**
4-Nitrophenol	2	1400	12
Dibenzofuran	NA	35	1.7
2,4-Dinitrotoluene	2	140	4.5
Diethylphthalate	1	240	2
4-Chlorophenyl-phenyl ether	NA	33	5.1
Fluorene	1	33	3.7
4-Nitroaniline	NA	410	5.2
4,6-Dinitro-2-methylphenol	2	550	17
N-nitrosodiphenylamine	NA	190	3
4-Bromophenyl-phenyl ether	NA	33	4.2
Hexachlorobenzene	NA	33	1.6
Pentachlorophenol	2	1300	18
Phenanthrene	1	33	0.5
Anthracene	1	33	0.5
Di-n-butylphthalate	1	61	3.7
Fluoranthene	1	68	3.3
Pyrene	1	33	2.8
Butylbenzylphthalate	1	170	3.4
3,3'-Dichlorobenzidine	NA	***3150****	12
Benzo(a)anthracene	1	170	1.6
Chrysene	1	120	2.4
bis (2-Ethylhexyl)phthalate	1	620	4.8
Di-n-octylphthalate	1	190	***7.5***
Benzo(b)fluoranthene	1	210	5.4
Benzo(k)fluoranthene	1	66	0.87
Benzo(a)pyrene	1	250	4.7

T3G2 9.9.94.jb

NA - Not analyzed
µg/m³ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
* - Lowest USAEC reporting limit is greater than SW-846 detection limit

Note: Values in ***bold italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection Limits, Page 5 of 7

Compound	[illegible]	[illegible]ples	Water Samples
BNAs ***(continued)***	[illegible]	[illegible]kg	µg/l
Indeno (1,2,3-cd)pyrene	1	290	8.6
Dibenz(a,h)anthracene	[illegible]	[illegible]	6.5
Benzo(g,h,i)perylene	1	250	6.1
PCBs	µg/[illegible]	[illegible]/g	µg/l
Aroclor-1016	0.3	66.6	0.16
Aroclor-1221	[illegible]	[illegible]	0.16
Aroclor-1232	0.6	66.6	0.16
Aroclor-1242	[illegible]	33.3	0.16
Aroclor-1248	0.6	66.6	0.16
Aroclor-1254	[illegible]	80.4	0.19
Aroclor-1260	0.6	80.4	0.19
Explosives	µg/m[illegible]	µg/g	µg/l
1,3-Dinitrobenzene (13DNB)	NA	***0.248***	***0.3055****
1,3,5-Trinitrobenzene (135TNB)	N[illegible]	***0.24***	***0.22***
2,4-Dinitrotoluene (24DNT)	NA	***0.212***	***0.0328****
2,6-Dinitrotoluene (26DNT)	NA	***0.262****	0.0738
2,4,6-Trinitrotoluene (246TNT)	NA	***0.228***	***0.3175****
Cyclotetramethylenetetranitramine (HMX)	NA	0.666	1.21
Hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX)	NA	0.587	***0.585***
N-Methyl-N-2,4,6-tetranitroaniline (Tetryl)	NA	***0.3655***	0.489
Nitrobenzene (NB)	NA	***1.205****	0.645
Agent Breakdown Products	µg/m[illegible]	µg/g	µg/l
Ethylmethyl phosphonic acid (EMPA)	NA	***1.055***	100
Fluoroacetic acid	N[illegible]	[illegible]2	100
Isopropylmethyl phosphonic acid (IMPA)	NA	***1.055***	100
Methyl phosphonic acid (MPA)	N[illegible]	[illegible]	128
Thiodiglycol	NA	3.94	48.8

T3G2 9.9.94.jb

NA - Not analyzed
µg/m³ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
µg/g - Microgram per gram

* - Lowest USAEC reporting limit is greater than SW-846 detection limit

Note: Values in ***bold italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection Limits, Page 6 of 7

Compound	Air Samples	Soil Samples	Water Samples
Metals	**μg/m³**	**μg/g**	**μg/l**
Aluminum	0.009	2.35	141
Antimony	NA	7.14	38
Arsenic	0.002	0.25	2.54
Barium	0.007	5.18	5
Beryllium	NA	0.5	5
Cadmium	NA	0.7	4
Calcium	NA	100	500
Chromium	0.001	***2.025****	6.02
Cobalt	NA	1.42	25
Copper	0.073	0.965	8.09
Iron	NA	3.68	38.8
Lead	0.009	0.177	1.26
Magnesium	NA	100	500
Manganese	NA	2.05	2.75
Mercury	0.002	***0.025***	***0.1215***
Nickel	0.002	1.71	34.3
Potassium	NA	100	375
Selenium	NA	0.25	3.02
Silver	0.002	0.589	4.6
Sodium	NA	100	500
Thallium	NA	***3.31****	***40.7****
Vanadium	NA	3.39	11
Zinc	0.036	***4.015****	***10.55***

T3G2 9.9.94.jb

NA - Not analyzed
μg/m³ - Micrograms per cubic meter
μg/l - Micrograms per liter
μg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
μg/g - Microgram per gram

* - Lowest USAEC reporting limit is greater than SW-846 detection limit

Note: Values in ***bold Italics*** are 1/2 certified reporting limit (CRL)

Table 3.2-1 • Analyte List and Detection Limits, [illegible] 7 of 7

Compound	Sa[illegible]	[illegible]es	Water Samples
Anions	µg/m[illegible]	[illegible]	µg/l
Bromide	NA	NA	1000
Chloride	NA	[illegible]	***1060***
Fluoride	NA	NA	***615***
Cyanide	1.4	[illegible]	2.5
Bicarbonate	NA	NA	5000
Sulfate	NA	[illegible]	5000
Nitrite and Nitrate	NA	NA	10
Phosphate	NA	[illegible]	13.3
Total Suspended Particulates	1 µg/m³	NA	NA
Total Organic Carbon	NA	[illegible]	NA

T3G2 9.9.94.jb

NA - Not analyzed
µg/m³ - Micrograms per cubic meter
µg/l - Micrograms per liter
µg/kg - Micrograms per kilogram
TIC - Tentatively Identified Compound
µg/g - Microgram per gram

* - Lowest USAEC reporting limit is greater than SW-846 detection limit

Note: Values in ***bold italics*** are 1/2 certified reporting limit (CRL)

Samples were collected from the six sampling locations over an approximate 3-week period, and collected from the SWMUs between September 21 and October 1, 1993. Following a sampling event, the corresponding meteorological data were reviewed to eva'uate whether the samples could be considered representative of reasonable worst-case conditions. Six sample events for all analyte groups were selected as representative of the entire period. SVOC field spikes and background samples were collected in two separate events on September 11 and October 3. A more complete description of the air monitoring program and its analytical results is presented in Appendix I.

3.3 EXPLOSIVE RISK DETERMINATION

To satisfy the conditions of the CSDP permit corrective action module, an explosive risk determination was performed at each of the Group 2 SWMUs. This explosive risk determination was completed in three steps. First, transect locations were selected (Figures 3.3-1 and 3.3-2) based on review of historical aerial photographs of each SWMU, the history of each SWMU, and field observations. Second, UXO experts walked each transect and recorded the type and condition of UXO observed within a 50-ft radius of points spaced approximately 300 ft apart along each transect. This characterization was extended into areas where the aerial photographs indicate little past activity so that all parts of the SWMUs were included in the assessment. Third, a global positioning system (GPS) was used to establish the longitude and latitude of each transect station where observations were made.

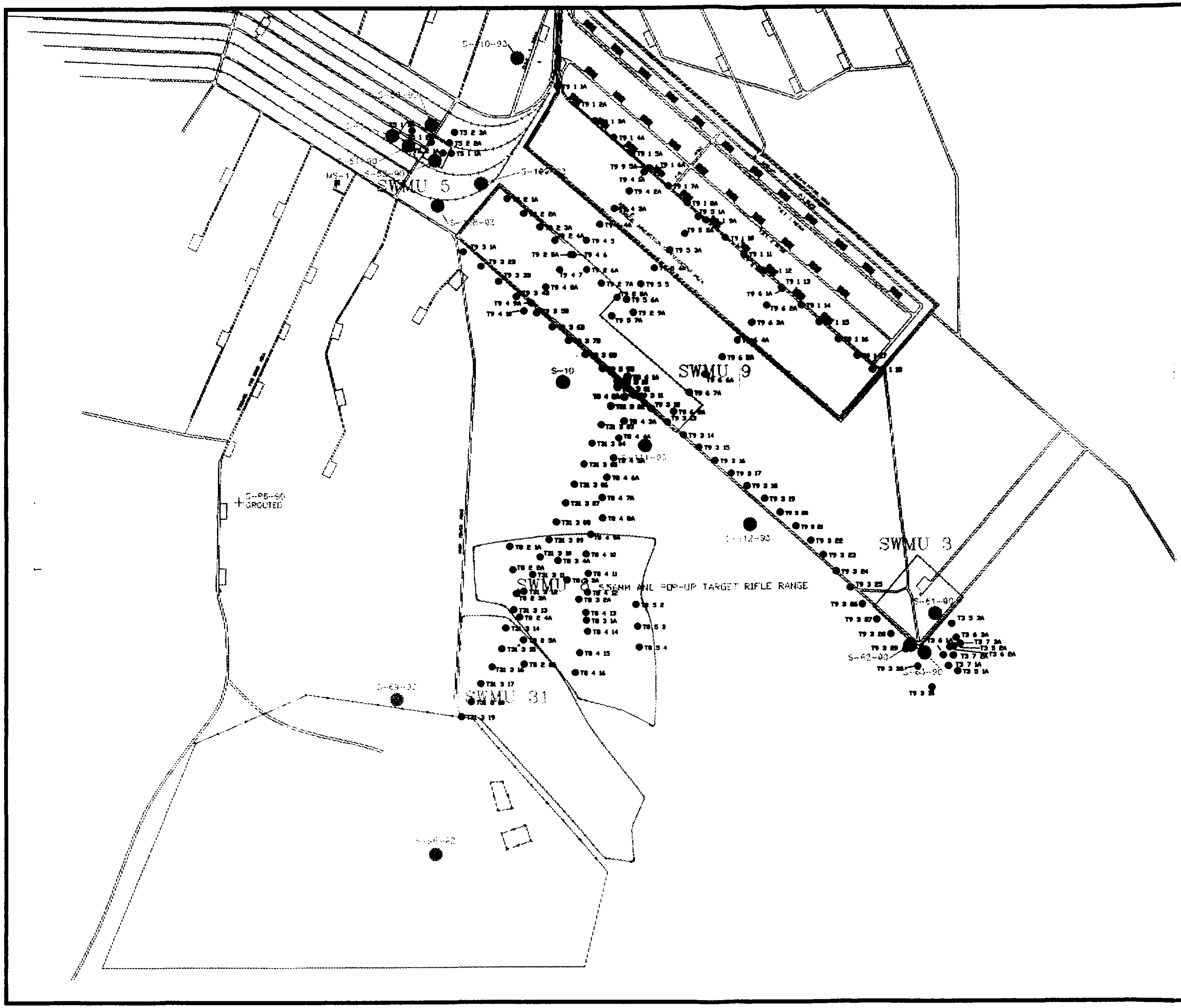
No UXO or UXO debris was found along transects in SWMUs 3, 5, 9, and 30. In SWMU 3, drums that formerly contained chemical agent and agent-neutralizing chemicals were found only in the open portion of the disposal trench. The UXO and UXO debris found in the Group 2 SWMUs (at SWMUs 8 and 31) is summarized in Table 3.3-1.

3.4 CHEMICAL AGENT MONITORING

Soil samples were screened for the presence of chemical agent, primarily as a safety measure. Split samples for chemical agent screening, chemical analysis, geotechnical analysis, and field logging were collected at the same time at each sampling location in SWMUs 3 and 9. The various sample splits remained in the custody of Army Technical Escort Unit (TEU) personnel or the CAMDS laboratory until chemical analysis confirmed that the samples were free of chemical agent. Agent contamination was not detected in any of the samples from these SWMUs. Agent screening was not required during work at SWMUs 5, 8, 30, or 31 due to the lack of activities (past or present) involving chemical agents at these SWMUs. Samples collected for agent screening were not composited.

3.5 SOIL GAS SAMPLING

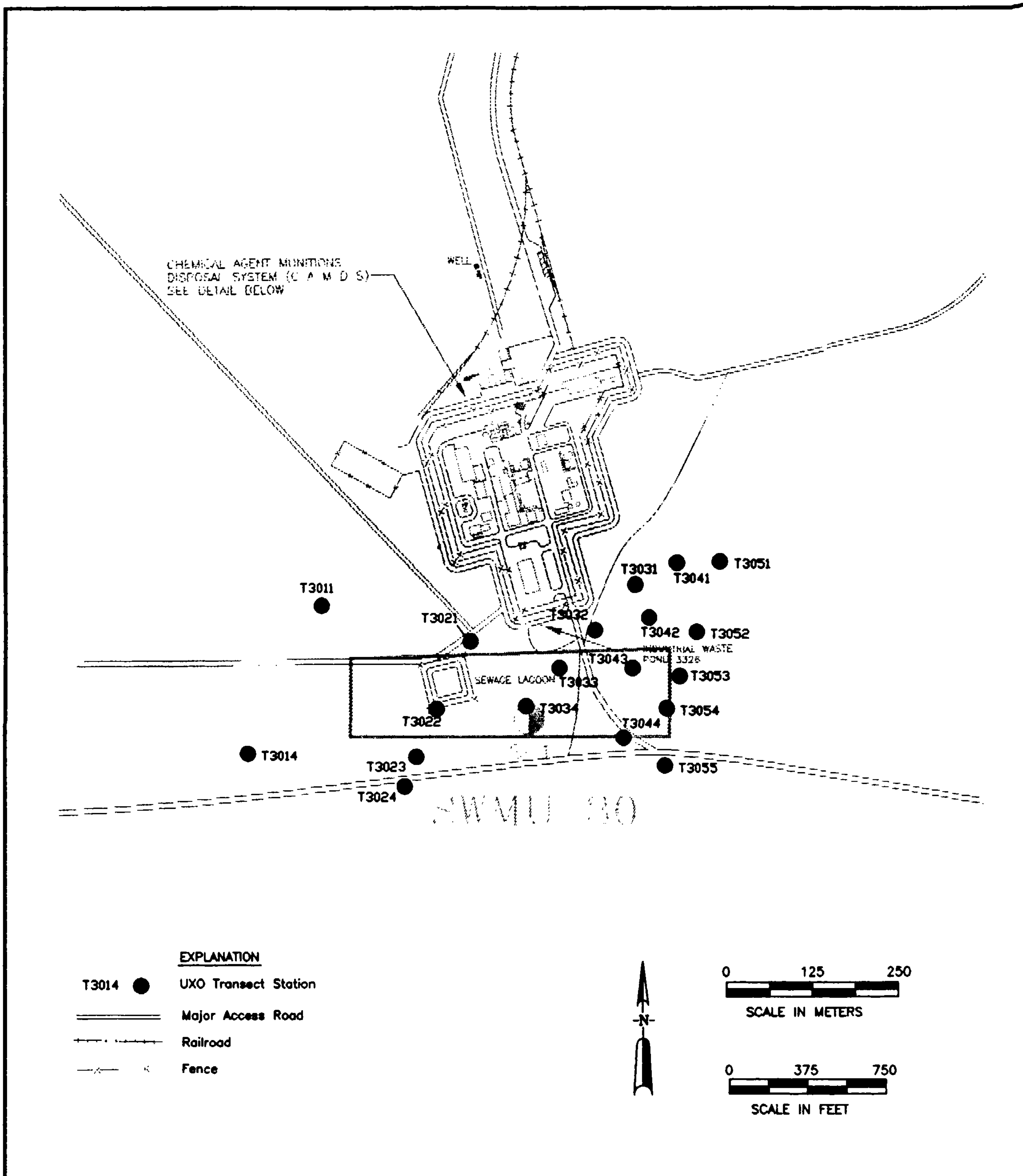
Soil gas sampling was performed at SWMU 5 between June 28 and July 2, 1993 to determine whether VOCs were present, and if so, to identify the potential source area of any such compounds. A total of 58 soil gas samples were collected and analyzed at SWMU 5 (Figure 3.5-1). Standards, duplicates, no-injection blanks, ambient air blanks, and probe blanks were



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.3-1
Location of UXO Inventory Transects at SWMUs 3,5,8,9, and 31

Prepared by:
Ebasco Services Incorporated



Prepared for:

U.S. Army Environmental Center

Aberdeen, Maryland

Figure 3.3-2

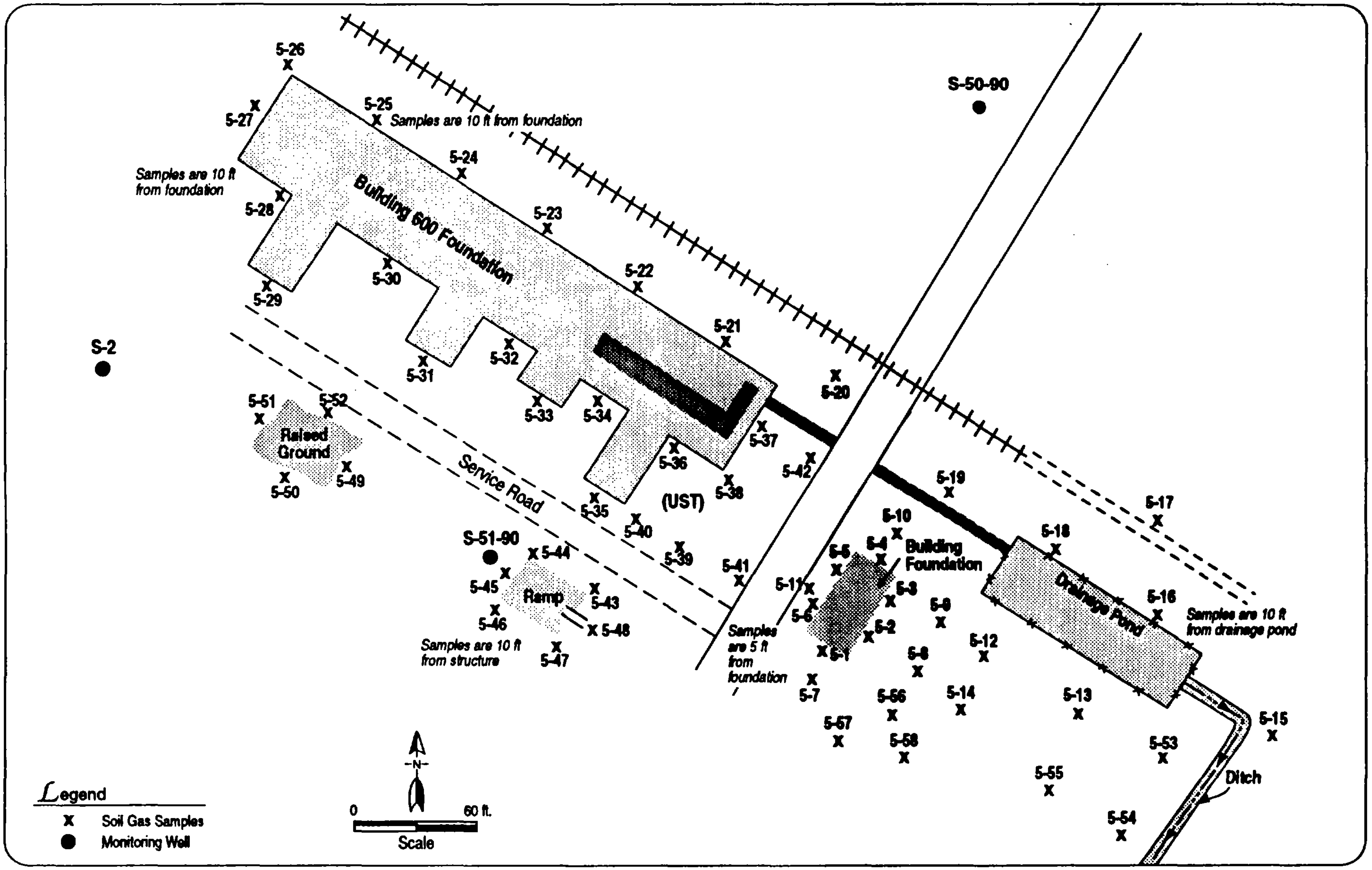
Location of UXO Inventory Transects at SWMU 30

Prepared by: Ebasco Services Incorporated

Table 3.3-1 Ordnance and Ordnance Debris at Group 2 SWMUs

SWMU 3	SWMU 5	SWMU 8	SWMU 9	SWMU 30	SWMU 31	Identifiable Ordnance or Ordnance Debris
		X			X	Proximity fuze (MK 73)
					X	MK 344 bomb fuze
					X	Bulk high explosive (HE)
					X	AIM 7 missile
					X	Crow warhead
		X			X	105 mm HE projectile
					X	M871 practice grenade
					X	40 mm HE grenade
					X	M77 incendiary bomb
					X	HEAT rifle grenade
		X			X	White phosporous grenade
					X	90 mm projectile
		X			X	37 mm projectile
		X			X	Recoilless rifle casings
					X	AGM shrike missile
					X	3.5" rocket containers
		X			X	40 mm HE antiaircraft projectile
		X				75 mm projectile
		X				6 lb flare casing
		X			X	Smoke grenade
		X				250 lb practice bomb
X						Chemical agent container
		X				100 lb bomb

HE high explosive
lb pound
mm millimeter



T3G2 9.16.94.jb

Figure 3.5-1

Soil Gas Survey Locations at SWMU 5

Tooele Army Depot - South Area

Prepared by: Ebasco Services Incorporated

EBASCO

analyzed throughout the field program to control the quality of the results. Data from the soil gas survey assisted in determining soil sampling locations at SWMU 5. More information on the soil gas sampling procedure and results can be found in Appendix L.

3.6 GEOPHYSICAL SURVEY

Three noninvasive geophysical techniques were employed in geophysical surveys at TEAD-S-ground penetrating radar (GPR), electromagnetic induction (EMI), and magnetics. The geophysical surveys were conducted to detect buried material and trenches and to aid in the placement of boreholes for sampling purposes. SWMUs surveyed included the following:

- SWMU 30 – Geophysical investigations consisting of EMI and magnetic surveys were conducted to map the locations of three burn trenches observed in aerial photographs of the site. The survey was conducted over an approximate 10-acre area.

- SWMU 5 – GPR was used to delineate the areal extent of underground storage tanks (USTs) prior to the drilling of soil borings to be placed adjacent to the tank sites.

- SWMU 9 – An EMI geophysical survey was conducted to map the location of four or five possible waste disposal trenches observed in aerial photographs of the unit. The survey was conducted over an approximate 15-acre area.

More information on the geophysical program at these SWMUs can be found in Appendix J.

3.6.1 SWMU 30 Geophysics

The geophysical survey at SWMU 30 was performed to locate a series of three burn trenches that were used from the mid 1950s to the early 1970s to burn wood and dispose of dunnage. Because the trenches have been covered, the locations of the burn trenches are not obvious based on current surface features. The burn trenches are visible on aerial photographs taken in 1959 and 1966, but are not discernible on more recent aerial photographs. Road intersections, drainage ditches, and other landmarks indicated on recent aerial photographs were used to select the survey area.

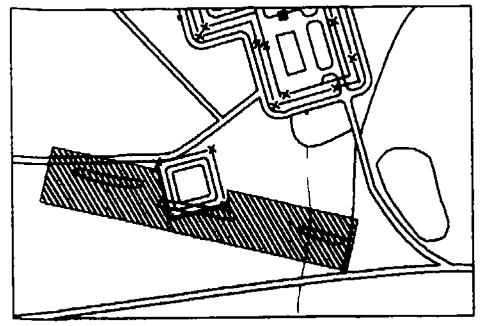
To conduct the survey, a grid measuring 1,400 ft in the east-west direction and 300 ft in the north-south direction was flagged at 40-ft intervals in the east-west direction and 20-ft intervals in the north-south direction. The grid as laid out encompassed the southern portion of a sewage lagoon that had been constructed as part of the CAMDS facility. No data were acquired within the chain-link fence surrounding the sewage lagoon.

The north-south profile lines were oriented perpendicular to the predominant orientation of the trenches as observed on the aerial photographs. EMI and magnetic data were obtained along lines at a 20-ft spacing (one line on the flagged stations and one line between the flags). Magnetic data were collected at a station spacing of 20 ft along each line. EMI data were collected continuously at 0.6-second intervals as each line was traversed at a constant speed. The 0.6-second interval equates to a data point every 2 to 2.5 ft along each line. These data were recorded using a digital electronic data logger.

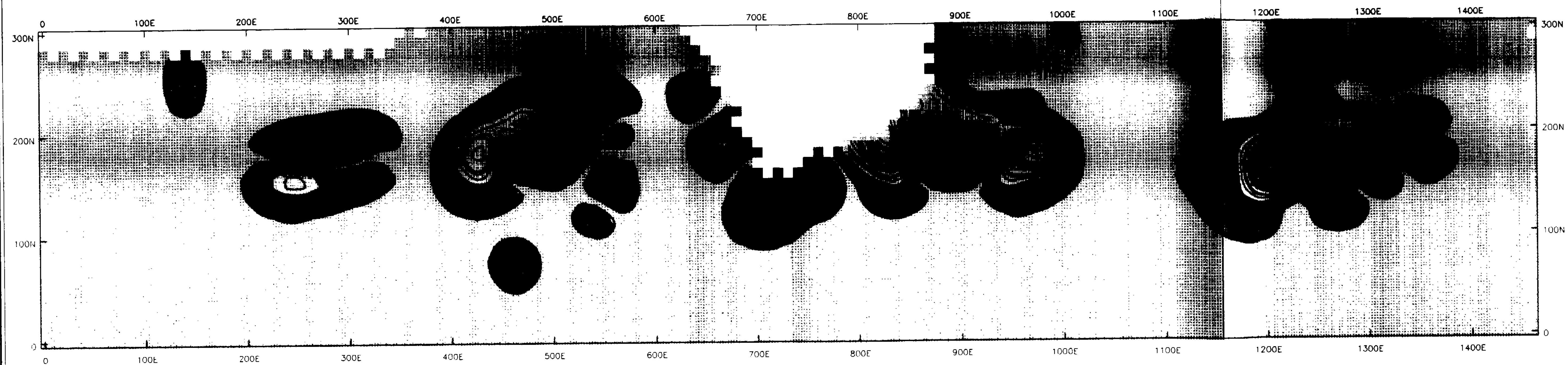
Concurrent with the geophysical survey, a surface features map was developed to document the location of surface scrap metal, groundwater monitor wells, roads, topography, vegetation, and other items observed at the site that could affect the geophysical instrument response.

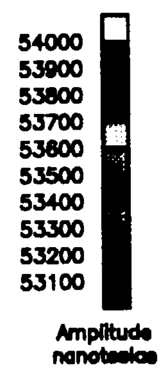
Figure 3.6-1 is a contour map of the total magnetic field data. Magnetic high values (red-toned colors) and magnetic low values (blue-toned colors) indicate magnetic anomalies. The anomalous areas around the wastewater lagoon located approximately at stations 600E to 900E on lines 150N to 300N are probably caused by the chain-link fence surrounding the wastewater lagoon, and therefore, may not indicate the presence of buried material. The large anomaly just east of the lagoon, approximately located on lines 150N to 200N at stations 850E to 975 E, may be caused by an abundance of metal debris at the surface; however, the character of this anomaly suggests that it may correspond to buried material. The small anomaly located approximately on line 75N at station 450E is caused by the metal surface casing of groundwater monitor well S-59-90. The small anomaly located approximately on line 250N at station 125E corresponds to metal posts at the ground surface. Three large anomalies that are probably caused by buried material within the burn pits are located within the grid on lines 125N to 200N at stations 200E to 350E, lines 100N to 250N at stations 375E to 575E, and lines 100N to 225N at stations 1100E to 1350E.

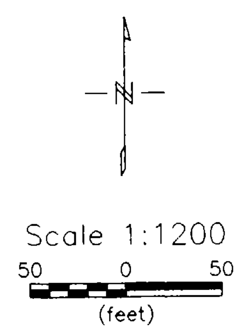
Figure 3.6-2 is a contour map of the EMI in-phase response. Four anomalies on the EMI data may indicate the presence of the burn pits. The first anomaly is located approximately between stations 150N to 200N on lines 200E through 300E. The second anomaly is located approximately between stations 150N to 200N on lines 425E through 500E. Both these anomalies are located on a small mound at the surface and correspond to magnetic anomalies shown in Figure 3.6-1. It is not known if these two anomalies represent different types of buried material at two places in one long pit, or if they represent two shorter pits. The third anomaly is located approximately between stations 150N to 200N on lines 875E to 950E. At this location in the magnetic survey, an anomaly is present that may be associated with scattered metallic debris. The EMI data, in conjunction with the magnetic data, may indicate the presence of a burn pit extending inside the fenced area at the sewage lagoon. The fourth anomaly is located approximately at stations 150N to 200N on lines 1150E through 1350E. This linear anomaly is located between groundwater monitor well S-1 to the west and a mound of soil to the east. This anomaly corresponds to a large magnetic anomaly and is most likely indicative of a covered burn pit. More information on the EMI and magnetic data can be found in Appendix J.



Index Map of Survey Area (Hachured)



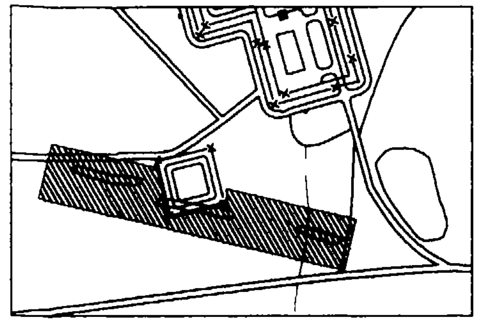




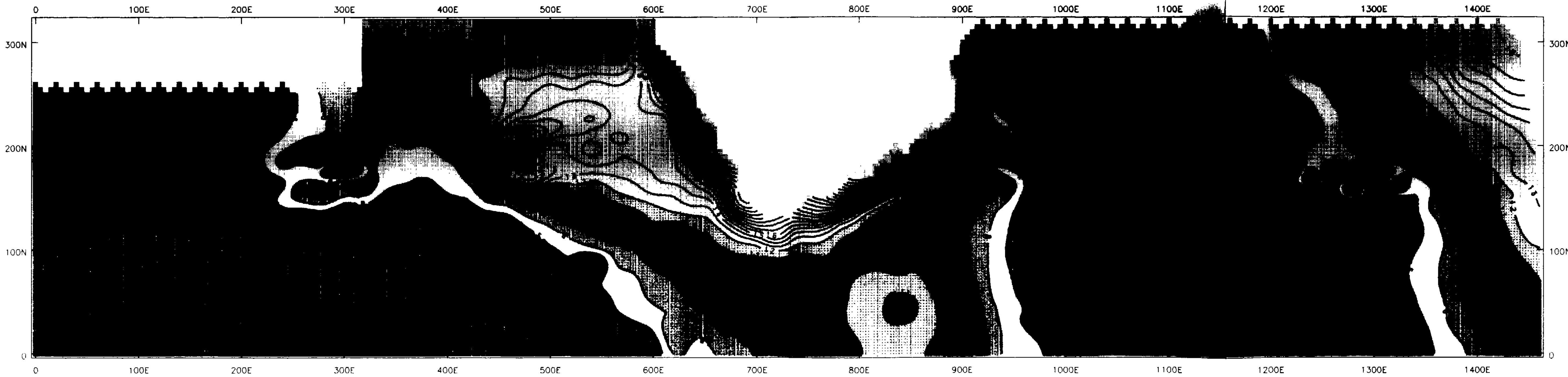
Prepared For: United States Army Environmental Center

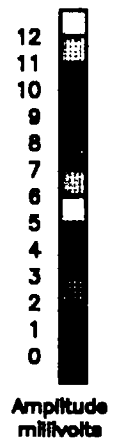
Figure 3.8-1
Total Field Magnetic Response at SWMU 30

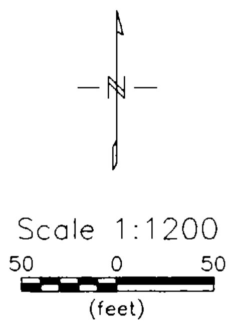
Prepared by:
Ebasco Services Incorporated



Index Map of Survey Area (Hachured)







Prepared For: United States Army Environmental Center

Figure 3.6-2
EMI In Phase Response at SWMU 30

Prepared by:
Ebasco Services Incorporated

3.6.2 SWMU 5 Geophysics

SWMU 5 consists of concrete building foundations, an earthen drainage pond, a ditch, and several peripheral structures. At one time, high-explosive and chemical munitions were renovated in the main building (Building 600). GPR was used at SWMU 5 to determine the size and orientation of one UST near the southeast corner of Building 600 and to determine whether or not another UST was located on the east side of Cross Street near the shower facility building (Figure 3.6-2A). Once the dimensions of the USTs were confirmed, soil boring locations were selected. Standpipes at each of these locations were used to focus the surveys.

GPR profiles were evaluated and proposed boring locations picked at the time of the survey. The extent of the UST at Building 600 was marked with pin flags in the field; however, no maps of the GPR data were made. The UST at Building 600 was found to be oriented with its long axis parallel to the concrete building foundation. A location (5-UST-2) for a 15-ft soil boring was chosen on the east side of the UST. The GPR survey at the standpipe near the shower facility building revealed no indication of a UST. A location (5-UST-1) was chosen for another 15-ft soil boring near the standpipe.

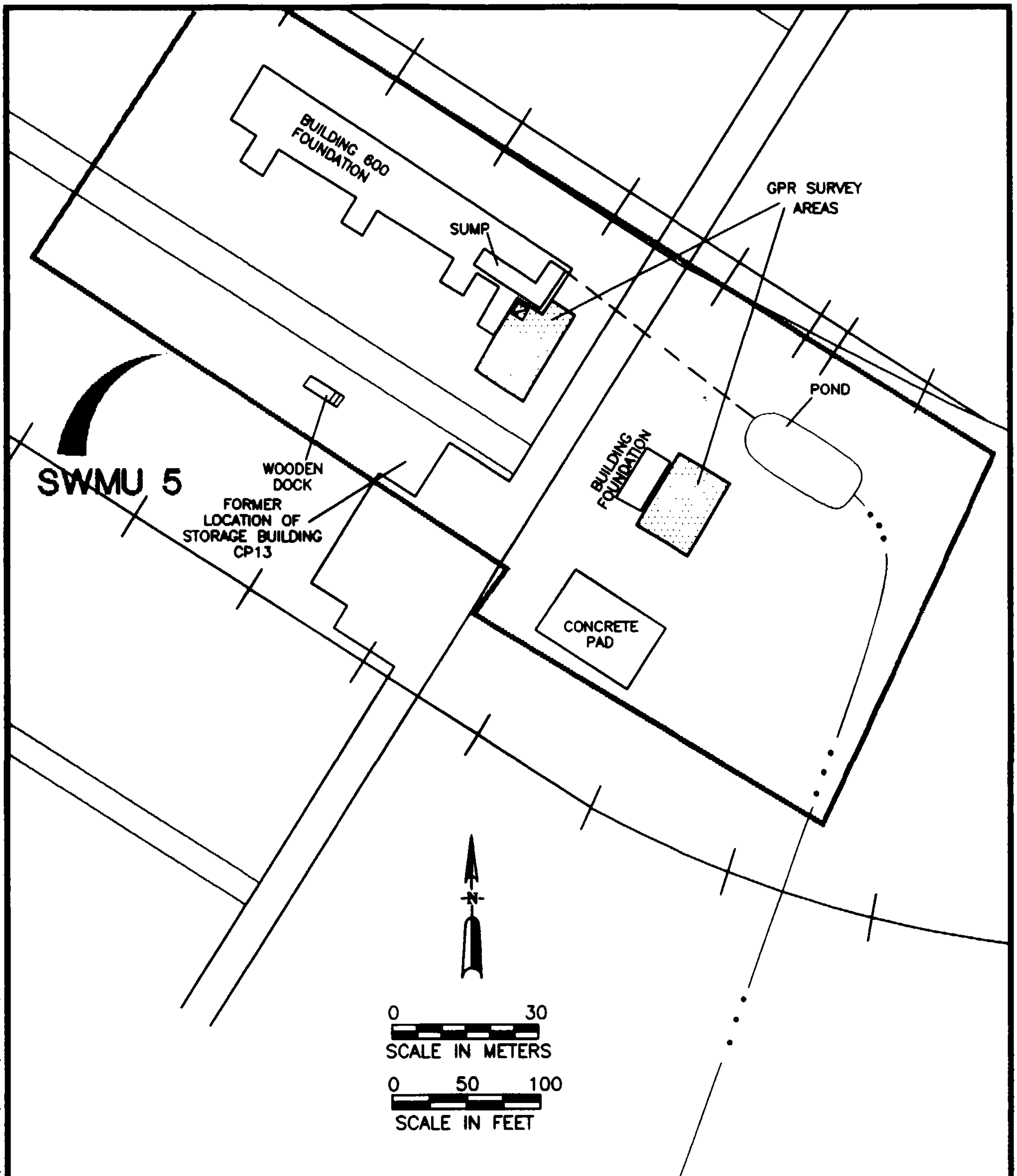
3.6.3 SWMU 9 Geophysics

SWMU 9 was used as a chemical munitions storage area. Although munitions were maintained and valves were changed at SWMU 9, leaking chemical agent containers were removed to SWMU 3 for renovation. Several chemical spills have been documented within the storage area, and a 1974 aerial photograph shows ground scars that were interpreted as burn trenches in an area southeast of the Old Mustard Holding Area (Old Area 2).

An EMI geophysical survey was conducted in the suspected burn trench area to determine whether trenches were present and whether debris and materials were present below ground surface in the trenches. The area chosen for the geophysical survey encompassed five potential burn trenches observed on the 1974 aerial photograph. A grid was established measuring 2,000 ft by 360 ft. The grid was staked every 100 ft in the east-west direction and every 50 ft in the north-south direction.

A surface features map was made for the gridded area. The surface features map documents the topography, vegetation, metallic and non-metallic objects, and debris on the ground surface that may effect the geophysical data. There is an abundance of corrugated sheet metal and other debris in the SWMU 9 survey area.

Lines of EMI data were acquired in the east-west direction every 25 ft in order to be perpendicular to the suspected burn trenches. Data were gathered continuously along each line at 0.6-second intervals, which equates to a sampling station at approximately every 2.5 ft along the line.



F:\PROJECTS\TOOELE\GRAPHICS\S5-GPR.DWG

EXPLANATION

- Approximate Surface Drainage
- Buried Drain Pipe
- Major Access Road
- Railroad Tracks
- Underground Storage Tank
- Approximate SWMU Boundary

Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.6-2A

SWMU 5 Location of GPR Surveys

Prepared by:
Ebasco Services Incorporated Revised: 2/22/96

The quadrature-phase response map (Figure 3.6-3) displays the effects of surface features. Drainage ditches can be seen trending from north to south at approximately stations 1150W to 825W, 900W to 700W, and 250W to 125W. Areas that appear on the aerial photographs as potential burn trenches show up on the quadrature data approximately at stations 1400W, 1100W, 700W, 400W, and 100W. These subtle anomalies are most likely caused by slight depressions or mounds of soil. The geophysical data do not indicate the presence of buried material or disturbed soil at the potential trench locations.

3.7 SOIL SAMPLING

Soil sampling locations were chosen by ground-truthing at each of the Group 2 SWMUs to provide coverage of all of the types of disposal features and operations identified in historical information about each SWMU. In addition, nonintrusive geophysical techniques were used at SWMUs 9 and 30 to delineate the location of suspected buried trenches, and at SWMU 5 to define the extent of suspected USTs. Table 3.7-1 lists the samples and analyses at each site. The sampling included both surficial and subsurface soils, with the top of the sampling interval indicated in the table.

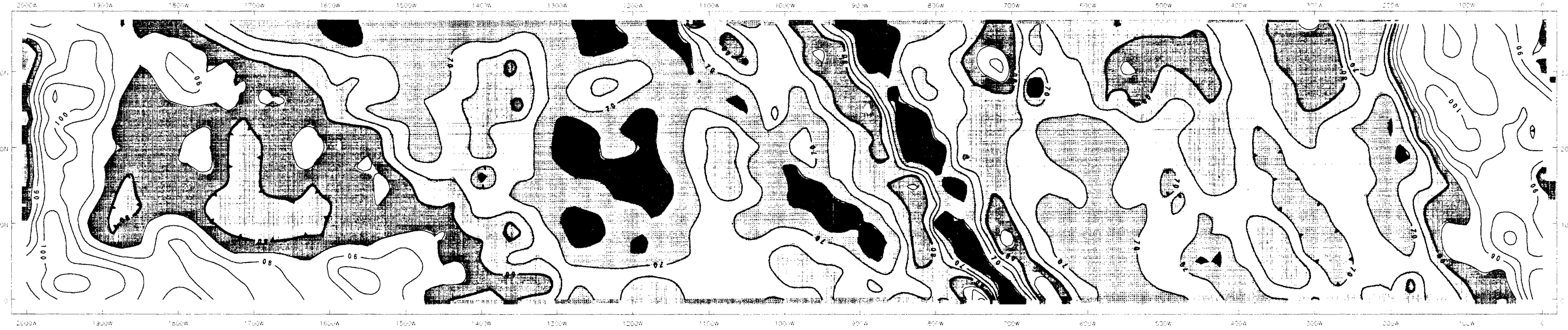
Because Army policies and procedures are still being developed for subsurface soil sampling in areas of potential chemical agent presence, the field program excluded subsurface soil sampling at the disposal trench in SWMU 3. Only surficial soil samples were collected around the open portion of the trench to determine the areal extent of wind-dispersed contamination from the open trench. SWMU 3 subsurface sampling in the covered trench will be performed once the Army has established policies and procedures for excavating and handling chemical agent-contaminated wastes.

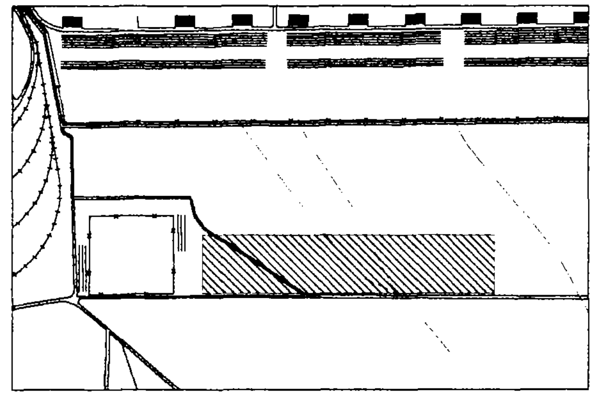
Army TEU continuous air monitor (MINICAMS) units were used for agent screening at boring and test pit locations in SWMUs 3 and 9, where chemical agent was previously stored or otherwise managed.

No sampling was conducted at SWMU 3 to locate a reported VX spill. An in-depth review of the IA (USATHAMA 1979) and other historical documents indicated that the reported VX spill at this site may have occurred in the southeast corner of SWMU 9 rather than at SWMU 3. However, no sampling for the spill occurred at SWMU 9 because the exact location of the VX spill could not be determined.

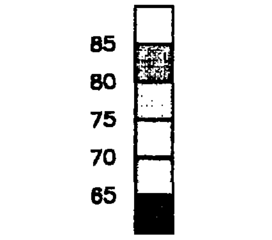
3.7.1 Soil Sampling Locations

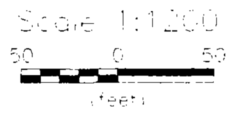
Even where geophysics was used to locate trenches, evidence of contamination observed in the field was used as a primary basis for selecting sampling locations. Preference was given to stained or disturbed areas and areas under or adjacent to waste debris. GPS data were used to establish the coordinates of soil sampling locations within 100 ft of the UXO transects (see Section 3.3). These data were used as the basis for the sampling location base maps.





Index Map of Survey Area (Hachured)





Prepared For: United States Army Environmental Center

Figure 3.6-3
EMI Quadrature Phase Response at SWMU 9

Prepared by
Ebasco Services Incorporated

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 1 of 6

SWMU	Features	Site ID	Site Type Matrix	Volatile Organics	Semivolatile/Base Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
3	Building	3-BLD-1	Grab: 0-2 in.	●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-2	Bore: 2-3 ft.	●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-3		●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-4		●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-5		●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-6		●	[illegible]	[illegible]	●	●	●	●	●
		3-BLD-7		●	[illegible]	[illegible]	●	●	●	●	●
	Metal Grates	3-GRT-1	Grab: 0-2 in.	●	●	●	●	●	●	●	●
		3-GRT-2	Bore: 2-3 ft.	●	●	●	●	●	●	●	●
	Open Trench (Surficial Soil Samples)	3-TRN-1	Grab: 0.2 in.	●	[illegible]	[illegible]	●	●	●	●	●
		3-TRN-2		●	[illegible]	[illegible]	●	●	●	●	●
		3-TRN-3		●	[illegible]	[illegible]	●	●	●	●	●
		3-TRN-4		●	[illegible]	[illegible]	●	●	●	●	●
		3-TRN-5		●	[illegible]	[illegible]	●	●	●	●	●
		3-TRN-6		●	[illegible]	[illegible]	●	●	●	●	●
	Background	3-BK-1	Grab: 0-2 in.							●	●
		3-BK-2	Bore: 2-3 ft.							●	●
5	Pond	5-PND-1	Grab: 0-2 in.		[illegible]	[illegible]				●	●
		5-PND-2	Bore: 0.5-1 ft., 2-3 ft., 4-5 ft.		[illegible]	[illegible]				●	●
	Pond Side	5-PND-3	Grab: 0-2 in.							●	●
		5-PND-4	Bore: 0.5-1 ft.							●	●

T3G2 Rev. 10.6.94.jb

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 2 of 6

SWMU	Features	Site ID	Site Type Matrix	Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
5	Surficial Soil	5-SS-1	Grab: 0-2 in.							•	•
		5-SS-2								•	•
		5-SS-3								•	•
		5-SS-4								•	•
	Ditch	5-DCH-1	Grab: 0-2 in.							•	•
		5-DCH-2	Bore: 2-3 ft.							•	•
		5-DCH-3								•	•
		5-DCH-4								•	•
	UST	5-UST-1	Bore: 4-5 ft., 9-10 ft., 14 ft.	•	•	•				•	•
		5-UST-2		•	•	•				•	•
	Building 600 Foundation/ Loading Dock	5-BLD-1	Grab: 0–2 in.	•	•	•				•	•
		5-BLD-2	Bore: 2-3 ft.	•	•	•				•	•
		5-BLD-3		•	•	•				•	•
		5-BLD-4		•	•	•				•	•
		5-BLD-5		•	•	•				•	•
		5-BLD-6		•	•	•				•	•
		5-BLD-7		•	•	•				•	•
		5-BLD-8		•	•	•				•	•
		5-BLD-9		•	•	•				•	•
		5-BLD-10		•	•	•				•	•
		5-BLD-11		•	•	•				•	•
		5-BLD-12		•	•	•				•	•
		5-BLD-13		•	•	•				•	•
		5-BLD-14		•	•	•				•	•
		5-BLD-15		•	•	•				•	•
		5-BLD-16		•	•	•				•	•
		5-BLD-17		•	•	•				•	•
		5-BLD-18		•	•	•				•	•
		5-BLD-19		•	•	•				•	•
		5-BLD-20		•	•	•				•	•

Analytical columns: Volatile Organics through Cyanide.

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 3 of 6

SWMU	Features	Site ID	Site Type Matrix	Analytical: Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
5	Background	5-BK-1	Grab: 0-2 in.							•	•
		5-BK-2	Bore: 2-3 ft.							•	•
8	Ground Scars	8-GS-1	Grab: 0-2 in., 2-3 ft.	•	•	•	•	•	•	•	•
		8-GS-2		•	•	•	•	•	•	•	•
		8-GS-3		•	•	•	•	•	•	•	•
		8-GS-4		•	•	•	•	•	•	•	•
		8-GS-5		•	•	•	•	•	•	•	•
		8-GS-6		•	•	•	•	•	•	•	•
		8-GS-7		•	•	•	•	•	•	•	•
	Streambed	8-DCH-1	Grab: 0-2 in., 2-3 ft.	•	•	•	[illegible]	•	•	•	•
		8-DCH-2		•	•	•	[illegible]	•	•	•	•
		8-DCH-3		•	•	•	[illegible]	•	•	•	•
	Trenches	8-WTR-1	Grab: 0-2 in., 2-3 ft.	•	•	•	•	•	•	•	•
		8-WTR-2		•	•	•	•	•	•	•	•
		8-NTR-1		•	•	•	•	•	•	•	•
		8-NTR-2		•	•	•	•	•	•	•	•
	Background	8-BK-1	Grab: 0-2 in.							•	•
		8-BK-2	Bore: 2-3 ft.							•	•

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 4 of 6

SWMU	Features	Site ID	Site Type Matrix	Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
9	Old Area 2	9-OA2-1	Grab: 0-2 in.	●	●	●		●	●	●	●
		9-OA2-2	Bore: 0.5-1 ft., 2-3 ft., 4-5 ft.	●	●	●		●	●	●	●
		9-OA2-3		●	●	●		●	●	●	●
		9-OA2-4		●	●	●		●	●	●	●
		9-OA2-5		●	●	●		●	●	●	●
		9-OA2-6		●	●	●		●	●	●	●
		9-OA2-7		●	●	●		●	●	●	●
		9-OA2-8		●	●	●		●	●	●	●
		9-OA2-9		●	●	●		●	●	●	●
		9-OA2-10		●	●	●		●	●	●	●
		9-OA2-11		●	●	●		●	●	●	●
		9-OA2-12		●	●	●		●	●	●	●
	Streambed	9-SB-1	Grab: 0-2 in.	●	●	●	●	●	●	●	●
		9-SB-2	Bore: 2-3 ft.	●	●	●	●	●	●	●	●
		9-SB-3		●	●	●	●	●	●	●	●
		9-SB-4		●	●	●	●	●	●	●	●
	Area 2	9-A2-1	Grab: 0-2 in.	●	●	●		●	●	●	●
		9-A2-2	Bore: 0.5-1 ft., 2-3 ft., 4-5 ft.	●	●	●		●	●	●	●
		9-A2-3		●	●	●		●	●	●	●
		9-A2-4		●	●	●		●	●	●	●
		9-A2-5		●	●	●		●	●	●	●
		9-A2-6		●	●	●		●	●	●	●
		9-A2-7		●	●	●		●	●	●	●
		9-A2-8		●	●	●		●	●	●	●
		9-A2-9		●	●	●		●	●	●	●
		9-A2-10		●	●	●		●	●	●	●
		9-A2-11		●	●	●		●	●	●	●
		9-A2-12		●	●	●		●	●	●	●
		9-A2-13		●	●	●		●	●	●	●
		9-A2-14		●	●	●		●	●	●	●

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 5 of 6

SWMU	Features	Site ID	Site Type Matrix	Analytical: Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
9	Burn Area	9-BA-1	Grab: 0-2 in., 2-3 ft., 4-5 ft. (9-BA-1 to 9-BA-4)	•	•	[illegible]	•	•	•	•	•
		9-BA-2		•	•	[illegible]	•	•	•	•	•
		9-BA-3		•	•	[illegible]	•	•	•	•	•
		9-BA-4		•	•	[illegible]	•	•	•	•	•
		9-BA-5	Grab: 4-5 ft., 9-10 ft.	•	•	•	•	•	•	•	•
	Background	9-BK-1	Grab: 0-2 in.							•	•
		9-BK-2	Bore: 2-3 ft.							•	•
	Trench	9-TP-1	Grab: 0-2 in., 2-3 ft., 4-5 ft.	•	•	[illegible]	[illegible]	•	•	•	•
		9-TP-2A	Grab: 0-2 in., 2-3 ft.	•	•	[illegible]	[illegible]	•	•	•	•
		9-TP-3	Grab: 0-2 in., 2-3 ft., 4-5 ft.	•	•	[illegible]	[illegible]	•	•	•	•
		9-TP-4	Grab: 0-2 in., 2-3 ft.	•	•	[illegible]	[illegible]	•	•	•	•
30	Trench	30-TP1-1	Bore: 0.5-1 ft., 2-3 ft., 4-5 ft., 5-6 ft.	•	•	•	•	•	•	•	•
		30-TP2-1		•	•	•	•	•	•	•	•
		30-TP3-1		•	•	•	•	•	•	•	•
	Surficial Soil	30-SS-1	Grab: 0-2 in.	•	•	[illegible]	•	•	•	•	
		30-SS-2		•	•	[illegible]	•	•	•	•	
		30-SS-3		•	•	[illegible]	•	•	•	•	
		30-SS-4		•	•	[illegible]	•	•	•	•	
		30-SS-5		•	•	[illegible]	•	•	•	•	
		30-SS-6		•	•	[illegible]	•	•	•	•	

Recycled Paper

Table 3.7-1 • Soil Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 6 of 6

SWMU	Features	Site ID	Site Type Matrix	Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
30	Open Storage Area	30-OSA-1 30-OSA-2 30-OSA-3	Grab: 0-2 in. Bore: 2-3 ft.	• • •	• • •	• • •	• • •	• • •	• • •	• • •	• • •
31	Crater Soil	31-CS-1 31-CS-2 31-CS-3 31-CS-4	Grab: 0-2 in., 0.5-1 ft., 2-3 ft.				• • • •			• • • •	• • • •
	Ditch Soil	31-DCH-1 31-DCH-2	Grab: 0-2 in., 2-3 ft.	• •	• •	• •	• •	• •	• •	• •	• •
	Background	31-BK-1 31-BK-2	Grab: 0-2 in. Bore: 2-3 ft.							• •	• •

3.7.1.1 SWMU 3

Soil sampling was conducted at 15 locations in SWMU 3 and at two background locations outside the approximate SWMU boundary (Figure 3.7-1). Six surficial soil samples (3-TRN-1 through 3-TRN-6) were collected from 0 to 2 inches deep in and around the open portion of the trench. These sample locations were selected based on the possibility of contamination in proximity to waste containers present at the surface. The contents of the trench from which these samples were collected were inventoried to assist in further identifying potential contaminants. Within the trench were vented drums that had once contained mustard. Smaller drums in the trench had labels identifying them as DS2 containers.

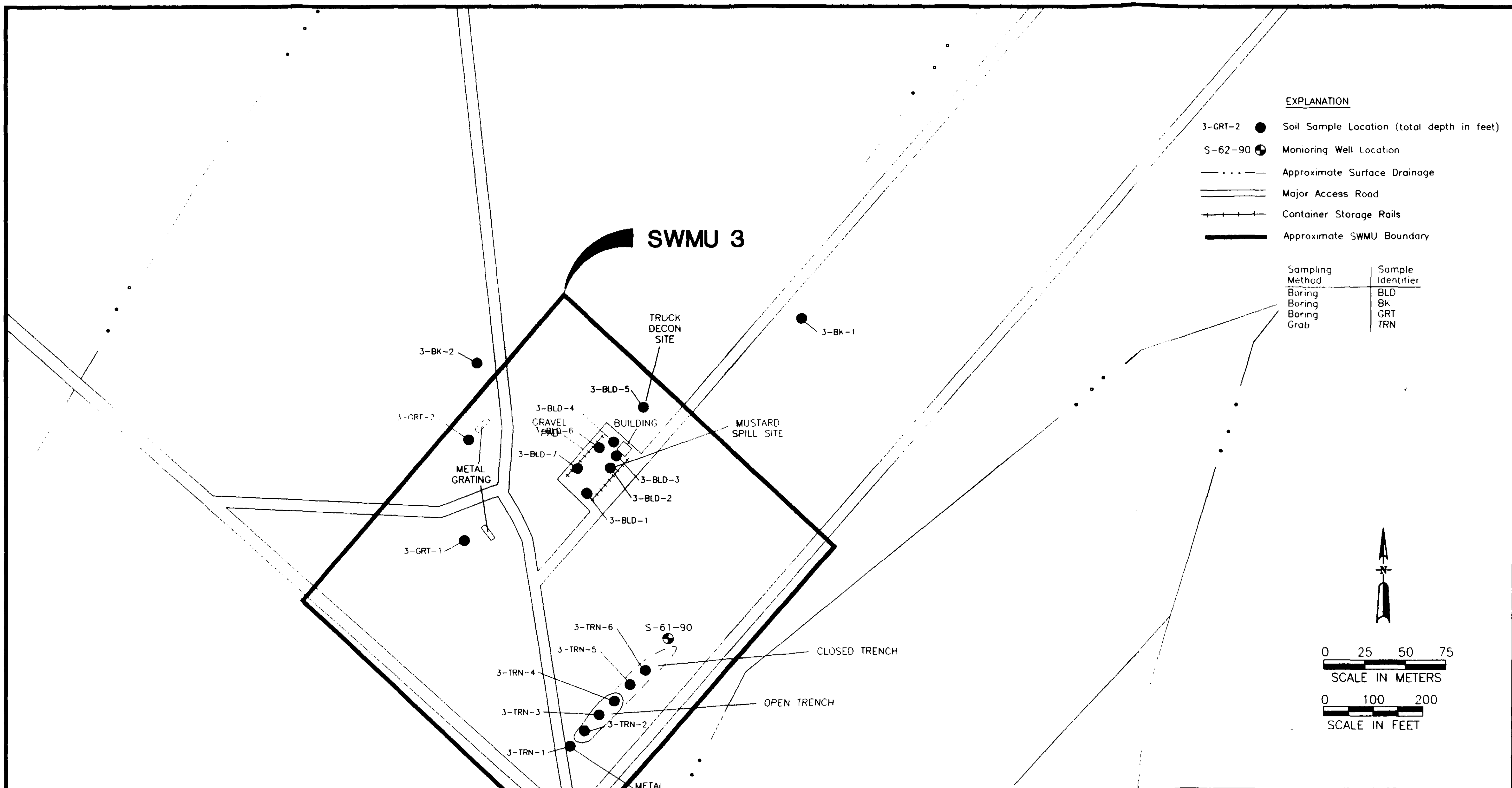
A total of seven soil borings (3-BLD-1 through 3-BLD-7) were drilled around the building. Two soil borings (3-GRT-1 and 3-GRT-2) were also drilled at the stacks of metal grating. All nine of these borings were drilled to a depth of 3 ft and sampled from the 0- to 2-inch and 2- to 3-ft intervals to determine the areal extent of contamination. Due to the potential for chemical agent contamination at SWMU 3, Army TEU personnel continuously monitored with MINICAMS units during all subsurface soil sampling at this SWMU.

Two background boreholes (3-BK-1 and 3-BK-2) were drilled outside the approximate SWMU boundary and sampled in the 0- to 2-inch and 2- to 3-ft depth intervals. The background boreholes were sampled and analyzed for metals and cyanide only. All other soil samples in SWMU 3 were analyzed for VOCs, SVOCs, explosives, metals, and agent breakdown products. The background borehole samples were also analyzed for total organic carbon (TOC), pH, cation-exchange capacity (CEC), and soil index properties to support the contaminant fate and transport modeling as part of the risk assessment. The index properties included bulk density, grain size, Atterberg limits, moisture content, specific gravity, effective porosity, and permeability.

3.7.1.2 SWMU 5

Soil samples were taken from 33 locations within SWMU 5 and from 1 ditch location and 2 background locations outside the approximate SWMU boundary (Figure 3.7-2). Four surficial soil samples (5-SS-1 through 5-SS-4) were collected from 0 to 2 inches around the pond to delineate any contamination due to fugitive dust, and four soil borings (5-PND-1 through 5-PND-4) were drilled to define the depth and extent of metals contamination below the pond and along its sides. Samples from 5-PND-1 and 5-PND-2, in the bottom of the drainage pond, were collected from the 0- to 2-inch, 6- to 12-inch, 2- to 3-ft, and 4- to 5-ft intervals. Samples from 5-PND-3 and 5-PND-4, in the sides of the pond, were collected from the 0- to 2-inch and 6- to 12-inch depth intervals. Four additional soil borings (5-DCH-1 through 5-DCH-4) were drilled in the drainage ditch downstream from the pond to determine the downstream extent of metals contamination there. These samples were collected from 0- to 2-inch, 6- to 12-inch, and 2- to 3-ft depth intervals.

Since previous groundwater sampling detected solvents, a soil gas survey was used to select the soil sampling locations and depths around the foundations and dock. Fifteen soil borings (5-



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-1

SWMU 3 Sample Location Map

Prepared by:
Ebasco Services Incorporated

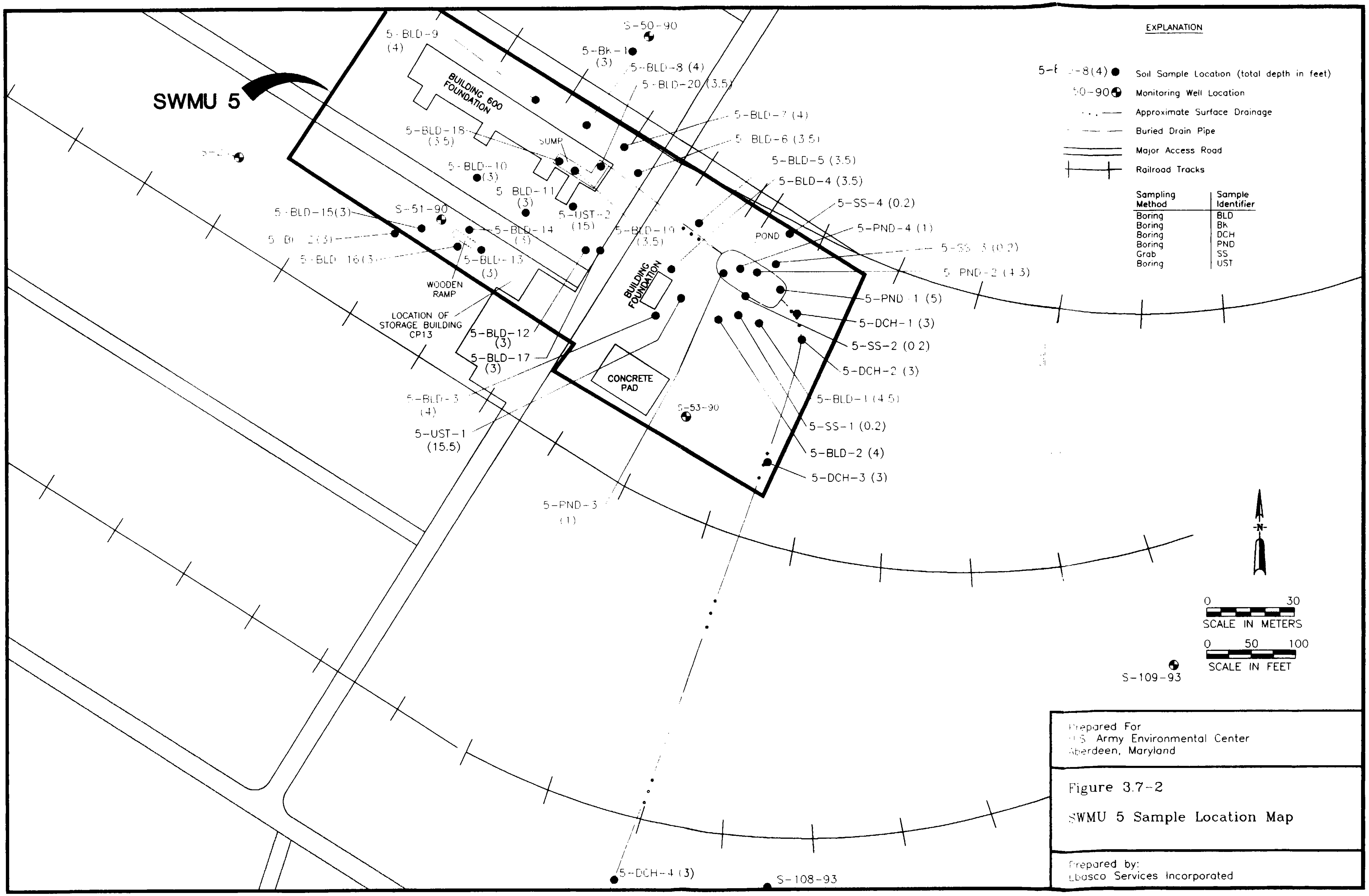


Figure 3.7-2

SWMU 5 Sample Location Map

BLD-6 through 5-BLD-20) were drilled around the Building 600 foundation and a wooden structure resembling a loading dock to determine the presence of any contamination released during loading or unloading operations involving munitions, paints, or other chemicals used at the former washout and painting facility. Five soil borings (5-BLD-1 through 5-BLD-5) were drilled east of the small building foundation on the east side of Cross Street. Two soil samples were collected from each of these borings (from the 0-to 2-inch and 2- to 3-ft depth intervals) and analyzed for VOCs, SVOCs, and metals.

Two background soil borings (5-BK-1 and 5-BK-2) were drilled outside the approximate boundary of SWMU 5. Samples from the 0- to 2-inch and 2- to 3-ft intervals in these borings were chemically analyzed for metals and cyanide only.

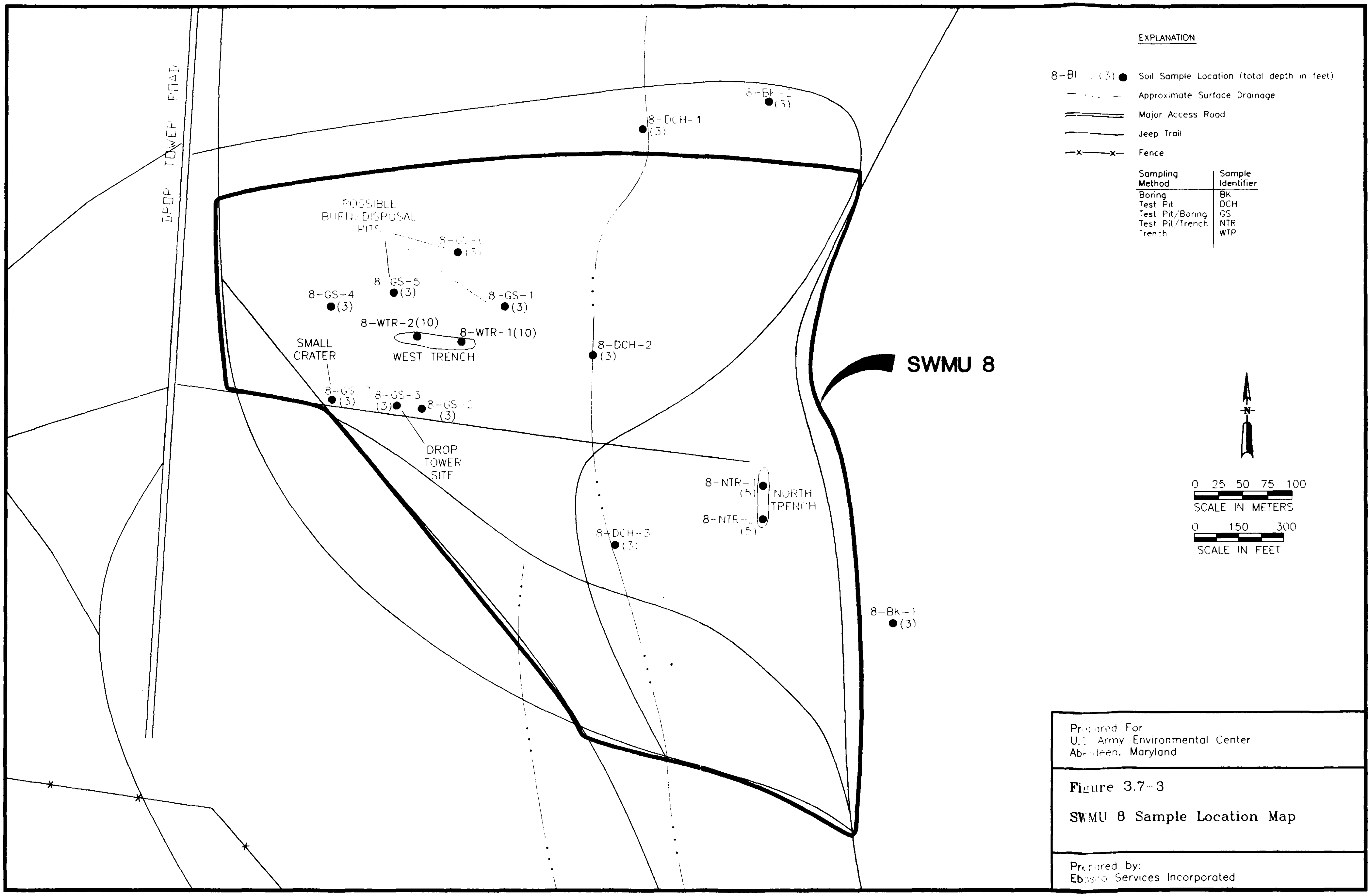
Samples from the two background borings, location 5-BLD-17, and monitor wells S-108-93 and S-109-93 were analyzed for pH, TOC, CEC and soil index properties. The index properties included bulk density, moisture content, grain size, Atterberg limits, specific gravity, effective porosity, and permeability. Geotechnical samples in the new monitor well boreholes were collected from the saturated zone. Geotechnical results are found in Appendix A4.

A simple volumetric leak test was performed in the pipe connecting the L-shaped sump and the drainage pond. Twenty-five gallons of approved water was poured into the pipe at the sump end of the pipe. The water was not recovered at the discharge end of the pipe in the drainage pond. The lack of water recovery may have been caused by either leaks or an obstruction in the pipe.

TEAD-S had initially planned to remove the UST near Building 600 prior to commencement of field activities. Because the UST had not been removed and whether or not a UST was associated with a standpipe near the shower facility building on the east side of Cross Street had not been determined prior to RFI-Phase II sampling at this SWMU, a noninvasive geophysical survey using GPR was conducted to delineate the areal extent of the known and suspected USTs. The geophysical survey determined the lateral extent of the UST near Building 600, but did not detect the presence of another UST at the shower facility building. One soil boring (5-UST-2) was drilled next to the known UST by Building 600. The other boring (5-UST-1) was drilled to the side of the standpipe near the shower facility building. Both borings were drilled to a depth of 15.5 ft; soil samples were collected from each boring at 4- to 5-ft, 9- to 10-ft, and 14- to 15-ft intervals. Samples were analyzed for VOCs, SVOCs, and metals.

3.7.1.3 SWMU 8

Soil samples were collected from 14 locations within SWMU 8 and from 2 background locations outside the approximate SWMU boundary (Figure 3.7-3). Soil sampling was conducted in SWMU 8 at several ground scars, the former drop tower site, and in the streambed through the unit. Field reconnaissance of this area was performed to identify the appropriate sampling locations for the northern ground scar using the 1966 aerial photograph because few of the ground scars shown by this photograph appear clearly on later photographs. Due to the presence



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-3

SWMU 8 Sample Location Map

Prepared by:
Ebasco Services Incorporated

of extensive metal debris in SWMU 8, which primarily consists of cluster bomblet casings and UXO ejected by ordnance detonation in the adjacent SWMU 31, all soil samples inside the SWMU were collected using a backhoe.

Five sampling locations (8-GS-1, 8-GS-4, 8-GS-5, 8-GS-6, and 8-GS-7) were placed at separate ground scars within the SWMU and two locations (8-GS-2 and 8-GS-3) near the former drop tower site. The soil was sampled at the 0- to 2-inch, 6- to 12-inch, and 2- to 3-ft depth intervals at these locations. The 6- to 12-inch interval sample was not collected at 8-GS-7 since the additional sampling and analytical costs would have exceeded the amount set forth in the contract.

Three test pits (8-DCH-1, 8-DCH-2, and 8-DCH-3) were excavated in the drainage ditch that flows through SWMU 8 from SWMU 9. Two samples were collected from each pit, typically from the 0- to 2-inch and 2- to 3-ft depth intervals. This sampling scheme was modified at the 8-DCH-1 site to include a black layer within the 6- to 12- inch interval. Samples from the ground scars and drainage ditch were analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals.

Since the west trench and the north trench (8-W-Trench and 8-N-Trench) in SWMU 8, which were open during the RFI-Phase I field program, are now covered, test pits were excavated to collect samples from within their boundaries (Figure 3.7-4). UXO contractor personnel performed the actual excavation of two test pits per trench (8-WTR-1 and 8-WTR-2 at 8-W-Trench; 8-NTR-1 and 8-NTR-2 at 8-N-Trench). A total of 16 soil samples were collected at the 0.5- to 1-ft, 3- to 4-ft, and 9- to 10-ft intervals and analyzed for VOCs and SVOCs, explosives, agent breakdown products, and metals. During excavation, the test pit soil was examined for debris and signs of contamination. No debris was found in the trenches; therefore, no inventory was required.

In addition, two background samples (8-BK-1 and 8-BK-2) were collected using a hollow-stem auger drill rig outside the SWMU 8 boundary in the 0- to 2-inch and 2- to 3-ft intervals and were analyzed for metals and cyanide only. Background boring soil samples were also analyzed for pH, total organic carbon, cation-exchange capacity, and soil index properties that are needed for contaminant fate and transport modeling. The index properties included bulk density, grain size, Atterberg limits, moisture content, specific gravity, effective porosity, and permeability.

3.7.1.4 SWMU 9

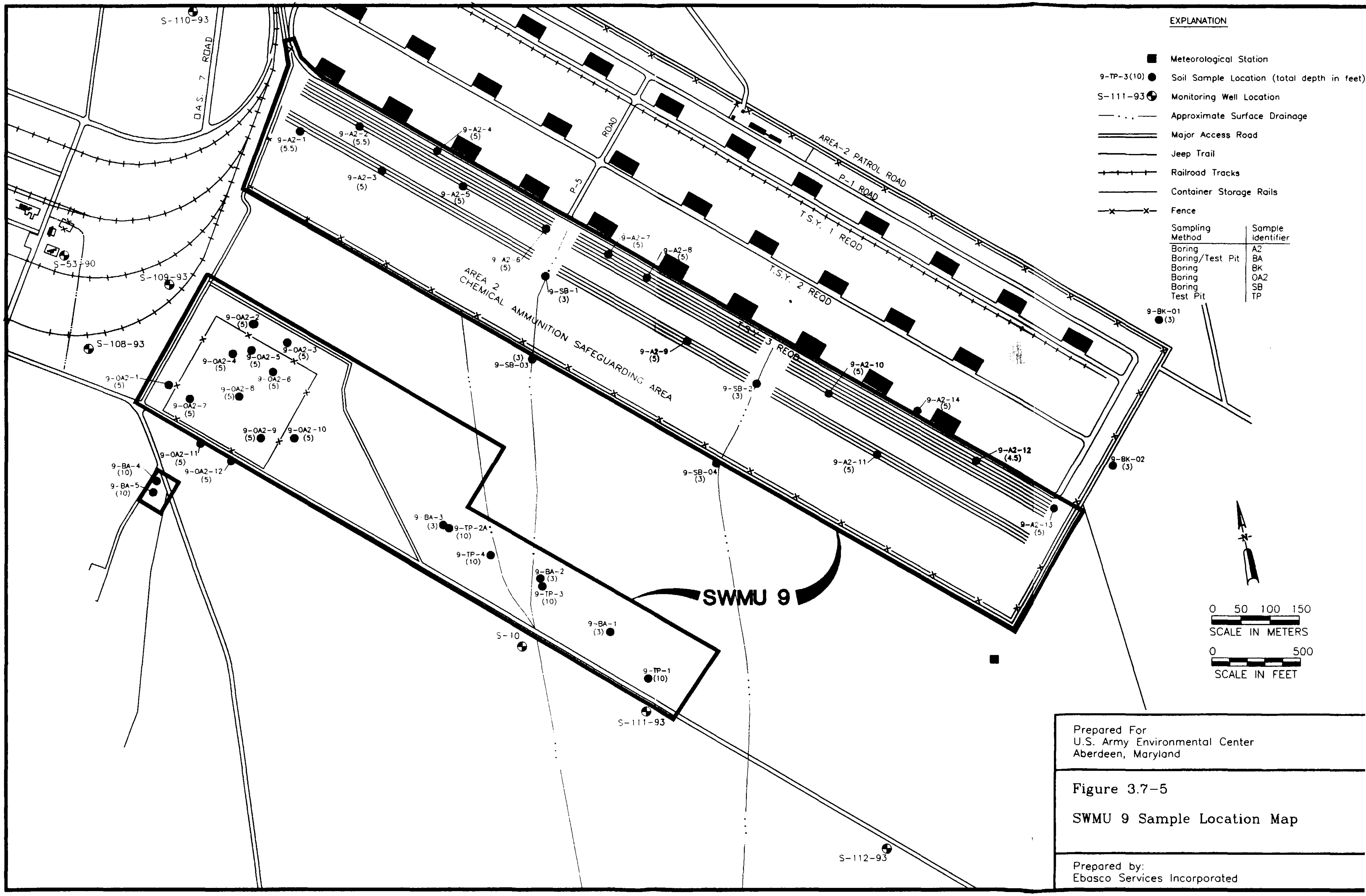
Soil samples were collected from 30 soil boring locations and 9 test pit and burn area locations within SWMU 9 (Figure 3.7-5). In addition, two background borings were sampled outside the eastern boundary of the SWMU. Army TEU personnel continuously monitored with a MINICAMS unit during sampling at this SWMU due to the possibility of encountering chemical agents.

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-4

Test Pit Excavation (8-NTR-2) at North Trench in SWMU 3.

Prepared by
Ebasco Services Incorporated



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-5

SWMU 9 Sample Location Map

Prepared by:
Ebasco Services Incorporated

Additional soil sampling was recommended at Old Area 2 in SWMU 9 to delineate the lateral and vertical extent of contamination previously detected during Phase I sampling (Weston 1991). A total of 12 borings were drilled in this area during the RFI–Phase II. The rationale for the sample location selection in Old Area 2, and other areas within the SWMU 9, is provided in Table 3.7-2. Seven borings (9-OA2-1, and 9-OA2-4 through 9-OA2-9) were drilled inside Old Area 2 at former operations and contaminated sites (Figure 3.7-6). Five borings (9-OA2-2, 9-OA2-3 and 9-OA2-10 through 9-AO-12) were drilled around the outside of this area. Each boring was sampled from 0- to 2-inch, 6- to 12-inch, 2- to 3-ft, and 4- to 5-ft intervals and analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals. Due to the possibility of encountering chemical agent, Army TEU personnel continuously monitored with a MINICAMS unit during sampling in Old Area 2.

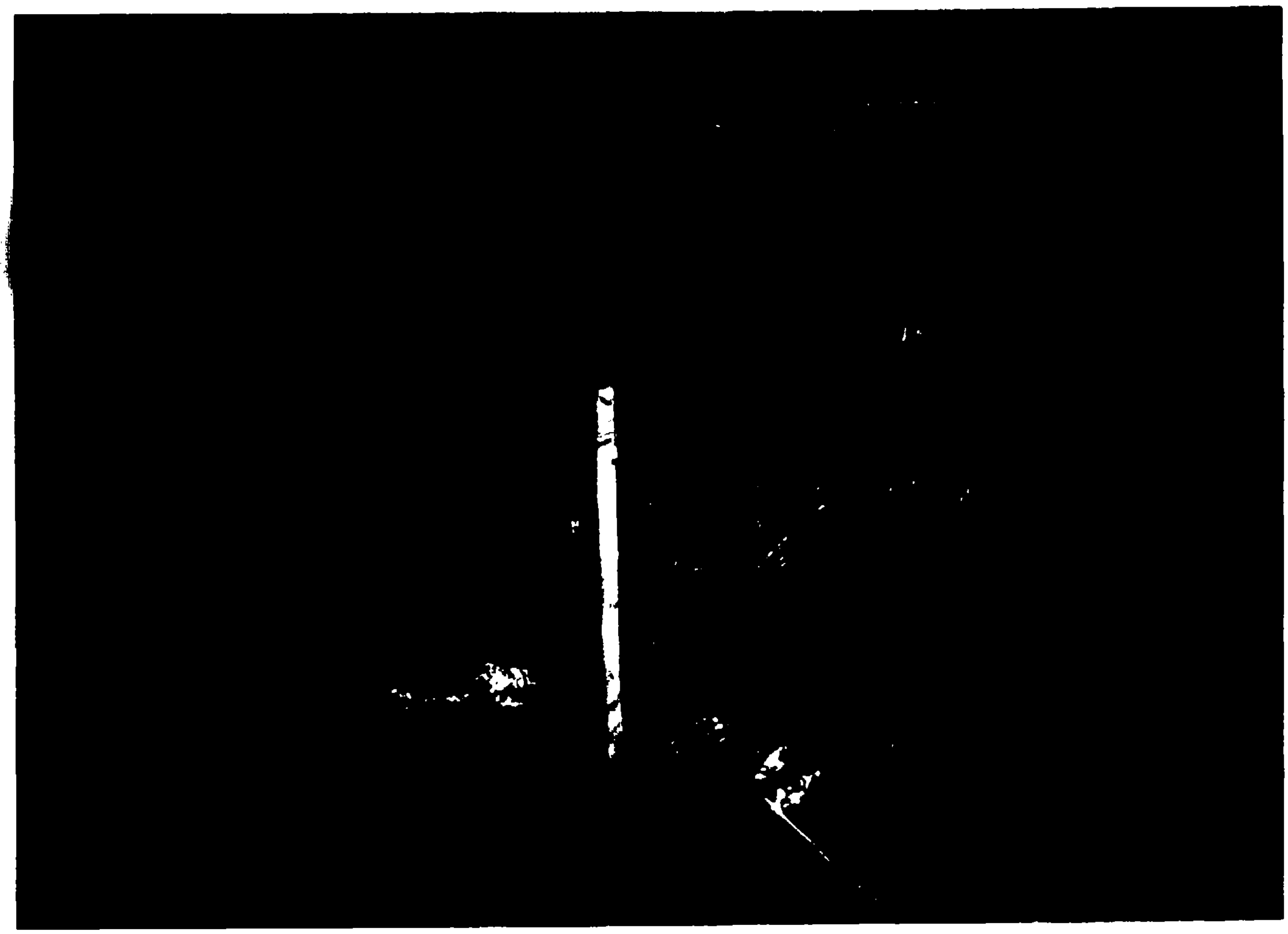
Prior to sampling, a noninvasive terrain conductivity geophysical survey was performed to determine the location of the former burn trenches. Although no trenches were delineated by this survey, three test pits (9-TP-1, 9-TP-2, and 9-TP-3) approximately 10 ft deep and 10 ft long were excavated by the UXO contractor east of the main drainage ditch in SWMU 9 (Figure 3.7-7). One test pit (9-TP-4) was also excavated on the west side of the secondary drainage ditch that is to the west of the main drainage ditch, and one test pit (9-TP-2A) was excavated in the western portion of the suspected burn trench area. In addition, each of the five burn area sites were excavated using a single backhoe scoop down to approximately 3 ft (Figure 3.7-8). Two of these sites (9-BA-1 and 9-BA-2) offset the test pit locations to the east of the main drainage ditch. Another site (9-BA-3) offset the 9-TP-2A location in the western portion of the burn trench area. The other two sites (9-BA-4 and 9-BA-5) were located on the hillside to the southwest of Old Area 2. Samples were taken in the 0- to 0.2-ft and 2- to 3-ft intervals at TP-2A, TP-4, and BA-1 through BA-4. TP-1 and TP-3 were sampled at 0- to 0.2-ft, 2- to 3-ft, and 4- to 5-ft intervals. BA-5 was sampled at 4- to 5-ft and 9- to 10-ft intervals. No samples were submitted for analyses from TP-2 since sampling at this location was not approved. These samples were analyzed for VOCs, SVOCs, explosives, agent breakdown products, dioxins and furans, and metals.

Previous samples collected from the drainage ditches east of Old Area 2 during the RI (Weston 1991) were limited to 1- to 1.5-ft depth because explosives tend to degrade near the surface. Four deeper soil borings (9-SB-01 through 9-SB-04) were drilled in these drainage ditches in and near Area 2 during the RFI-Phase II field investigation to collect samples from the 0- to 2-inch and 2-to 3-ft intervals. These samples were analyzed for VOCs, SVOCs, explosives, agent breakdowns products, and metals.

In the open portion of Area 2 (i.e., southwest of the ammunition storage buildings) samples were collected at 14 locations (9-A2-1 through 9-A2-14). At each location, soil was sampled at the 0- to 2-inch and 6- to 12-inch, 2- to 3-ft, and 4- to 5-ft intervals. The samples were analyzed for VOCs, SVOCs, agent breakdown products, and metals.

Table 3.7-2 Rationale for SWMU 9 Sample Locations

Waste Management Area	Site ID	Location Rationale
Area 2	9-A2-1	Former Phosgene Storage Site (Storage Rail 10)
Open Storage	9-A2-2	North Side of Storage (Rail G)
	9-A2-3	Between Storage Rails 2 and 3 where Trucks Moved
	9-A2-4	Drainage Ditch Downgradient from Storage Rails
	9-A2-5	Splash on Storage Rail 5
	9-A2-6	Former Mustard Storage Site (Storage Rail 4)
	9-A2-7	Southside of Storage Rail 2
	9-A2-8	Stain on Storage Rail 3
	9-A2-9	Ties on Storage Rail 8
	9-A2-10	North Side of Storage Rail 6
	9-A2-11	Ties on Storage Rail 9
	9-A2-12	Stain on South Side of Storage Rail 1
	9-A2-13	Near Wood/Canvas Lean-to at end of Storage Rail 3
	9-A2-14	Former VX Storage Site between Warehouses
	9-SB-1	Downstream from Storage Rails
	9-SB-2	Downstream from Fertilizer and Agent Storage
	9-SB-3	Downstream from Area 2 Operations
	9-SB-4	Downstream from Area 2 Operations
Old Area 2	9-OA2-1	Former Storage Rail Area
	9-OA2-2	North of old Area 2
	9-OA2-3	North of Old Area 2
	9-OA2-4	BZ-Bomb Support Frame in Old Area 2
	9-OA2-5	Debris Pile in Old Area 2
	9-OA2-6	Former Structure Location in Old Area 2
	9-OA2-7	Former Structure Location in Old Area 2
	9-OA2-8	Debris Pile near Treatment Tank
	9-OA2-9	Former Structure Location
	9-OA2-10	East of Old Area 2
	9-OA2-11	South of Old Area 2 and Road
	9-OA2-12	South of Old Area 2 and Road
Burn Trench Area	9-TP-1	Eastern Trench on Aerial Photo
	9-TP-2A	Western Trench on Aerial Photo
	9-TP-3	West Central Trench on Aerial Photo
	9-TP-4	Central Trench on Aerial Photo (west of drainage ditches)
	9-BA-1	Burn Debris on Ground Surface
	9-BA-2	Site of Former Building
	9-BA-3	Stain near West Trench
	9-BA-4	South Burn Trench
	9-BA-5	South Burn Trench



Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-6

Soil Boring Location (9-OA2-8) in debris near Former Treatment Unit in Old Area 2 at SWMU 9.

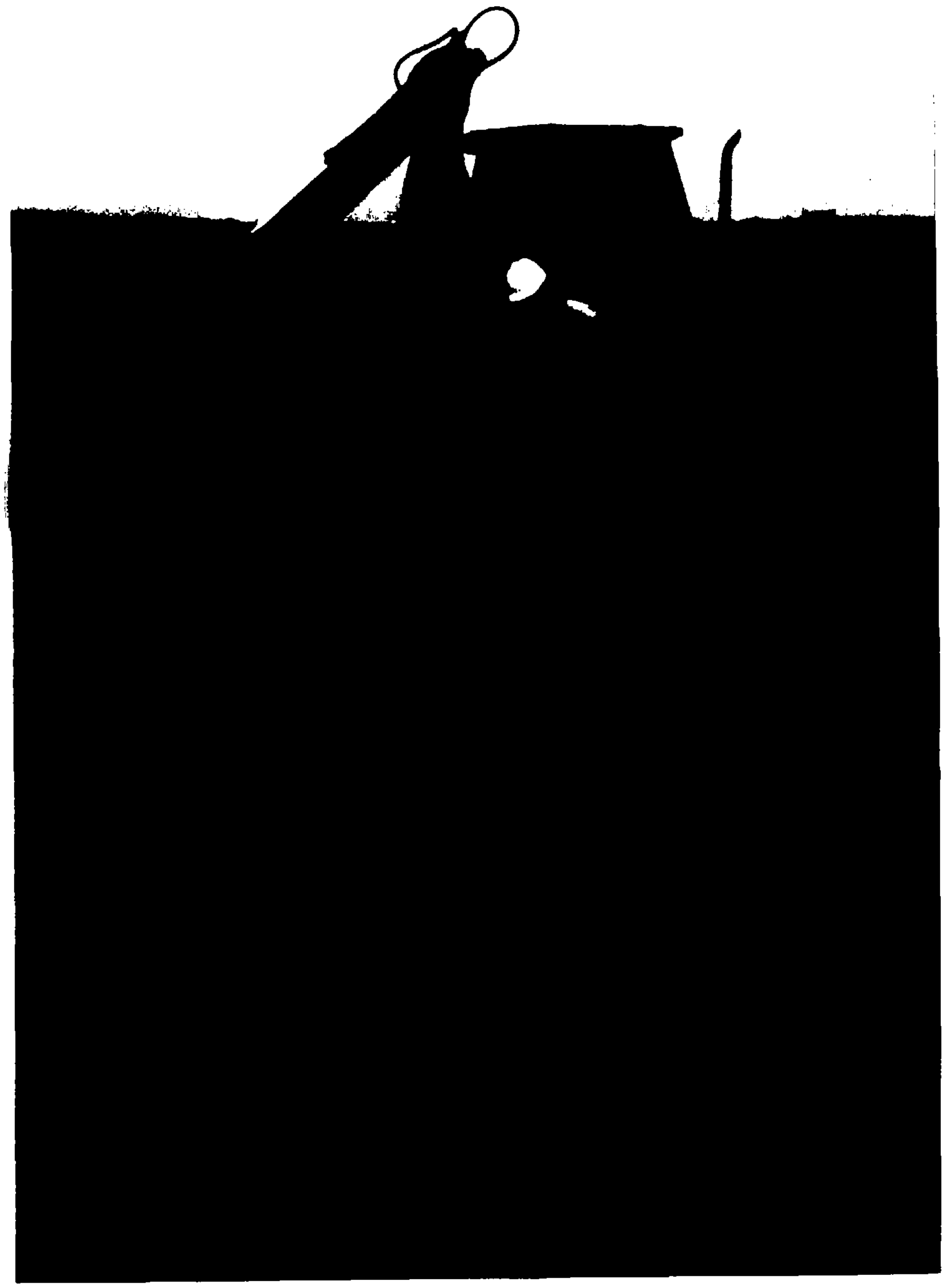
Prepared by:
Ebasco Services Incorporated

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-7

Test Pit Excavation (9-TP-3) in Burn Trench Area at SWMU 9.

Prepared by:
Ebasco Services Incorporated



Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-8

Shallow Burn Area Excavation (9-BA-2) in Burn Trench Area at SWMU 9.

Prepared by:
Ebasco Services Incorporated

In addition, two background borings (9-BK-01 and 9-BK-02) were sampled at SWMU 9 in the 0- to 2-inch and 2- to 3-ft depth intervals. Background borehole samples were chemically analyzed for metals and cyanide only.

Geotechnical samples were collected from the background soil borings and from the saturated zone in monitor wells S-110-93 and S-111-93. These samples were analyzed for pH, TOC, CEC, and soil index properties to support fate and transport modeling as part of the risk assessment.

3.7.1.5 SWMU 30

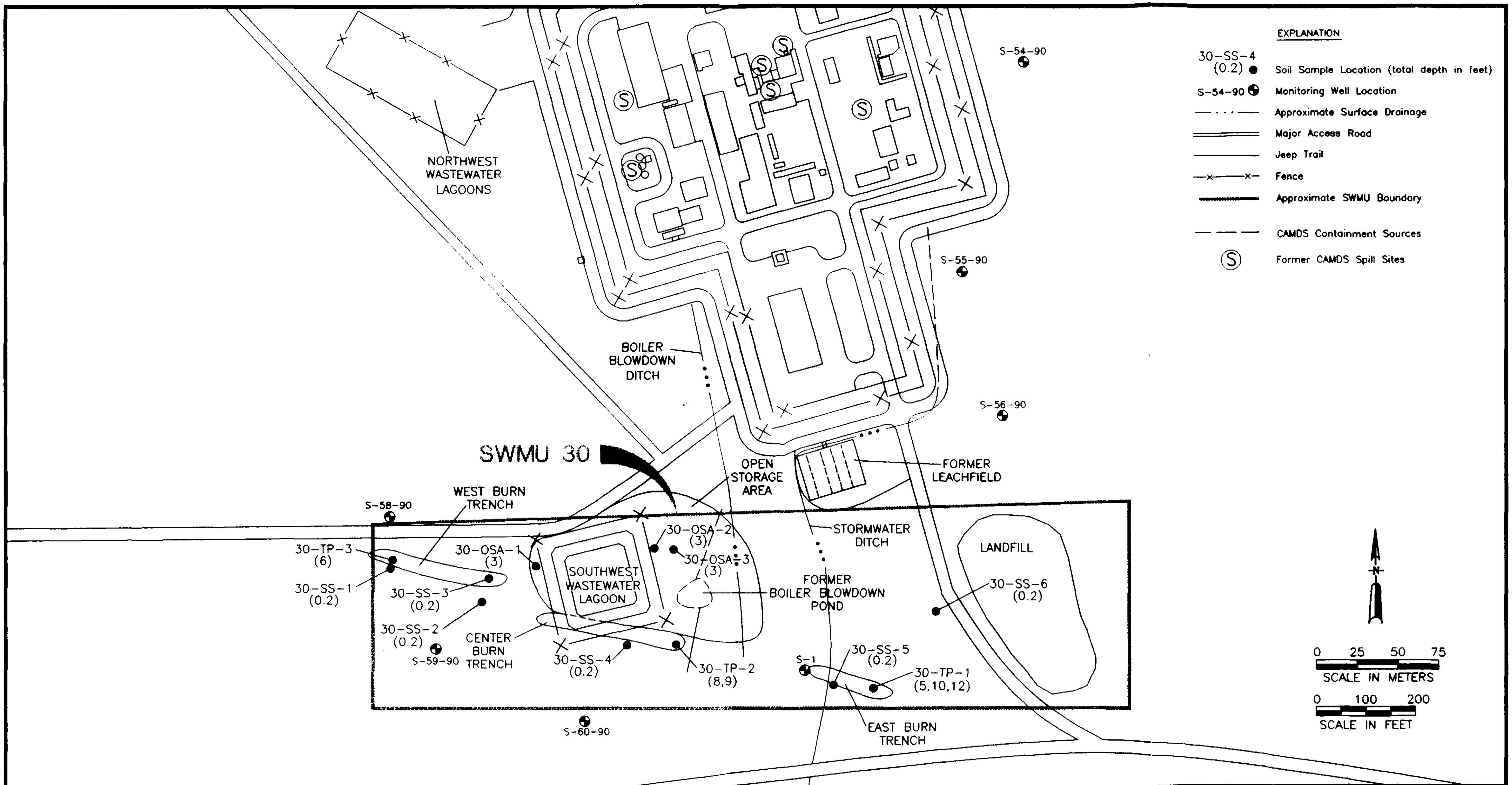
Soil samples were collected from three test pits, three soil borings, and six surficial soil locations within the approximate SWMU boundary (Figure 3.7-9). No background borings were sampled at this SWMU because several background locations in this area were previously sampled as part of the RFI-Phase II of known releases SWMU 13 (CAMDS). Noninvasive magnetic and EMI geophysical surveys were used to locate the three covered trenches at SWMU 30. One test pit was then excavated in each of these three trenches (30-TP-1 through 30-TP-3) to expose the trench contents for inventory and sampling (Figure 3.7-10). Three samples of the fill were collected from each trench and analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals. Six surficial soil samples (30-SS-1 through 30-SS-6) were collected around the three trenches and analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals. In addition, three soil borings (30-OSA-1 through 30-OSA-3) were drilled in the area just north of the trenches where dunnage was reportedly stored prior to burning. Soil samples were collected from the 0- to 2-inch and 2-to 3-ft intervals and analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals.

Soil samples from the three borings in the open storage area (OSA) were analyzed for geotechnical parameters including total organic carbon, pH, cation-exchange capacity, and soil index properties to support fate and transport modeling in the risk assessment.

3.7.1.6 SWMU 31

Soil samples were collected from six soil excavations, four surface water samples were collected from locations within SWMU 31, and two background soil borings were drilled outside the SWMU boundary (Figure 3.7-11). Due to the presence of extensive metal debris and potential UXO in the bottom of the detonation pits where soil samples were collected, all soil samples were collected using a backhoe (Figure 3.7-12). Four soil borings (31-CS-1 through 31-CS-4) were collected from active detonation pits. All soil samples from these pits were analyzed for explosives and metals only.

Two 3-ft excavations (31-DCH-1 and 31-DCH-2) were made in the streambed downgradient from the detonation craters. The excavations were sampled at the 0- to 2-inch and 2- to 3-ft intervals.



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-9

SWMU 30 Sample Location Map

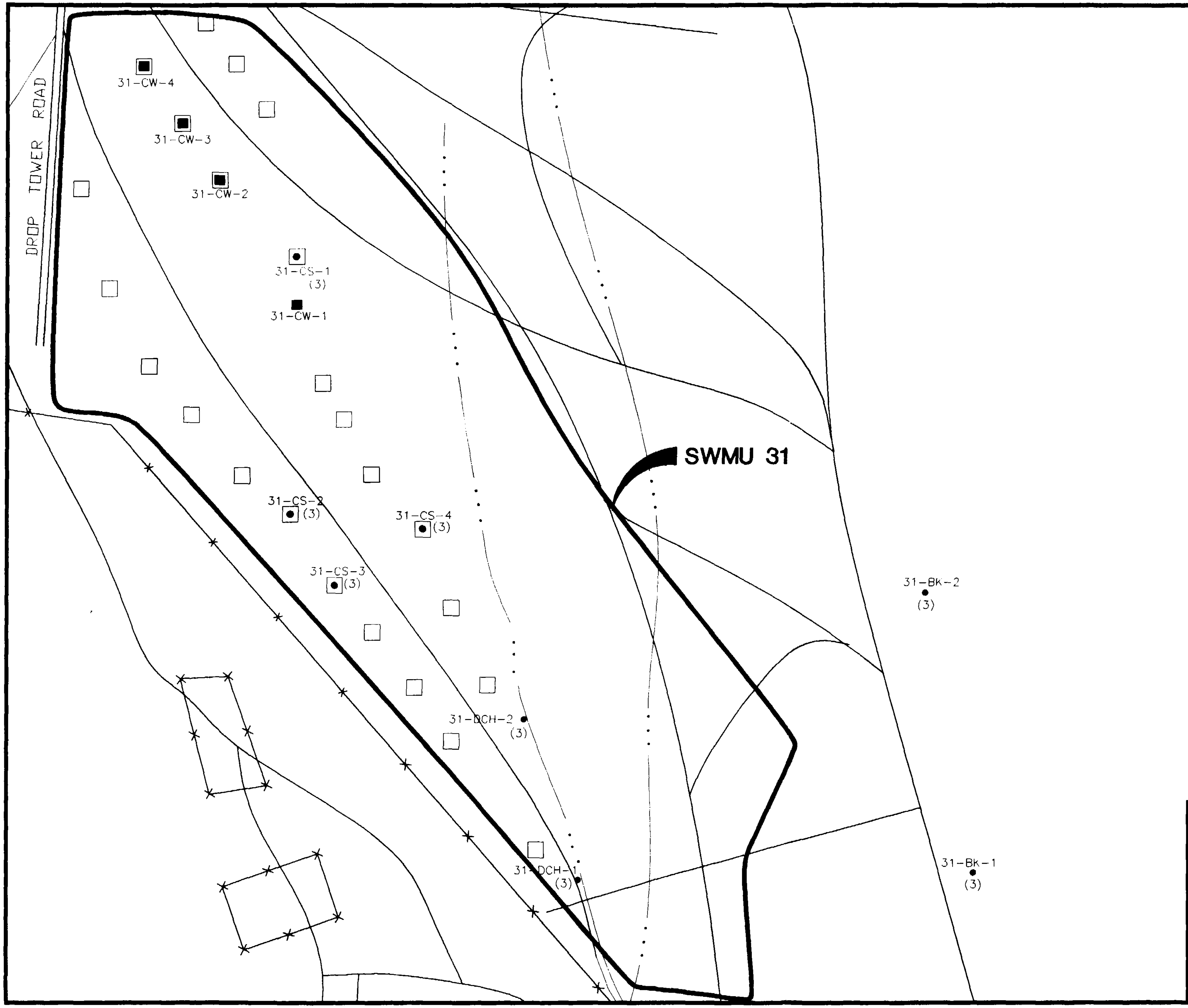
Prepared by:
Ebasco Services Incorporated Revised: 2/22/96

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-10

Test Pit Excavation (30-TP-1) at East Trench in SWMU 30

Prepared by:
Ebasco Services Incorporated



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-11

SWMU 31 Sample Location Map

Prepared by:
Ebasco Services Incorporated

Prepared For:
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.7-12

Soil Sample Location (31-CS-1) in Detonation Pit at SWMU 31.

Prepared by:
Ebasco Services Incorporated

Samples from the streambed were analyzed for VOCs, SVOCs, explosives, agent breakdown products, and metals since this streambed in part of a drainage system that flows from SWMUs 8 and 9.

In addition, two background boreholes (31-BK-1 and 31-BK-2) were sampled at SWMU 31 in the 0- to 2-inch and 2- to 3-ft intervals using a hollow-stem auger drill rig. These samples were chemically analyzed for metals and cyanide only. Soil samples from these background borings were also analyzed for geotechnical parameters including pH, total organic carbon, cation-exchange capacity, and soil index properties to support fate and transport modeling as part of the risk assessment. Geotechnical results are found in Appendix A4.

3.7.2 Soil Sample Collection

All surficial soil samples were collected manually using a stainless steel trowel and bowl. Two sampling methods were used to collect surficial samples. In undisturbed areas, surficial soil samples were collected to characterize areas where contamination may have been dispersed during waste disposal or by wind or surface-water transport. In disturbed areas (i.e., where the likely locations of contaminant releases were indicated by debris or other evidence left by the operations or disposal process), a single soil sample of sufficient volume was collected as close as possible to the remaining waste or debris.

Subsurface soil samples at SWMUs 3, 5, 8, 9, 30, and 31 were collected in 2-ft split-spoon samplers advanced by hollow-stem auger drill rigs wherever no UXO were located. A backhoe was used to collect samples where surface debris prevented downhole UXO detection. Table 3.7-3 lists the method of collection for the subsurface samples at these SWMUs.

Samples for VOC analysis were immediately placed in the proper containers. All remaining samples were described by the geologist on the appropriate log form and then containerized for sample shipment or archival purposes. This logged information was subsequently coded and entered into the Installation Restoration Data Management Information System (IRDMIS). The surficial, shallow boring, and subsurface (monitor well) boring logs are presented in Appendix A1. The preservation methods and soil sample container requirements are listed in Table 3.7-4.

3.7.3 Soil Sample Chemical Analyses

Chemical analyses were performed using EPA SW-846 methods and USAEC-approved methods, most of which were developed from the SW-846 methods themselves. Methods developed solely by USAEC were used for analyses of compounds for which no SW-846 method exists. The analytical program for soil and groundwater samples included gas chromatography/mass spectrometry (GC/MS) analyzing for VOCs, SVOCs, BNAs, polychlorinated biphenyls (PCBs), explosives, metals (total metals in both soil and groundwater), and cyanide (see Section 3.12.1). Both EPA and USAEC quality control (QC) programs were followed to ensure data of high quality.

Table 3.7-3 Subsurface Soil Collection Methods at Group 2 SWMUs

SWMU	Feature	Site ID	Depth (ft)	Subsurface Collection Method
3	Building	3-BLD-1 through 3-BLD-4	3.0	Drill Rig
		3-BLD-5	3.0	Hand Auger
		3-BLD-6 and 3-BLD-7	3.0	Drill Rig
	Metal Grates	3-GRT-1 and 3-GRT-2	3.0	Hand Auger
	Open Trench	3-TRN-1 through 3-TRN-6	0.2	Scoop
	Background	3-BK-1 and 3-BK-2	3.0	Hand Auger
5	Pond	5-PND-1	5.0	Hand Auger
		5-PND-2	4.3	Hand Auger
	Pond Side	5-PND-3 and 5-PND-4	1.0	Hand Auger
	Surficial Soil	5-SS-1 through 5-SS-4	0.2	Scoop
	Ditch	5-DCH-1 through 5-DCH-4	3.0	Hand Auger
	UST	5-UST-1	15.5	Drill Rig
		5-UST-2	15.0	Drill Rig
	Building 600 Foundation/Ramp	5-BLD-1	4.5	Drill Rig
		5-BLD-2 and 5-BLD-3	4.0	Drill Rig
		5-BLD-4 through 5-BLD-6	3.5	Drill Rig
		5-BLD-7 through 5-BLD-9	4.0	Drill Rig
		5-BLD-10 through 5-BLD-17	3.0	Drill Rig

Table 3.7-3 Subsurface Soil Collection Methods at Group 2 SWMUs

SWMU	Feature	Site ID	Depth (ft)	Subsurface Collection Method
5		5-BLD-18 through 5-BLD-20	3.5	Drill Rig
	Background	5-BK-1 and 5-BK-2	3.0	Drill Rig
	Groundwater Monitoring Wells	S-108-93	77.0	Drill Rig
		S-109-93	74.3	Drill Rig
8	Ground Scars	8-GS-1 through 8-GS-7	3.0	Backhoe
	Streambed	8-DCH-1 through 8-DCH-3	3.0	Backhoe
	Trenches	8-WTR-1 and 8-WTR-2	10.0	Backhoe
		8-NTR-1 and 8-NTR-2	5.0	Backhoe
	Background	8-BK-1 and 8-BK-2	3.0	Drill Rig
9	Old Area 2	9-OA2-1 through 9-OA2-12	5.0	Drill Rig
	Streambed	9-SB-1	3.0	Hand Auger
		9-SB-2	3.0	Drill Rig
		9-SB-3 and 9-SB-4	3.0	Hand Auger
	Area 2	9-A2-1 and 9-A2-2	5.5	Drill Rig
		9-A2-3 through 9-A2-11	5.0	Drill Rig
		9-A2-12	4.5	Drill Rig
		9A2-13 and 9-A2-14	5.0	Drill Rig

Table 3.7-3 Subsurface Soil Collection Methods at Group 2 SWMUs

SWMU	Feature	Site ID	Depth (ft)	Subsurface Collection Method
9	Trench	9-TP-1 through 9-TP-4	10.0	Backhoe
	Burn Area	9-BA-1	3.0	Hand Auger
		9-BA-2	3.0	Backhoe
		9-BA-3	3.0	Hand Auger
		9-BA-4 and 9-BA-5	10.0	Backhoe
	Background	9-BK-1 and 9-BK-2	3.0	Drill Rig
	Groundwater Monitoring Wells	S-110-93	84.0	Drill Rig
		S-111-93	78.0	Drill Rig
		S-112-93	85.0	Drill Rig
30	Trench	30-TP-1	5.0	Backhoe
		30-TP-2	8.0	Backhoe
		30-TP-3	5.0	Backhoe
	Surficial Soil	30-SS-1 through 30-SS-6	0.2	Scoop
	Open Storage Area	30-OSA-1 through 30-OSA-3	3.0	Drill Rig
31	Crater Soil	31-CS-1 through 31-CS-4	3.0	Backhoe
	Ditch Soil	31-DCH-1 and 31-DCH-2	3.0	Backhoe
	Background	31-BK-1 and 31-BK-2	3.0	Drill Rig

Table 3.7-4 • Preservation Methods and Soil Sample Container Requirements

Soil Analysis	Container	Preservation
Volatile Organics	2 x 40 ml glass[1]	Cool to 4° C
Semivolatile Organic Compounds Base-Neutral/Acid PCBs Explosives Metals ICP Metals, As, Se, Pb, Hg Cyanide	2 x 500 ml glass	Cool to 4° C
Agent Breakdown Products IMPA, MPA, EMPA Fluoroacetic Acid Thiodiglycol	2 x 500 ml glass	Cool to 4° C
RCRA Characteristics Toxicity Ignitability Corrosivity Reactivity	2 x 500 ml glass	Cool to 4° C
pH Total Organic Carbon Conductivity	1 x 500 ml glass	

[1] All glass containers will be amber in color.

T3G2 9.16.94.jb

3.7.4 Soil Sample Geotechnical Analyses

A contractor laboratory conducted geotechnical analyses on 19 samples. These analyses included grain size, moisture content, density, plasticity, Unified Soil Classification System (USCS) classification, pH, cation-exchange capacity, and total organic carbon content. Geotechnical samples were obtained from locations at each of the Group 2 SWMUs. Samples were collected from background soil borings at five of the SWMUs to adequately cover the areas sampled and the soil types encountered. At SWMU 30, these samples were collected from the OSA borings. The geotechnical samples submitted from the new monitor well locations typically represent the soil types near the water-bearing zone. The complete results of the geotechnical parameters are found in Appendix A4.

3.8 SURFACE WATER SAMPLING

Surface water samples were collected at SWMU 31 from the open detonation pits that contained standing water. All sampling procedures followed the FOPs, which are provided in Appendix A of the Data Collection Quality Assurance Plan (EBASCO 1993b).

The process for collecting these samples began by immersing the appropriate sample container in the crater water and filling the container to capacity. The outside of the container was then wiped clean and preserved according to the requirements listed in Table 3.8-1. Water quality parameters, pH, and electrical conductivity were measured in the field. The samples were then enclosed in ziplock bags for handling and shipped to the designated laboratory. The analysis for surface water samples included explosives and total metals (Table 3.8-2).

QA/QC samples required for surface water samples consisted of field duplicates, matrix spike, and matrix spike duplicates. For every set of four surface water samples collected, one of each QA/QC sample type was taken and also sent for chemical analysis. The results for these QA/QC samples were evaluated and compared to actual sample results as a validation of the sampling procedures and for the site assessment.

Because of the ephemeral nature of the surface water in the detonation pits, it was necessary to move to a different crater to resample 31-CW-4. The original location had dried up between October 27 and November 1993.

3.9 MONITOR WELL INSTALLATION AND DEVELOPMENT

A total of five groundwater monitor wells were installed at SWMUs 5 and 9 during the RFI-Phase II (Figures 3.7-2 and 3.7-5) to further characterize the distribution of the relatively low concentrations of groundwater contaminants that were detected in the RFI-Phase I and previous investigations. These wells monitor the uppermost water-bearing zone. Wells were drilled and installed following the field operating procedures (FOPs) and the USATHAMA Geotechnical

Table 3.8-1 • Preservation Methods and Water Sample Container Requirements

Water Analysis	Container	Preservation	
Volatile Organics	4 x 40 ml glass	None	Cool to 4° C
Semivolatile Organic Compounds			
Base-Neutral/Acid (GC/MS)	2 x 1 L glass	None	Cool to 4° C
PCBs (GC)	2 x 1 L glass	None	Cool to 4° C
Agent Breakdown Products			
IMPA, MPA, EMPA	2 x 250 ml septum cap vial	None	Cool to 4° C
Fluoroacetic Acid			
Thiodiglycol	3 x 1 L glass	None	Cool to 4° C
Explosives	Included with Thiodiglycol volume	None	Cool to 4° C
Dissolved Metals			
ICP Metals, As, Se, Pb, Hg	1 x 1 L plastic	HNO_3 to pH < 2	Cool to 4° C
Anions			
Cl, Br, Fl, Bicarbonate, Sulfate	1 x 1 L plastic cubitainer	None	Cool to 4° C
NO_2, NO_3	1 x 1 L plastic cubitainer	H_2SO_4 to pH <2	Cool to 4° C
Cyanide	1 x 1 L plastic cubitainer	NaOH to pH > 12	Cool to 4° C

T3G2 9.16.94 jb

ml milliliter
L Liter
°C degrees Centigrade

Table 3.8-2 • Groundwater and Surface Water Sampling During the Phase II RFI at SWMUs 3, 5, 8, 9, 30, and 31, Page 1 of 1

				Analytical							
SWMU	Features	Site ID	Site Type Matrix	Volatile Organics	Base-Neutral Acid Extractables	PCBs	Explosives	Thiodiglycol	Agent Breakdown Products	Metals (ICP metals, As, Hg, Pb, Se)	Cyanide
3	Groundwater Monitoring Wells	S-61-90	Well	•	•	•	•	•	•	•	•
		S-62-90		•	•	•	•	•	•	•	•
		S-63-90		•	•	•	•	•	•	•	•
5	Groundwater Monitoring Wells	S-108-93	Well	•						•	•
		S-109-93		•						•	•
		S-2		•						•	•
		S-50-90		•						•	•
		S-51-90		•						•	•
		S-53-90		•						•	•
9	Groundwater Monitoring Wells	S-10	Well	•	•	•		•	•	•	•
		S-110-93		•	•	•	•	•	•	•	•
		S-111-93		•	•	•	•	•	•	•	•
		S-112-93		•	•	•	•	•	•	•	•
31	Crater Surface Water	31-CW-1	Grab (Surface water)				•			•	•
		31-CW-2					•			•	•
		31-CW-3					•			•	•
		31-CW-4					•			•	•

T3G2 9.14.94.jb

Requirements, which are provided in Appendices A and C of the Data Collection Quality Assurance Plan (EBASCO 1993b), respectively.

The drilling subcontractor ensured that all State of Utah drilling requirements were met. EBASCO obtained permits for drilling each well, and with the drillers, submitted all required well completion forms to the state.

3.9.1 Drilling Methods

All boreholes for monitor wells were drilled using hollow-stem augers (Table 3.9-1). Samples were collected with split-spoon samplers. All downhole equipment was fully decontaminated prior to use.

3.9.2 Borehole Sampling

Subsurface stratigraphy generally was characterized by collecting 2-ft-long split spoons at 5-ft intervals. The split-spoon samplers were then opened and cleared by the Health and Safety Officer and the core was logged by the Field Geologist. Upon completion, samples were placed in glass jars for archiving. Four of these archived samples collected near the saturated zone were subsequently submitted for geotechnical analysis (Appendix A3).

3.9.3 Well Construction

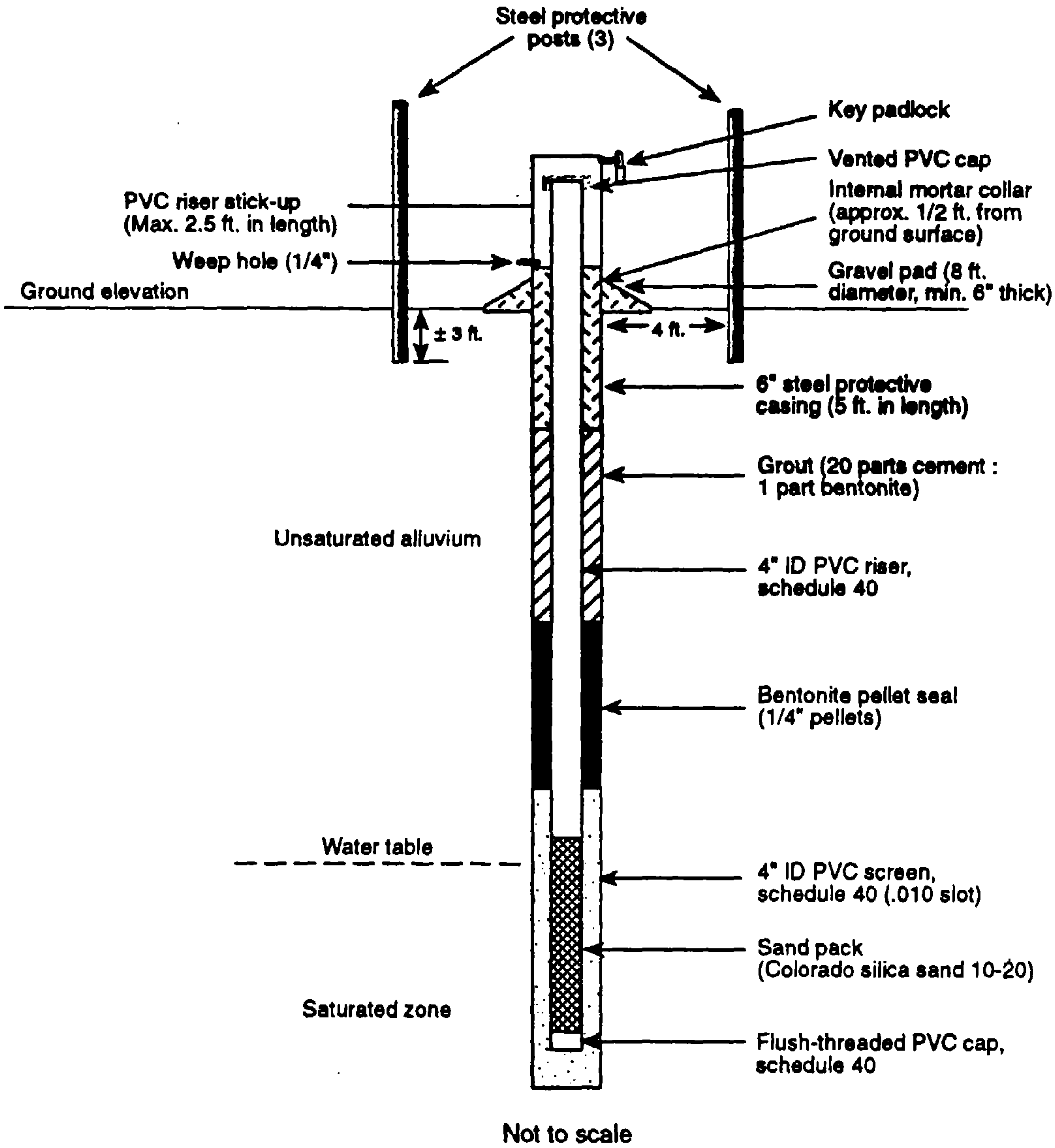
The Field Geologist selected the screened interval of each well based on subsurface lithology determined from cores, cuttings, and drilling conditions. All well-construction design conformed with the USATHAMA Geotechnical Requirements (USATHAMA 1987).

Borehole depths and water levels were measured and recorded prior to well installation until static conditions had been achieved and sufficient water produced so that each well would be representative of the local groundwater conditions.

Well construction began, to the extent practicable, within 48 hours of boring completion, and was supervised by the Field Geologist to ensure compliance with USATHAMA Geotechnical Requirements (USATHAMA 1987). Four-inch inside diameter (ID) schedule 40 polyvinyl chloride (PVC) well casing and screens were installed following decontamination. The screened intervals in the monitor wells were 10 ft. Table 3.9-1 summarizes the well construction information including total depth, drilling method, screened interval, and other installation specifications. A generalized well construction and surface completion is illustrated in Figure 3.9-1. Further details on each of the five new monitor wells can be found in Appendix A1 on the appropriate Well Construction Log. This data was subsequently coded and entered in the IRDMIS database.

Well ID	SWMU #	Boring Depth* (from GSL)	Drilling Method	Sampling Method	Well Depth* (from TOC)	Screen Length* (depth interval) (from TOC)	Filter Pack* (depth interval) (from GSL)	Seal Thickness* (depth interval) (from GSL)	Top Of PVC Casing Elevation*	Ground Elevation*	UTM Coordinants 1927 N.A.D. (Meters) North	East
S-108-93	5	77.0	HSA	SS	78.0	10	20	5.0	5146.11	5144.43	4,460,379.400	387,656.759
						(67.5 - 77.5)	(57.0 - 77.0)	(52.0 - 57.0)				
S-109-93	5	74.3	HSA	SS	74.5	10	17.3	5.0	5150.42	5148.33	4,460,423.279	387,848.312
						(64.0 - 74.0)	(57.0 - 74.3)	(52.0 - 57.0)				
S-110-93	9	83.6	HSA	SS	85.3	10	16.2	5.5	5164.69	5162.58	4,460,876.787	388,019.165
						(74.8 - 84.8)	(67.4 - 83.6)	(61.9 - 67.4)				
S-111-93	9	72.75	HSA	SS	74.4	10	15.75	5.7	5127.35	5125.32	4,459,555.903	388,501.419
						(63.9 - 74.9)	(57.0 - 72.75)	(51.3 - 57.0)				
S-112-93	9	80.2	HSA	SS	82.5	10	15.4	5.8	5125.35	5122.83	4,459,234.996	388,854.942
						(72.0 - 82.0)	(64.8 - 80.2)	(59.0 - 64.8)				

* All values in feet unless specified
HSA Hollow-Stem Auger Drilling
SS Split-Spoon Sampling



T3G2 9.16.94.jb

Figure 3.9-1

Generalized Well Construction

Tooele Army Depot - South Area
Prepared by: Ebasco Services Incorporated

EBASCO

3.9.4 Monitor Well Installation Activities

3.9.4.1 SWMU 5

Two additional monitor wells were installed at SWMU 5 to aid in delineating the lateral extent of possible solvent contamination in groundwater. One well, S-109-93, was positioned to the southeast of the drainage pond to obtain downgradient data since groundwater flow direction is believed to be southeasterly through the eastern portion of SWMU 5. The other well, S-108-93, was installed further downgradient from the drainage pond, east of the southern end of the drainage ditch that runs through SWMU 5. This well was installed to determine whether contaminants migrated from SWMU 5 or were released within this area south-southeast of SWMU 5. The two new wells, along with the other existing monitor wells at SWMU 5, were sampled for VOCs, metals, anions, and dissolved organic carbon. Slug tests were performed in these two new wells to gain a better understanding of hydraulic characteristics of the aquifer at SWMU 5. Figure 3.7-2 illustrates the locations of these monitor wells.

3.9.4.2 SWMU 9

With confirmation of soil contamination at Old Area 2 and open storage of agent-filled containers occurring in the southern part of Area 2, groundwater monitor wells were installed upgradient (S-110-93) and downgradient (S-S-111-93 and S-112-93) of these sites to evaluate whether a release to groundwater had occurred at SWMU 9. These wells were analyzed for VOCs, SVOCs, agent breakdown products, metals, anions, and dissolved organic carbon. In addition, well S-10 was resampled for analysis of agent breakdown products and metals. The SVOC analysis of groundwater from well S-10 was repeated in response to the relatively high level of phthalates detected in the RFI-Phase I. Slug tests were performed in the three new wells to determine hydraulic characteristics of the aquifer at SWMU 9. Figure 3.7-5 illustrates the locations of these monitor wells.

3.9.5 Well Development

Each well was developed to increase the hydraulic connection between the well and the surrounding aquifer. Generally, each monitor well was developed no sooner than 48 hours and no later than 7 consecutive days after well construction. Development of well S-108-93 was delayed approximately 1 week because of a change in drilling subcontractors.

The Field Geologist calculated the volume of water to be removed during well development. This included the removal of five times the total amount of water standing in the casing and annulus plus any water used in the well installation. The amount of water in the saturated annulus was calculated based on an assumed 30 percent porosity. The development water was removed using a decontaminated bailer. The Field Geologist recorded pH, specific conductivity, temperature, and turbidity readings for every volume of water bailed from the well. Development was complete when the appropriate volume of water had been removed from the well and the parameters had generally stabilized. Turbidity readings often continued to read off-scale. All water removed was contained in 55-gallon drums for subsequent disposal, according to analytical results for groundwater samples from that well, as either hazardous or nonhazardous wastes. Well development records are included in Appendix A1.

Prior to and following each well development, the Field Geologist calibrated the pH, conductivity, and turbidity meters per the manufacturer's instructions. A copy of these instructions was kept with each instrument.

3.10 GROUNDWATER SAMPLING

Groundwater samples were obtained from wells for the full suite of analyses described in Table 3.8-2, page 3-56. The wells sampled included those installed under this program, all existing monitor wells at SWMUs 3, 5, and 9, and well 1-S, the USAEC-approved water supply well. The RFI-Phase I groundwater samples collected from SWMU 3 wells (S-61-90, S-62-90, and S-63-90) missed the holding time for the explosives analysis. Therefore, these three wells were resampled during the RFI-Phase II and analyzed for VOCs, SVOCs, explosives, agent breakdown products, anions and metals.

Upon completion of the well installation, a dedicated PVC bailer was left suspended just below the cap inside each well for groundwater sampling. The sampling rope was removed after each sampling event to ensure that a clean rope would always be used for future sampling. The bailers were thoroughly decontaminated by a contractor laboratory and approved by USAEC prior to installation. The use of dedicated bailers reduces the potential for cross-contamination between wells during sampling events.

The Field Geologist collected groundwater samples in each well installed under this program no sooner than 14 days after well development was completed to allow for well stabilization. The headspace in the monitor wells was monitored for VOCs immediately after the well was uncapped. No headspace concentrations above background were measured. All samples were collected after five times the volume of water in the PVC casing and saturated well annulus had been removed using the dedicated PVC bailer. All water removed from the borehole was drummed for later disposal, according to the results of groundwater sampling and analysis, as hazardous or nonhazardous waste. The Field Geologist recorded pH, specific conductivity, temperature, and turbidity readings after each casing volume was removed. If the well dewatered during purging, it was allowed to recharge before being sampled. The field documentation of pre-sample purging is presented on the water quality field data sheets in Appendix A2.

The Field Geologist was responsible for the preparation and maintenance of equipment required for groundwater sampling as outlined in detail in the FOPs in Appendix A of the RFI-Phase II DCQAP (EBASCO 1993b). Prior to and following each well-sampling event, the Field Geologist calibrated the pH, conductivity, and turbidity meters per the manufacturer's instructions. A copy of these instructions was kept with each instrument.

Samples were collected in appropriate containers (Table 3.8-1, page 3-55). All glass vials were amber in color. All sample containers were cleaned, rinsed, packaged, and labeled at the laboratory and delivered to the site with correct preservatives in separate containers. In the field, the bottles were rinsed three times with the water being sampled and then prepared according to analytical requirements listed in Table 3.8-1. The rinsing procedure neutralizes chemical binding sites on the inside surface of the container. Before transportation, the samples were packed with ice to maintain the samples at 4°C.

Loss of VOCs to evaporation was minimized by transferring samples to the 40-milliliter (ml) vials rapidly but without agitation. VOC sample containers were filled to capacity (to avoid air bubbles) and then shipped in metal cans filled with vermiculite. Although past experience at this site has shown that suspended solids in samples from fine-grained aquifer zones introduce considerable variability in the sample results, the regulators required that only unfiltered samples were collected for metals analyses.

3.10.1 Monitor Well Surveying

A qualified subcontractor surveyed each monitor well for horizontal and vertical control. The minimum requirements of the surveying were the following:

- The horizontal control for each well installed under this contract was surveyed to determine its state planar and military map coordinates to within 0.5 ft.

- The vertical control included determination of the elevation of the natural ground surface and the highest point on the rim of the uncapped well casing (not protective casing) of each well to within 0.01 ft using the National Geodetic Vertical Datum of 1927.

Corrected survey field data included loop closure for survey accuracy. These data list the coordinates, system, and elevations (see Appendix C). The names, characteristics, and locations of all permanent and semipermanent reference marks used for horizontal and vertical control were noted.

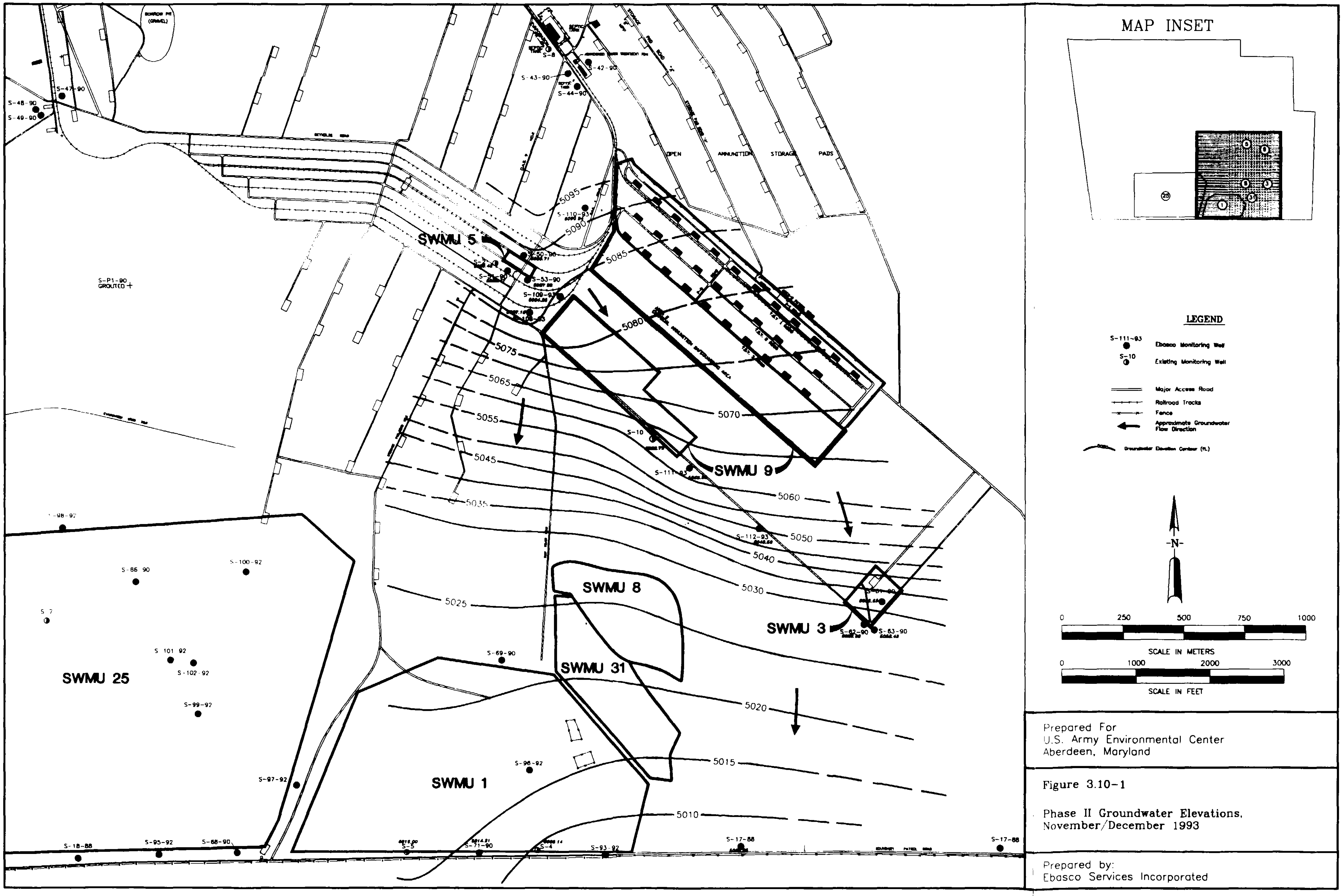
3.10.2 Groundwater Elevation Measurements

Groundwater elevations were measured and recorded during well construction, well development, and at the time of sampling (the latter in mid-November to early December 1993), as is specified in the FOPs. One other round of water-level measurements was completed during the RFI-Phase II in new and previously installed wells at SWMUs 3, 5 and 9 in April, 1994. During the April 1994 activity, water-level measurements were also taken in several previously installed wells (S-16-88, S-17-88, S-43-90, S-49-90, S-71-90, S-97-92, S-98-92 and S-SBR-1) outside the Group 2 SWMUs to provide more control points for determining groundwater flow directions. These data, presented in Table 3.10-1, were used to construct the water-elevation maps shown in Figures 3.10-1 and 3.10-2.

Table 3.10-1 Tooele South Groundwater Measurements

Well	Ground Surface Elevation (ft above msl)	Top of PVC Elevation (ft above msl)	November/December 1993		April 26, 1994	
			Measured Depth to Water (ft)	Elevation of Water (ft above msl)	Measured Depth to Water (ft)	Elevation of Water (ft above msl)
S-2	5145.60	5148.42	58.94	5089.48	58.60	5089.82
S-10	5122.50	5125.60	66.81	5058.79	66.51	5059.09
S-16-88	5097.76	5099.46	*	*	96.42	5003.04
S-17-88	5075.70	5077.28	*	*	71.14	5006.14
S-43-90	5185.50	5187.39	*	*	78.91	5108.48
S-49-90	5139.00	5140.63	*	*	97.84	5042.79
S-50-90	5151.30	5153.09	63.38	5089.71	63.48	5089.61
S-51-90	5146.60	5148.18	58.71	5089.47	58.71	5089.47
S-53-90	5148.10	5149.99	62.13	5087.86	62.17	5087.82
S-61-90	5120.90	5122.94	90.35	5032.59	90.84	5032.10
S-62-90	5115.60	5117.99	89.01	5028.98	89.14	5028.85
S-63-90	5116.60	5118.45	90.02	5028.43	89.97	5028.48
S-71-90	5053.80	5056.24	*	*	41.09	5015.15
S-97-92	5083.96	5086.54	*	*	70.11	5016.43
S-98-92	5046.31	5048.76	*	*	18.59	5030.17
S-108-93	5144.43	5146.11	58.96	5087.15	58.69	5087.42
S-109-93	5148.33	5150.42	66.17	5084.25	65.95	5084.47
S-110-93	5162.58	5164.69	73.75	5090.94	73.55	5091.14
S-111-93	5125.32	5127.35	67.42	5059.93	67.23	5060.12
S-112-93	5122.83	5125.35	76.76	5048.59	76.36	5048.99
S-SBR-1	5226.80	5229.38	*	*	127.10	5102.28

* Data not collected at this time

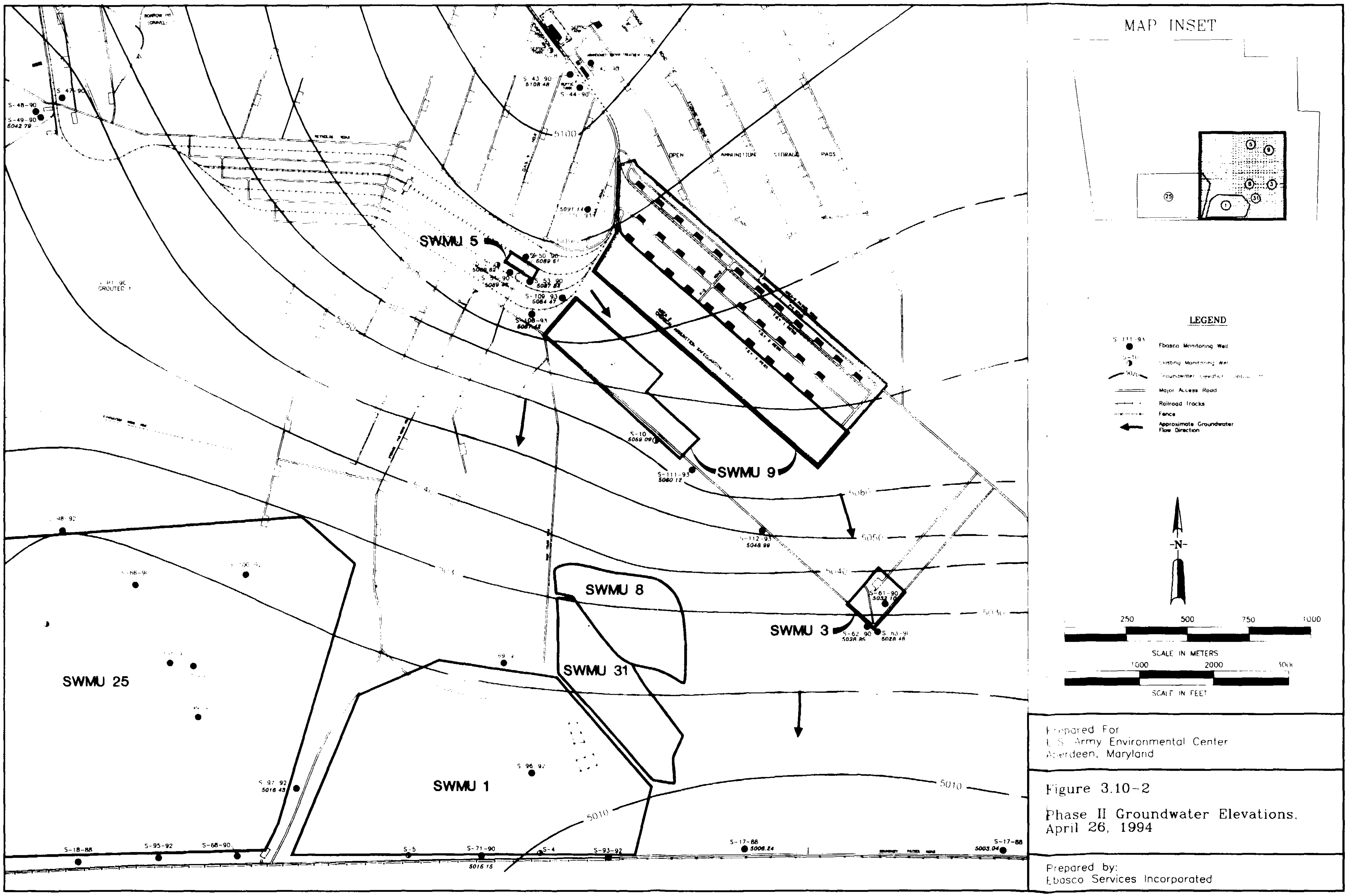


Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.10-1

Phase II Groundwater Elevations, November/December 1993

Prepared by:
Ebasco Services Incorporated



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.10-2

Phase II Groundwater Elevations, April 26, 1994

Prepared by:
Ebasco Services Incorporated

The Field Geologist measured the depth to groundwater in each well with an electronic water-level meter. The depth was measured from the highest point on the rim of the PVC well casing and was recorded to the nearest 0.01 ft in the field data logbook. The meter tape and other downhole materials were thoroughly rinsed with USAEC-approved water between uses. The depth to groundwater and casing stickup were recorded in the logbook with the well name, date, and time of measurement. All of these recorded data are stored in the IRDMIS, as is outlined in the DMP (EBASCO 1993b). Figure 3.10-3 shows the depth of the groundwater at the eastern Group 2 SWMUs based on the November/December 1993 groundwater elevations.

3.11 AQUIFER TESTING

Aquifer tests were performed between December 2 and December 5, 1993 to determine the hydraulic properties of the upper saturated zone at SWMUs 5 and 9. This information is used to estimate groundwater travel times. It also indicates whether an aquifer zone is productive enough to be used as a water supply.

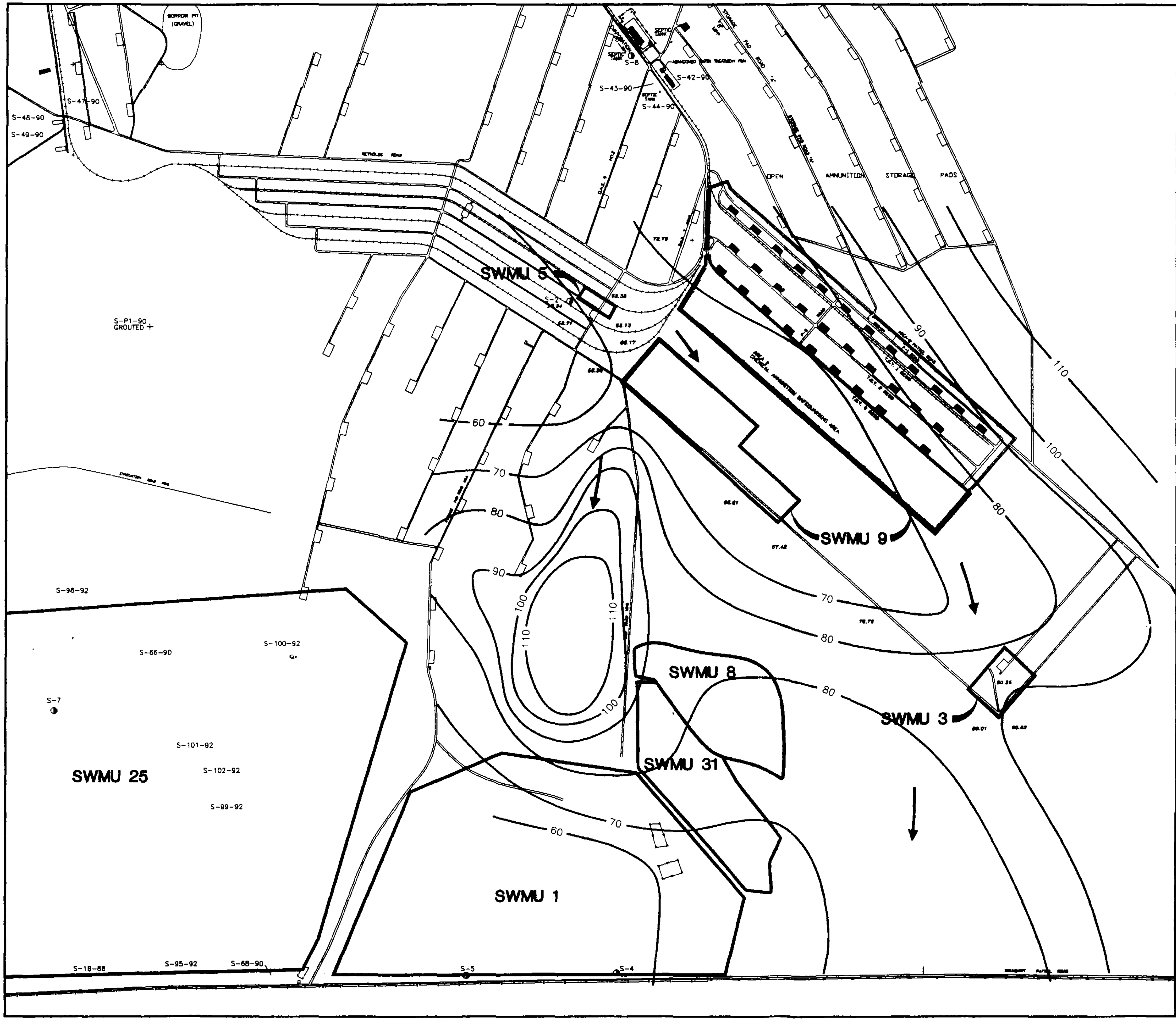
After well development, sampling, and subsequent stabilization of the water level, single-well hydraulic conductivity tests, known as slug tests, were performed in the five new monitor wells at SWMUs 5 and 9. These tests are useful for evaluating relatively fine-grained, low-conductivity aquifers and for conducting tests in many wells during a short time period.

Slug tests allow estimation of local hydraulic conductivity by observing the aquifer response to a stress applied to a small zone around each well. Stress was applied by instantaneously reducing the head in a well by withdrawing a closed PVC cylinder. This technique resulted in an order of magnitude estimate of horizontal hydraulic conductivity in the immediate vicinity of the well.

3.11.1 Aquifer Test Procedure

Aquifer tests were completed in three steps: First, a well was opened and the air in the upper part of the casing was monitored using organic vapor analyzers; second, the static water level was measured and verified to the nearest 0.01 ft using a decontaminated electronic water-level meter; and third, the total depth of the well was measured and verified using a decontaminated weighted tape. The water level and total depth measurements were recorded and compared to well installation, development, and sampling records to confirm that water levels had stabilized. After the water level had stabilized, the test equipment was set up.

A pressure transducer was connected to a data logger, which was programmed to sample water levels in the well in a logarithmic time interval mode. The transducer was referenced to the static water level as measured from the top of casing and lowered to its preplanned depth within the well (below the planned bottom of the slug for a slug injection test). The transducer was allowed to adjust to groundwater temperature before further measurements were made.



Prepared For
U.S. Army Environmental Center
Aberdeen, Maryland

Figure 3.10-3

Approximate Depth to Groundwater
November/December 1993

Prepared by:
Ebasco Services Incorporated

Because the transducer and the transducer line displace water within a well, the water-level meter measured the new water level after the transducer was placed in the well. The transducer reading was then checked against the water-level meter reading and the reference level on the data logger set to the new water level. The transducer line was secured to the well casing and marked with electrical tape so that the referenced depth could be maintained. A calibration test was then performed on the data logger and transducer prior to staring the slug test.

For the slug injection, or falling head, test, one to three 5-ft-long sections of PVC pipe were connected to form the slug, which was attached to a decontaminated nylon rope. Electrical tape was attached to the rope at reference points to ensure that the slug would hang just above the water level prior to the test and approximately 2 ft below the starting water level as the test began. Just before the test began, the water level was verified and the transducer referenced to a new water level. To initiate the slug test, the logger was started and the slug was lowered quickly and smoothly and secured in its submerged position. The starting time and initial displacement were measured and recorded. During the test, data logger readings were checked periodically using the water-level meter. The slug injection test was terminated after water levels had recovered to within 10 percent of the static water level measured prior to the slug injection or once 48 hours had elapsed.

After programming a new test on the data logger, the slug withdrawal, or rising head, test was initiated by starting the logger and smoothly removing the slug from the well. For the slug withdrawal test, water levels were also measured periodically with a water-level meter. The slug withdrawal test was terminated after water levels returned to within 10 percent of the static water level prior to the slug injection test or once 48 hours had elapsed.

Once each test was completed, the data were printed out and the data files were downloaded from the data logger. In addition, all downhole equipment (slug, rope, bailer, transducers, and water-level meter) were decontaminated.

3.11.2 Aquifer Test Data Analysis

Estimates of hydraulic conductivity were obtained from the test data using conventional methods presented by Bouwer (1989) and Bouwer and Rice (1976). These methods were preferred for interpreting the test results because they are appropriate for partially penetrating wells in an unconfined aquifer. Slug test results, including falling-head curves, rising-head curves, aquifer analysis input parameters, and hydraulic conductivity results are presented in Appendix B. A summary of the hydraulic conductivity results is presented in Sections 4.2.3 and 4.4.3.

3.12 PRESENT AND REASONABLE FUTURE USE INVESTIGATION

The human health and ecological risk assessment of SWMUs 3, 5, 8, 9, 30, and 31 was conducted using information on the present use of the site as well as conservative assumptions about future use. During the RFI-Phase II field program, information was collected through document review and TEAD employee interviews on present work patterns at the site, especially in areas where exposure to the contaminants in these SWMUs could occur. Currently, predominant work patterns include routine security patrols of the installation roads throughout TEAD-S, and demilitarization operations at SWMU 31 at TEAD-S. The uses of other surrounding areas were investigated to ensure that the risk assessment would evaluate the receptors with the greatest potential exposures. Installation personnel were consulted about planned future uses of the installation. In the case of base closure, which is not currently anticipated, the most likely future use of this area would involve ranching.

3.13 DATA VALIDATION AND MANAGEMENT

3.13.1 Chemical Analytical Program

The RFI-Phase II samples were analyzed for VOCs, SVOCs, explosives, PCB compounds, metals, cyanide, alkalinity, agent breakdown products, thiodiglycol, and RCRA characteristics. The methods used to perform these analyses, listed in Table 3.13-1, include USAEC-approved methods for all analyses except alkalinity.

The USAEC-approved methods, developed by independent laboratories for Army use only, are derived from EPA methods, employing similar extraction and analytical techniques and achieving similar analyte detection limits. EPA SW-846 methods 8240, 8270, 8080, 8330, 6010, and 7000 were used as a basis for the development of USAEC methods for VOCs, SVOCs, PCBs, explosives, and metals. USAEC methods developed by the Army were employed for agent breakdown products since there are no EPA methods.

USAEC method detection limits are established during the method certification process. The detection limits for SW-846 methods are established by the individual laboratories with EPA guidance. Method detection limits for USAEC methods are comparable to EPA detection limits. However, method detection limits are always dependent upon sample matrix.

3.13.2 Field Quality Assurance/Quality Control

Field quality control (QC) samples were collected at the time of sampling in accordance with the RFI-Phase II Data Collection Quality Assurance Plan for SWMUs 3, 5, 8, 9, 30, and 31 (EBASCO 1993b). The QC samples consisted of trip blanks, equipment rinse blanks, and field sample duplicates. Trip blanks are used as a check for sample contamination originating from sample transport. Trip blanks are prepared for each shipment of samples for volatile organic analysis and are analyzed for volatiles only. Rinse blanks are used to assess the effectiveness of equipment decontamination. Field duplicates are used to assess the precision of the sampling and analysis program.

Table 3.13-1 • Summary of Approved Methods USAEC/EPA Method Equivalents

Method Name	EPA Method Number Soil	EPA Method Number Water	USAEC Method Soil	USAEC Method Water
Volatiles	8240	8240	LM23	UM21
Base-Neutral/Acid Extractable Semivolatiles	8270	8270	LM25	UM25
PCBs	8080	8080	LH17	UH20
ABPs - FC2A, IMPA, MPA, EMPA	None	None	LT03	UT02
ABP - Thiodiglycol	None	None	LW18	UW22
ICP Metals	6010	6010	JS12	SS12
Arsenic	[illegible]	[illegible]	[illegible]	[illegible]
Lead	7421	7421	JD21	SD18
Mercury	7471	7470	[illegible]	[illegible]
Selenium	7740	7740	JD20	SD25
Cyanide	9010	9010	KF15	[illegible]
Explosives	None	None	LW23	UW25
Anions				
Fluoride	NA	300.0	NA	TT09
Chloride	NA	300.0	NA	TT09
Bromide	NA	300.0	NA	TT09
Sulfate	NA	300.0	NA	TT09
Phosphate	NA	365.4	NA	TF29
Bicarbonate	NA	310.2	NA	NA
Nitrate/Nitrite	NA	353.2	NA	LL8
Total Organic Carbon	9060	NA	NA	NA

T3G2 9.14.94.jb

NA - Not Applicable
PCB - Polychlorinated biphenyl
ABP - Agent Breakdown Product
FC2A - Fluoroacetic acid
IMPA - Isopropylmethyl phosphoric acid
MPA - Methyl phosphor:c acid
ICP - Inductively coupled plasma

3.13.2.1 Trip Blanks

During the RFI-Phase II sampling program, nine soil trip blanks were collected and analyzed for VOCs. Three soil trip blanks indicated trace levels of chloroform ranging from 0.63 µg/l to 3.0 µg/l. These low-level detections are possibly the result of laboratory contamination and indicate that little or no contamination by VOCs occurred during transport of samples from the field to the laboratory.

3.13.2.2 Rinse Blanks

Water used during drilling and decontamination operations was from water supply well 1-S at TEAD-S. This water required USAEC approval for its quality prior to its use during the RFI-Phase II field program. Samples from well 1-S water were collected in October 1992 and January, March, April, and May of 1993. These samples were analyzed for the same suite of analytes as planned for the RFI-Phase II field samples. The analyses of the supply well samples resulted in detections of metals and anions. No organic analytes were detected. A summary of the water supply results can be found in Table 3.13-2. The results of the April 1993 analysis are not consistent with the other samples since the samples were not filtered.

Equipment rinse blanks were collected and analyzed for all analytes in the RFI-Phase II sampling program to ensure that proper decontamination of field sampling equipment was achieved. The rinse blanks for VOCs, agent breakdown products, and cyanide revealed no evidence of carry-over from sampling equipment for these contaminant groups. However, the rinse blank analyses for SVOCs, explosives, PCBs, metals, and anions indicated possible sample contamination carryover for these analyte groups.

During the RFI-Phase II sampling program, 13 rinse blanks were collected and analyzed during soil sampling and one during groundwater sampling. Detections of metals were found in the soil sampling rinse blanks; however all values were within or below the range of values detected in the water supply well samples.

The rinse blank results contained one detection of 1,3-dinitrobenzene (13DNB), one detection of acetone (ACET), one detection of 2,4-dinitrotoluene (24 DNT), one detection of bis (2-ethylhexyl) phthalate (B2EHP), and one detection of carbon disulfide (CS2). A review of the field sample results for samples collected before and after these rinse blank detections indicated no detections of these analytes in the field samples. The detections of acetone, carbon disulfide, and B2EHP are possibly the result of laboratory contamination. No apparent cross-contamination is evident based on a review of rinse blank data. A summary of the rinse blank data can be found in Table 3.13-3.

Table 3.13-2 Summary of Analytical Results for Water (Well 1-S)

	10/14	1/8	3/11	4/14	5/4
Metals					
Barium (Ba)	70.9	61.9	83.4	77.2	82.1
Calcium (Ca)	92,000	78,600	96,000	86,600	92,600
Copper (Cu)	92.6	>8.09	>18.8	255	>18.8
Iron (Fe)	525	>38.8	>77.5	1,180	97.3
Potassium (K)	1,560	3,710	>1,240	>1,240	>1,240
Mangesium (Mn)	31,700	31,300	36,800	33,200	35,900
Sodium (Na)	9.71	>2.75	>9.67	513	9.67
Lead (Pb)	19,400	30,800	21,300	19,200	22,500
Antimony (Sb)	748	>1.26	>4.47	>4.47	>4.47
Selenium (Se)	>3.03	50.9	>60.0	513	>0.5
Vanadium (V)	>3.02	>3.02	>2.53	3.03	3.31
Zinc (Zn)	>11.0	17.8	>27.6	516	>27.6
	69.0	>21.1	>18.0	541	70.5
Anions					
Chloride (CL)	49,000	44,000	595	37,000	420
Nitrate (NO_3)		2,000	2,900	1,900	1,800
Bicarbonate (CHO_3)		36,200			

Recycled Paper

Table 3.13-3 Summary of Analytical Results for Rinse Blanks

Analytical Group/Analytes Detected	3-GRT-2	5-DCH-4	8-BK-1	8-GS-1
<u>Semivolatile Organics (µg/l)</u>				
Acetone				
Bis (2-ethylhexyl) phthalate	18.0			
Carbon disulfide				
<u>Explosives: (µg/l)</u>				
1,3-Dinitrobenzene				
2,4-Dinitrotoluene				
<u>Metals: (µg/l)</u>				
Barium (Ba)	70.9		76.3	75.5
Calcium (Ca)	86,500	290	92,700	86,200
Potassium (K)	1,600		1,460	1,320
Magnesium (Mg)	31,900		34,100	31,300
Manganese (Mn)	4.68	5.73	4.30	4.47
Sodium (Na)	18,300	389	19,600	18,100
Copper (Cu)	4.27		4.55	34.5
Iron (Fe)	30.7	63.5	23.8	183
Zinc (Zn)	15.2		14.6	33.5
Vanadium (V)	16.9	11.9	16.8	
Lead (Pb)			3.04	3.36

µg/l micrograms per liter
LT less than the lower certified reporting limit

Analytical Group/Analytes Detected	9-A2-2	9-A2-74	9-A2-8	9-A2-12
Semivolatile Organics (µg/l)				
Acetone				
Bis (2-ethylhexyl) phthalate				
Carbon disulfide				
Explosives: (µg/l)				
1,3-Dinitrobenzene				
2,4-Dinitrotoluene				
Metals: (µg/l)				
Barium (Ba)	70.7	72.4	73.1	96.6
Calcium (Ca)	86,200	87,300	87,700	85,100
Potassium (K)	1,230	1,360	1,430	1,200
Magnesium (Mg)	31,600	32,000	32,200	31,400
Manganese (Mn)		4.27		5.62
Sodium (Na)	17,800	18,600	18,600	17,900
Copper (Cu)			13.5	
Iron (Fe)		208		24.2
Zinc (Zn)				
Vanadium (V)				17.0
Lead (Pb)				

µg/l micrograms per liter
LT less than the lower certified reporting limit

Recycled Paper

Analytical Group/Analytes Detected	9-OA2-2	9-OA2-9	9-SB-2	9-TP-2A
Semivolatile Organics (µg/l)				
Acetone			34.0	
Bis (2-ethylhexyl) phthalate				
Carbon disulfide				
Explosives: (µg/l)				
1,3-Dinitrobenzene				
2,4-Dinitrotoluene				
Metals: (µg/l)				
Barium (Ba)	73.0	72.3	72.0	70.9
Calcium (Ca)	86,500	86,400	85,100	85,500
Potassium (K)	1,280	1,090	1,590	1,510
Magnesium (Mg)	31,700	31,600	31,500	31,400
Manganese (Mn)		6.58	4.85	4.16
Sodium (Na)	18,300	18,400	18,100	18,100
Copper (Cu)	9.69	25.0	5.65	10.65
Iron (Fe)	77.2	366	38.4	31.0
Zinc (Zn)		52.1	18.3	11.3
Vanadium (V)		12.5	13.0	14.1
Lead (Pb)		2.06		

µg/l micrograms per liter
LT less than the lower certified reporting limit

Analytical Group/Analytes Detected	31-DCH-2
Semivolatile Organics (µg/l)	
Acetone	
Bis (2-ethylhexyl) phthalate	
Carbon disulfide	1.40
Explosives: (µg/l)	
1,3-Dinitrobenzene	9.614
2,4-Dinitrotoluene	0.172
Metals: (µg/l)	
Barium (Ba)	71.9
Calcium (Ca)	87,000
Potassium (K)	1,210
Magnesium (Mg)	32,300
Manganese (Mn)	4.420
Sodium (Na)	18,700
Copper (Cu)	
Iron (Fe)	29.2
Zinc (Zn)	
Vanadium (V)	14.8
Lead (Pb)	

µg/l micrograms per liter
LT less than the lower certified reporting limit

3.13.2.3 Field Sample Duplicates
A total of 14 field sample duplicates, (1 groundwater sample and 13 soil samples) were collected during the RFI-Phase II sampling program. The purpose of the field duplicates is to determine the precision of the sampling and analysis program. Evaluation of the duplicate data for inorganics was conducted by determining the relative percent difference (RPD) between the field sample and the duplicate (Table 3.13-4). Organic results for field sample duplicates is limited to isolated detections.

In general, the field sample and duplicate results showed good reproducibility. Sodium showed poor reproducibility at sites 9-A2-2, 9-A2-12, and 9-TP-2A. Arsenic showed poor reproducibility at 9-A2-2 and 9-A2-8. Thallium showed poor reproducibility at site 9-A2-8.

In seven cases for inorganics and two cases for organics, results were reported for either the sample or the duplicate, but not for both. These values were all near the reporting limit, with the exception of the thallium results at site 9-TP-2A, which had a less than (LT) 6.2-µg/g result for the field sample and a 27.8-µg/g result for the duplicate.

Organic field sample/duplicate results are available in only two cases. In the first case, toluene was detected in both samples at 9-OA2-9. Although the field sample value of 0.002 µg/g is twice the duplicate sample result, both values are near the reporting limit and are within two times the reporting limit. In the second case, the methylene chloride detection in the groundwater sample showed good reproducibility.

Based on the limited field/duplicate data available for groundwater samples, the reproducibility of groundwater samples is not as good as that indicated for the soil samples.

The concentration of analytes plotted at locations where field duplicates were collected is an average of the two detected values. If either the field sample or the duplicate was a nondetection, the detected value was plotted. Alternatively, if both values for the field sample and the duplicate were nondetections, the sample analysis plotted was considered as a nondetection.

In summary, the field duplicate results for the RFI-Phase II soil sampling analyses indicated that a high level of precision was achieved in both the field sampling procedures and the analytical methodologies. The analytical results for all field and field duplicate samples can be found in Appendix F.

Table 3.13-4 Field Sample/Duplicate Relative Percent Difference

	3-GRT-2	5-DCH-4	8-BK-1	8-GS-1	9-A2-2	9-A2-7	9-A2-8	9-A2-12	9-SB-2	9-TP-2A	9-OA2-2	9-OA2-9	31-DCH-2	S-110-93
Analyte														
Al	-8.94	0.68	7.59	2.09	4.15	14.59	-6.24	2.63	-11.44	7.00	-18.31	5.90	10.29	35.49
As		-3.36	-1.36	-12.86	83.55	27.05	49.84		4.57	15.78	2.28	1.79		119.76
Ba	-15.64	-1.82	0.00	10.10	-0.71	1.18	-4.62	4.28	-8.36	2.80	0.80	-2.90	-5.57	28.32
Be	2.00	6.27	-13.74	-16.69	LT	9.88	(4)	2.34	26.09	(2)	51.11	16.18	(2)	
Ca	-0.61	-8.00	3.51	5.13	-26.09	9.52	0.00	17.58	-13.59	15.38	0.00	-11.76	0.00	46.82
Cd	(2)	LT	21.67	-36.0	LT	(3)	(4)	LT	LT	-11.32	LT	(2)	2.11	
Co	-9.48	-1.18	15.81	-0.72	33.56	15.52	-20.17	0.29	-0.48	1.02	4.32	17.62	-2.88	-7.17
Cr	-11.48	1.26	13.04	-0.95	-0.90	24.00	3.39	1.82	-9.05	3.37	-17.75	2.26	7.16	26.06
Cu	-2.64	-1.49	15.89	24.87	14.47	14.06	-15.05	1.33	-9.19	10.53	-4.26	32.12	-3.55	37.91
Fe	-5.52	0.00	5.76	2.11	-11.15	24.07	-10.54	-2.68	-11.55	6.11	-6.15	11.95	4.00	36.72
Hg	-22.22	LT	LT	-2.41	28.57	-36.36	(4)	LT	LT	LT	LT	LT	-10.07	
K	-4.81	0.00	2.92	2.08	23.12	10.20	-5.04	-10.46	-6.73	-4.09	-11.30	23.54	4.72	33.10
Mg	-0.71	-1.99	1.86	6.32	15.12	5.71	0.00	9.09	-9.26	2.49	-2.01	4.42	1.97	34.43
Mn	-1.42	-4.53	-0.58	9.08	11.04	3.47	-1.99	-14.60	-3.92	-0.44	4.94	32.24	-5.73	35.29
Na	-22.65	-4.91	0.68	-0.76	49.03	9.27	-8.00	47.04	-7.71	-51.70	-4.48	17.04	-3.88	-0.95
Ni	-7.29	-6.50	11.86	-2.72	8.54	23.36	0.49	1.16	-14.33	8.24	-6.27	15.16	-2.51	21.61
Pb	LT	-1.92	-4.44	-4.08	-26.80	11.98	14.29		11.11	18.18	8.41	0.37		62.10
Sb												(1)		
Tl	-5.41	10.02	-5.56	10.13	-5.96	(2)	48.01	12.45	-7.79	(2)	5.11	11.70	(1)	
V	-10.93	4.32	5.33	3.06	31.23	34.15	-1.92	0.84	-8.58	6.93	-18.11	4.20	12.37	33.33
Zn	-7.65	-0.97	5.85	12.88	26.02	20.86	-13.19	-5.00	-12.10	4.07	-2.03	24.47	4.82	46.30
CH_2CL_2														-8.00
NIT														18.18
PO_4														-33.33
CCL_3F				(2)						(2)				
MEC_6H_5												(5)		

(1) Analyte detected in field sample only
(2) Analyte detected in duplicate sample only
(3) Analyte reported in field sample below Certified Reporting Limit (CRL)
(4) Analyte reported in duplicate sample below CRL
(5) Values within two times the CRL
Please see the Chemical Acronoym List for acronym definitions

3.13.3 Laboratory Quality Assurance/Quality Control

Laboratory QC samples were analyzed with the actual samples to estimate and evaluate the informational content of analytical data and to determine the necessity of corrective action for analytical procedures. Two types of QC were employed to satisfy both USAEC and EPA protocols.

3.13.3.1 USAEC Method Quality Assurance/Quality Control

The QC samples associated with the USAEC methodologies included method blanks and QC spikes. A blank is an artificial sample designed to monitor the introduction of contaminants into a process. The method blank is used to verify that the laboratory is not a source of sample contamination. The method blank for the chemical data lot IVVA for semivolatile organic compounds in soil exhibits detections of toluene, di-n-butyl phthalate, and mesityl oxide. There are no detections of toluene or mesityl oxide found in the samples associated with this lot. There are 5 detections of di-n-butyl phthalate found in lot IVVA field samples, although the concentrations are less than the concentration found in the method blank. Therefore the AEC flagging code of "B" (analyte found method blank) has been used to qualify the associated detections. The method blank results for all other organic compounds exhibit no detections above the criteria of detection. Lead and arsenic were detected in method blanks due to contaminants in the standard soil used for the blanks. The method blank results indicate laboratory contamination did not occur during the extraction and analysis of the samples.

The QC spike samples are analytical samples that have known amounts of control analytes added to standard matrices (determined by USAEC) to verify method performance and to provide precision and accuracy data. Three USAEC QC spikes per analytical batch are required by each method. One spike concentration is set at a level two times the lower certified reporting limit (CRL), and the other two concentrations are duplicate spikes set at ten times the lower CRL. USAEC samples and QC spikes are analyzed in a specific order to ensure that all sample results are bracketed by QC results. Spike recovery data are plotted by lot designator on control charts to evaluate precision and accuracy. Trend and outlier analyses are performed to assess method control and data acceptance. The final acceptance of the analytical data provided by USAEC methodologies is the decision of USAEC and is based on the control-charted QC data.

Other QA/QC acceptance criteria for USAEC methods include ensuring that sample extraction and analysis holding times are met. All sampling and analysis dates were compared to method-specific holding times. The verification of sample holding times reveals analytical holding time criteria were met for the RFI-Phase II field samples, with the exception of the following samples. The sample extraction holding times were exceeded for the explosive analysis at SWMU 30 (locations 30-TP-2 and 30-TP-3), and the PCB analysis at SWMU 5 (5-BLD-1 only) located south of the drainage pond.

Well samples for bicarbonate were analyzed using an EPA method that has not yet been certified by USAEC. Consequently, the method code for bicarbonate analysis is identified as method 99. The data in these lots are considered valid by USAEC.

3.13.3.2 Matrix Spike and Matrix Spike Duplicate Evaluation

QC for EPA methodologies consists of blanks, matrix spike (MS), matrix spike duplicate (MSD), and replicate samples. The laboratory blank is a reagent blank that is analyzed with every batch of samples to ensure that no contamination has occurred during the extraction or analysis. One MS/MSD pair should be analyzed for every batch of 20 samples. The MS/MSDs are actual samples that are split three ways into one control sample and two other samples to be used as duplicates. The two sample duplicates are spiked with predetermined quantities of control analytes. For this project, the spiking levels for the MS/MSDs were the same as those used for the USAEC spikes. The control samples were analyzed to determine actual background analytes that were then subtracted from the spike data. The percent recoveries are calculated for detected analytes in the MS/MSDs and are used to assess analytical accuracy. In addition, the RPD between the MS and MSD was calculated and used to assess the analytical precision. Precision was also assessed by means of replicate laboratory sample analyses. Replicate samples were prepared by dividing a sample into two aliquots and analyzing each aliquot. The precision and accuracy data collected by EPA methodologies are not control-charted due to the numerous different types of sample matrices. MS/MSDs were analyzed with both USAEC and EPA methodologies to provide information regarding sample matrices and the capability of the analytical methods to extract the analytes of interest from the matrices.

The analytical accuracy and precision control limits for EPA methodologies are established by the individual laboratories on an ongoing basis as part of a formal QC program in accordance with EPA guidelines. The ranges for accuracy and precision are established through continuous analysis of sample MS/MSDs. The EPA ranges for SW-846 methodologies can be found within each method. However, these ranges have generally been determined through repetitive analysis of blank spiking and they differ from actual sample MS/MSD recovery data. The ongoing data quality checks are compared with established performance criteria to determine whether the results meet the performance characteristics of the method. A basic statistical approach for environmental data is the use of plus or minus two standard deviations from the mean to yield a 95 percent confidence level for data. USAEC also utilizes this approach for establishing upper and lower control-chart limits. The analytical precision as plotted for USAEC methods is specific to the analyte and method and ranges between 10 and 30 percent. However, USAEC MS/MSD recoveries were not assessed as part of data validation for this program.