3.0 PREVIOUS AND RFI-PHASE I INVESTIGATIONS

This section presents summaries of previous investigations and the RFI-Phase I field investigation at some of the 27 suspected releases SWMUs. As stated earlier, an Additional Sampling Program was completed as part of the RFI Phase I field investigation in June 1992. This program was completed where insufficient data was available to support either a no action or Phase II recommendation. Details of this Additional Sampling Program are given in Section 3.10.10. Many of the previous studies addressed areas outside the 27 suspected releases SWMUs that are the subject of the current RFI. The details of historical research or analytical results in these programs that are pertinent to the RFI or that characterize the affected environment where further sampling or corrective action are proposed are included in the discussions of each SWMU in Section 5.0.

3.1 INSTALLATION ASSESSMENT - 1979

The initial investigation of TEAD-N and TEAD-S was performed by USATHAMA as part of a program to identify potential contamination at all suspect Army installations (USATHAMA 1979). The purpose of the study was to assess environmental quality with regard to the use, storage, treatment, and disposal of toxic and hazardous materials and to define any conditions which might adversely affect health and welfare or result in environmental degradation.

The assessment was based upon review of available records and interviews with past and present employees. Environmental sampling was not conducted. This study includes information on SWMUs 1, 2, 3, 4, 5, 8, 9, 11, 14, 15, 21, 22, 23, 25, 26, 27, and 28.

The mustard storage areas (SWMU 9, including Area 2), burial areas, and demolition grounds (SWMUs 1 and 25) were identified as potentially contaminated areas. SWMUs 1 and 25 were considered to have the greatest potential for contaminant migration because of the shallower water table in those areas.

The recommendations in this report were to locate and identify the contents of former demolition pits 27 through 30 in SWMU 1, install monitoring wells around landfills (possibly SWMUs 26 and 28) to a depth of 10 meters, and establish a sampling program for surface drainage systems.

3.2 AERIAL PHOTOGRAPHY INTERPRETATION - 1982

Through an interagency agreement between the U.S. Environmental Protection Agency (EPA) and the Army, the Environmental Photographic Interpretation Center (EPIC) provided analysis of aerial photographs for the USATHAMA Installation Assessments (EPIC 1982). Data available for TEAD-S was limited to black and white photographs from September 1974 and low altitude color infrared photographs from July 1981.

The locations of potentially hazardous sites, as well as surface drainages, ground scars, extraction pits, and munitions storage areas were identified using the photographs. A total of 28 sites were analyzed that encompassed in some part the following SWMUs: 1, 2, 8, 9, 11, 14, 21, 22, 23, 25, 26, 27, 28, 29, 30, 32, and 34. Significant changes noted at TEAD-S between 1974 and 1981

included the expansion and upgrading of Chemical Ammunition Safeguarding Area 10 (SWMU 11), and the creation of a new landfill (SWMU 26) east of the administration area.

3.3 INSTALLATION ENVIRONMENTAL ASSESSMENT - 1982

This report, prepared by the Army, is a summary of all TEAD features that were thought to have environmental significance (Inland Pacific Engineering Company 1982). Research for this study involved the examination of resources in and around the installation, identification of on-base activities, and the evaluation of the potential impacts of these activities on resources on and off the base.

Eleven areas at TEAD-S were identified as potentially contaminated: the sanitary landfill (SWMU 26); the abandoned sanitary landfill (SWMU 28); the spoil area (north boundary); the Imhoff tank and sewage lagoon (SWMU 27); 12 septic tanks and drainfields (interspersed roughly around SWMUs 13, 19, 20, 21, 22, and storage areas 2 and 10; the administration area; Buildings S-541 and S-553; the unlined drainage pond (SWMU 5); the demolition and burning ground areas (SWMUs 1 and 25); two mustard-holding areas in Storage Area 2; two mustard-holding areas used for burning (SWMU 1); the 4.2-inch mortar pit (SWMU 1); and the covered disposal pits (SWMU 1).

3.4 EXPLORATORY SURVEY - 1982

Under the direction of USATHAMA, the Earth Technology Corporation (Ertec) conducted a two-phase exploratory survey of TEAD to determine the presence of contaminants and the potential for contaminant migration (Ertec 1982).

The first phase (1981) consisted of a review of existing data and preliminary visits to identify sites with the greatest potential to contaminate both the surface and subsurface environments. This phase resulted in a matrix relating potential sources and potential contaminants. The RFI-Phase I investigation SWMUs included as potential sources of contamination at TEAD-S by Ertec included the following SWMUs: 1, 2, 5, 8, 9, 11, 14, 15, 19, 21, 22, 23, 25, 26, and 28.

The second phase consisted of sampling and analysis of soil, sediment, surface water, and groundwater at the sites identified during the first phase. This sampling was conducted from January to July 1982. Samples were collected from existing supply wells 1 and 3, 11 new monitoring wells (S-1 through S-8, S-10, S-12, and S-14), four well borings (S-1, S-2, S-8, and S-11), three surface water sites (S-SW1 through S-SW3), and four sediment sample sites (S-SD1 to S-SD4). Another monitoring well (S-9) was also installed, but has never yielded water. The soil and sediment samples were analyzed for semivolatiles, explosives, metals, anions, radionuclides, oil and grease, and cyanide. The surface and groundwater samples were analyzed for volatiles, semivolatiles, explosives, metals, anions, radionuclides, oil and grease, and cyanide.

The conclusion of the Phase II investigation was that TEAD-S was generally uncontaminated except for arsenic, gross-alpha, and gross-beta. High arsenic levels were found in the groundwater of the uppermost aquifer in the south-central portion of the site. The arsenic was

hypothesized to be either naturally occurring or related to possible spills of arsenic-containing agents. Gross alpha and gross beta radiation was found to be high in two surface water samples (S-SW1 and S-SW2) and in one groundwater sample (S-12). Because there was no evidence or record of use, storage, or disposal of any radioactive material at TEAD-S, this radiation was attributed to naturally occurring radionuclides.

The survey recommended a groundwater monitoring program to sample existing wells semiannually. Ten surface soil and sediment samples were recommended to be collected from the south-central portion of the site and were to be analyzed for arsenic. Most of these samples were to be taken from the demilitarization area/demolition pits (SWMUs 1 and 25).

3.5 AERIAL PHOTOGRAPHY INTERPRETATION ADDENDUM - 1986

This report by EPIC for USATHAMA is an addendum to the 1982 report. It provides a more detailed study of selected sites using U.S. Geological Survey (USGS), Agricultural Stabilization and Conservation Service (ASCS), EPA, and commercial aerial photographs from 1952, 1959, 1966, and 1978. The sites at TEAD-S that were studied further included the demilitarization area burning and burial ground (SWMU 1 or 25) and three small landfills labeled sites 10 (SWMU 30), 22 (SWMU 26), and 5 (SWMU 29).

By stereoscopically viewing pairs of transparencies of these additional photographs, more details and changes were ascertained. Trenching was observed at the SWMU 30 landfill in 1959 and 1966. Trenching also occurred in 1952, 1959, and 1966 at SWMU 26. There was no evidence of filling at SWMU 29 until an on-site observation in 1978. The demilitarization area burning and burial grounds of SWMUs 1 and 25 included open trenches, pits, craters, and mounds in 1952, 1959, and 1966.

3.6 SWMU EVALUATION - 1986

The U.S. Army Environmental Hygiene Agency (USAEHA) prepared this report on all SWMUs at TEAD-S to identify data gaps in the existing database for the RCRA Part B Application that was pending for CAMDS (USAEHA 1986).

This review evaluated data from the Installation Assessment by USATHAMA (1979), the exploratory survey by Ertec (1982), and the photographic analyses by EPIC (1982 and 1986). This information was combined with field surveys of the SWMUs, but no samples were collected. The evaluation included suspected releases SWMUs 1, 2, 3, 4, 5, 8, 9, 11, 14, 15, 19, 21, 22, 23, 25, 26, 27, 28, 29, 30, and 31.

This review concluded that suspected releases SWMUs 14, 19, and 20 did not fit the definition of a SWMU and, therefore, should be removed from the list of SWMUs. Because of the low potential for release of hazardous wastes to the environment, no further investigation was recommended for SWMUs including 2, 3, 4, 8, 11, 15, 21, 22, 23, 26, 27, 28, 29, 30, and 31. Additional investigation was recommended of SWMUs 1, 5, 7, 9, 17, and 25 due to a moderate to high potential for contaminant release.

3.7 FINAL INTERIM RCRA FACILITY ASSESSMENT - 1987

This RCRA Facility Assessment (RFA) was performed by NUS Corporation to evaluate releases of hazardous wastes or hazardous constituents and to identify corrective actions, as necessary, under the Hazardous and Solid Waste Amendments of 1984. The RFA provided information on SWMUs at TEAD-S, evaluated the potential for releases to the environment, and determined the need for further investigation.

First, existing information from EPA and State of Utah files was reviewed and compiled. Then, a site inspection was conducted in May 1987, with TEAD officials providing confirmation of SWMU characteristics and releases, identifying additional SWMUs, and identifying possible sampling locations and rationale. This investigation included all suspected releases SWMUs except SWMUs 14 and 20. NUS recommended further investigation at SWMUs 1, 2, 3, 4, 5, 8, 9, 15, 21, 22, 23, 25, 26, 27, 31, and 36. No further investigation was recommended at SWMUs 11, 19, 28, 29, 30, 32, 33, and 34.

3.8 PRELIMINARY ASSESSMENT/SITE INVESTIGATION - 1988

EA Engineering Science and Technology, Incorporated prepared this report for USATHAMA after performing a database review and a preliminary field sampling and analysis program between September 1985 and November 1987. The review used maps, aerial photographs, literature provided by USATHAMA, information obtained from record searches, interviews with TEAD personnel during the site visit, and observations made during site surveys and an aerial flyover. A field sampling plan was then developed in which 17 sites at TEAD-S were identified as potential sources of contamination. Sites considered to present a significant potential threat included three suspected releases SWMUs: the bomb washout area at former Building 600 (SWMU 5), the Building 3200 laundry effluent ponds (SWMU 36), and the explosion craters at the old demilitarization range (SWMU 25).

There was no indication of releases of toxic or hazardous materials to the environment at the sewage lagoon (SWMU 27), laboratory, munitions storage area 10 (SWMU 11), old munitions storage area 2 (northern part of SWMU 9), warehouse C-4002 demilitarization pit (SWMU 15), active sanitary landfill (SWMU 26), or abandoned sanitary landfill (SWMU 28). Releases of contaminants to the environment had potentially occurred at the mustard holding area (southern part of SWMU 9), chemical demilitarization range disposal pits (SWMU 1), windrows (SWMU 25), gravel pits (SWMU 2), and burial pit (SWMU 3).

Before the field sampling plan was initiated, four new monitoring wells were installed. Three were installed at CAMDS (S-CAM-1, S-CAM-2, and S-CAM-3), and one was installed at the north perimeter (S-SBR-1) for obtaining background groundwater quality data. Groundwater samples were collected from the new wells and existing wells. Of the three wells at CAMDS, two (S-CAM-1 and S-CAM-2) had floating product on the water surface and were not sampled. One surface water sample was collected at CAMDS, and two were collected from the explosion craters in SWMU 25. Four soil samples were collected at the bomb washout pond (S-WOP-1 through 5) at SWMU 5, and one (S-LWOP-1) was collected at the laundry pond at SWMU 36.

Analyses performed on surface water and groundwater included total metals, base/neutral/acid extractable organics, volatile organics, inorganics, explosives, agent indicators, nitrate-nitrite-nitrogen, and radionuclides. Soil samples were analyzed for explosives and nitrogen.

This report concluded that the source and extent of groundwater contamination could not be attributed to any individual sites due to the natural occurrence of many of the constituents of concern and the absence of upgradient and downgradient monitoring wells at the sites in question. The monitoring well network indicated that TEAD-S groundwater quality did not present an immediate risk to the health or welfare of the public, and there was no indication of off-site contaminant migration.

Recommendations included installing additional monitoring wells at the southeastern, southwestern, and northwestern perimeter, and sampling and analyzing soil in the former mustard holding area (SWMU 9).

3.9 REMEDIAL INVESTIGATION - 1991

The remedial investigation (RI) was performed by Roy F. Weston Inc. for USATHAMA. The objective of the RI was to sample and analyze groundwater, surface water, soil, and sediments for potential contamination at four areas within TEAD-S: CAMDS (known release SWMU 13), the former mustard holding area (SWMU 9), the deactivation furnace area (SWMU 17), and the south general and perimeter areas.

Groundwater samples were taken from existing wells and from new wells (S-16-88 through S-31-88). Soil samples were collected during drilling of wells S-16-88 and S-20-88. Eleven hand auger samples and three sediment samples were collected from the former mustard holding area (SWMU 9). Fourteen other sediment samples and seven surface water samples were collected from areas outside the boundaries of the RFI-Phase I SWMUs. Analyses of these samples included volatiles, semivolatiles, nitroaromatics, chemical agent breakdown products, petroleum hydrocarbons, metals, anions, and radionuclides.

The investigation concluded that the former mustard holding area was contaminated. The south general and perimeter areas also contained potential contaminants. The former mustard holding area required remediation to eliminate exposure from contaminated soil and soil dust.

3.10 RFI-PHASE I FIELD INVESTIGATION - 1990

3.10.1 Scope

The RFI-Phase I field investigation was conducted at the 27 suspected releases SWMUs. Twenty-one of these 27 SWMUs were sampled as part of the RFI-Phase I field investigation. The selection of these 21 SWMUs was determined from the scope of work outlined by USATHAMA in the Task Order, the initial site visit, and interviews with present and former TEAD personnel familiar with the histories of the SWMUs. SWMU 37 was not sampled because this SWMU was identified after the field program had ended. In Section 5.0 of this report, the

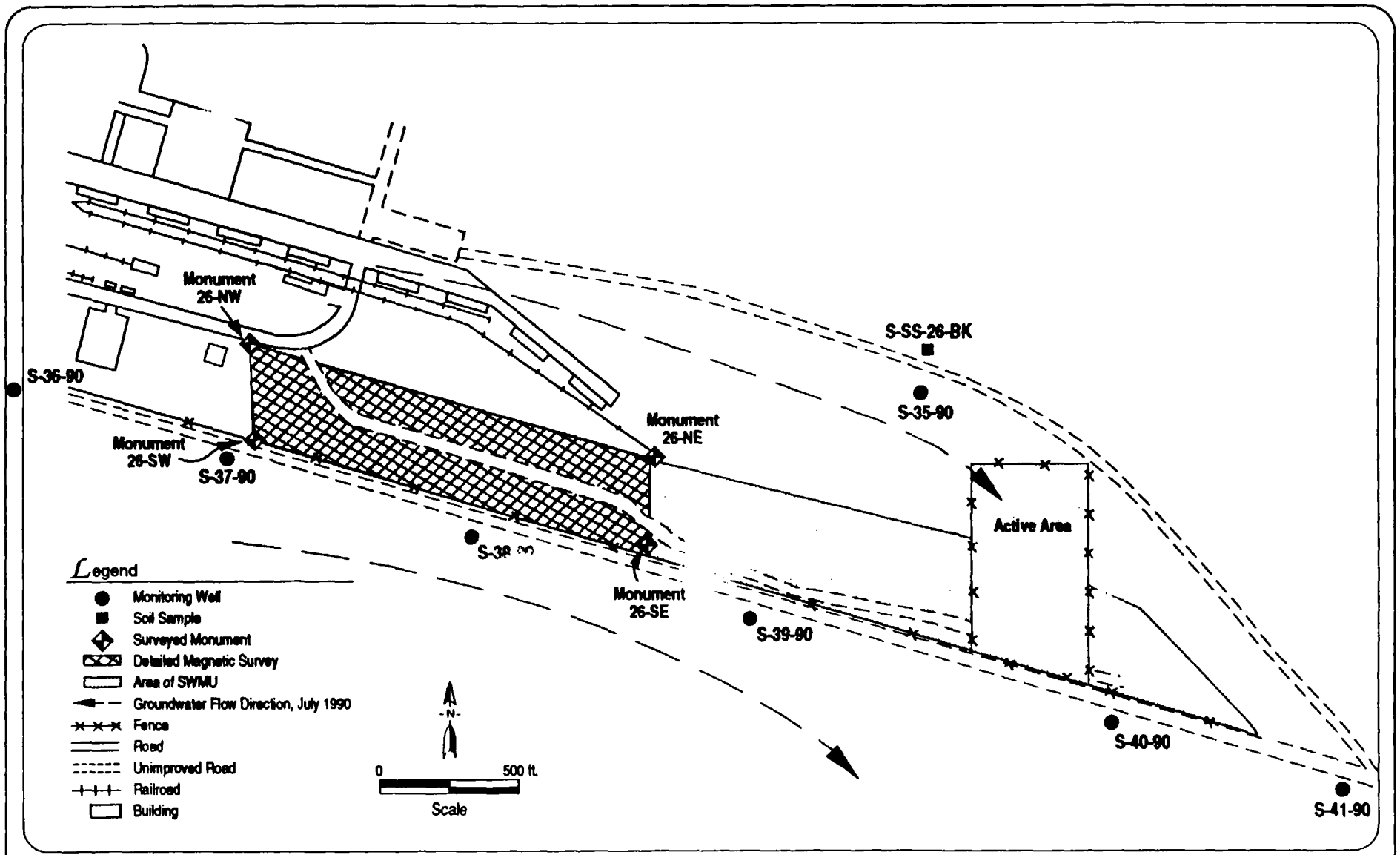
RFI-Phase I data are combined with historical data and the results of previous sampling to assess the potential for contamination at each SWMU. The data from RFI-Phase I field investigation were collected to indicate the presence or absence of contamination at selected SWMUs, but not the extent of any contamination. An Additional Sampling Program was also completed at selected SWMUs where original Phase I data were insufficient to support a recommendation of no action or a Phase II investigation. The details of this program are presented in Section 3.10.11.

Each of the elements of the RFI-Phase I field program are briefly discussed in this section:

- Geophysical investigation of SWMU 26
- Excavation to confirm geophysical results at SWMU 26
- Grab sampling of solid waste contents of open containers in SWMUs 29 and 32
- Installation of 41 groundwater monitoring wells and three piezometers
- Unexploded ordnance (UXO) and buried utility clearance at each soil boring and well drilling location
- Collection and field analysis of soil gas samples at four SWMUs
- On-site analysis of soil samples from SWMU 26 trenches
- Collection and analysis of 51 soil samples from ten SWMUs and ten from background areas
- Collection and analysis of 48 soil samples from eight meteorological stations
- Quarterly groundwater elevation measurements in all wells and piezometers
- Collection and analysis of groundwater samples from all monitoring wells
- Waste handling
- Groundwater monitoring well and selected SWMU location surveying

3.10.2 Geophysical Survey

A magnetic survey was conducted in the western portion of SWMU 26 (Sanitary Landfill, Figure 3.10-1). This survey was conducted to confirm the presence or absence of 300 to 400 55-gallon drums of transformer oil and trichloroethylene reportedly buried in this area (NUS 1987; see Section 5.16.1). The survey was conducted in the western portion of SWMU 26



Source:
EBASCO Field Measurement
Basic Information Maps 1985

Figure 3.10-1
SWMU 26 - Sanitary Landfill
(Active and Inactive)

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

EBASCO

because a former site employee interviewed in August 1989 stated that if the reported burial of waste oils and solvents occurred, it would have occurred in this area (Painter 1989).

The magnetic data were used to plan excavations to verify or refute the existence of the drums. The geophysical and excavation data were also intended to be used to site groundwater monitoring wells S-36-90, S-37-90, and S-38-90, which were installed south of this part of the SWMU. Since the geophysical and excavation data did not indicate any specific contamination sources in the landfill, the wells were spaced at equal distances along the south side of this SWMU.

Methodology

For the magnetic survey, parallel survey lines were spaced 25 ft apart. Magnetic data were collected at 10 ft stations along the survey lines. Each survey line began and ended at a point outside of the suspected disposal area. All magnetic data were referenced to four surveyed monuments at the corners of the survey area. Horizontal control along the magnetic lines was maintained using a compass and a fiberglass tape measure.

A data logbook was used to document and record the survey line number, horizontal references, data interval, instrument settings, weather, date, time, and personnel. The digital magnetic field data were transferred from the survey instrument to a portable computer and stored on floppy disks prior to data processing.

Instrumentation

Magnetic data were acquired using an EDA OMNI IV magnetometer using two sensors spaced 0.5 meter apart. The lower sensor height was 6 ft above ground level. The OMNI IV contains a digital memory that can store over 1,000 readings. Two readings were taken at each measurement station, one with each sensor, to obtain both total field and gradient values. The data were stored in random access memory (RAM) and downloaded in the field into a portable computer for processing and display.

The OMNI IV was used as a gradient magnetometer, or gradiometer. A gradiometer measures total magnetic field intensity twice at each station; once with the lowest sensor on the sensor staff and again with the upper sensor 0.5 meter higher on the staff. The difference between the two readings divided by the sensor separation is the gradient measured in gammas per foot. Gradient measurements tend to resolve composite or complex anomalies into their individual constituents and automatically remove the regional magnetic gradient, as well as variations caused by solar flares, magnetic storms, and solar winds.

Total magnetic field intensity data were collected as part of the gradient data. When only total magnetic field data are used for analysis, it is necessary to account for diurnal effects, which are the daily changes that occur in the earth's magnetic field and which distort the external magnetic field. It is necessary to establish a base station or use tie lines to account for diurnal effects.

Tie lines were used for the magnetic survey conducted at SWMU 26. After the diurnal trend was established, undesirable diurnal effects were removed from the data collected at the SWMU.

Data Interpretation

Preliminary interpretation of the magnetic data was completed at the end of each day to aid in planning the remaining field work. At the completion of the field program, the magnetic survey data were processed and interpreted. Magnetic data contour maps and 3-D perspective view plots were generated using SURFER, a contour plotting program.

The interpretation of the magnetic data identified many anomalous zones in SWMU 26. Geophysical anomalies were described as locations where the instrument response deviated from the background values. Magnetic anomalies associated with the SWMU were evaluated in terms of increases or decreases in signal amplitude when compared with undisturbed native soils. Other information such as historical documents, aerial photographs, and surface conditions were used to aid in the geophysical data interpretation.

The corrected total field map and gradient map exhibited the same general characteristics (EBASCO 1991). The corrected total field data defined the road across the SWMU, while the gradient data emphasized cultural features such as the manhole and steel posts located within the survey area. These geophysical results are detailed in the Phase I Data Collection Quality Assurance Plan (EBASCO 1991) and summarized in Section 5.16.

3.10.3 SWMU 26 Landfill Exploratory Excavation

Five exploratory trenches were excavated in the SWMU 26 landfill to investigate the areas of magnetic anomalies (Figure 3.10-2). The excavation sites were located in the field using the survey-controlled staking from the geophysical program to ensure that specific magnetometer data were investigated.

Each excavation was made with a backhoe to depths ranging from approximately 8 to 11 ft. The backhoe excavated layers approximately 1 ft thick, and the excavated material and trench walls were described in detail during each excavation. Table 3.10-1 summarizes the dimensions and contents of each trench. No drums of waste oil or solvents were found in any of these trenches. Two fill samples were collected from each trench for laboratory analysis. The analytical methods used are listed in Section 3.10.10. These samples are discussed in Section 5.16.3 of this report. Each trench was backfilled with the original fill material, and the replaced fill was compacted into the trench with the excavating equipment.

3.10.4 Product Sampling

Grab samples of exposed, partially containerized product were obtained from SWMUs 29 and 32 in October 1989. The waste was sampled using a stainless steel scoop and was analyzed for EP toxicity (EPTOX), semivolatiles, anions, organophosphorous pesticides, chlorinated herbicides, and oil and grease. The results of this sampling are discussed in Sections 5.19 and 5.22.

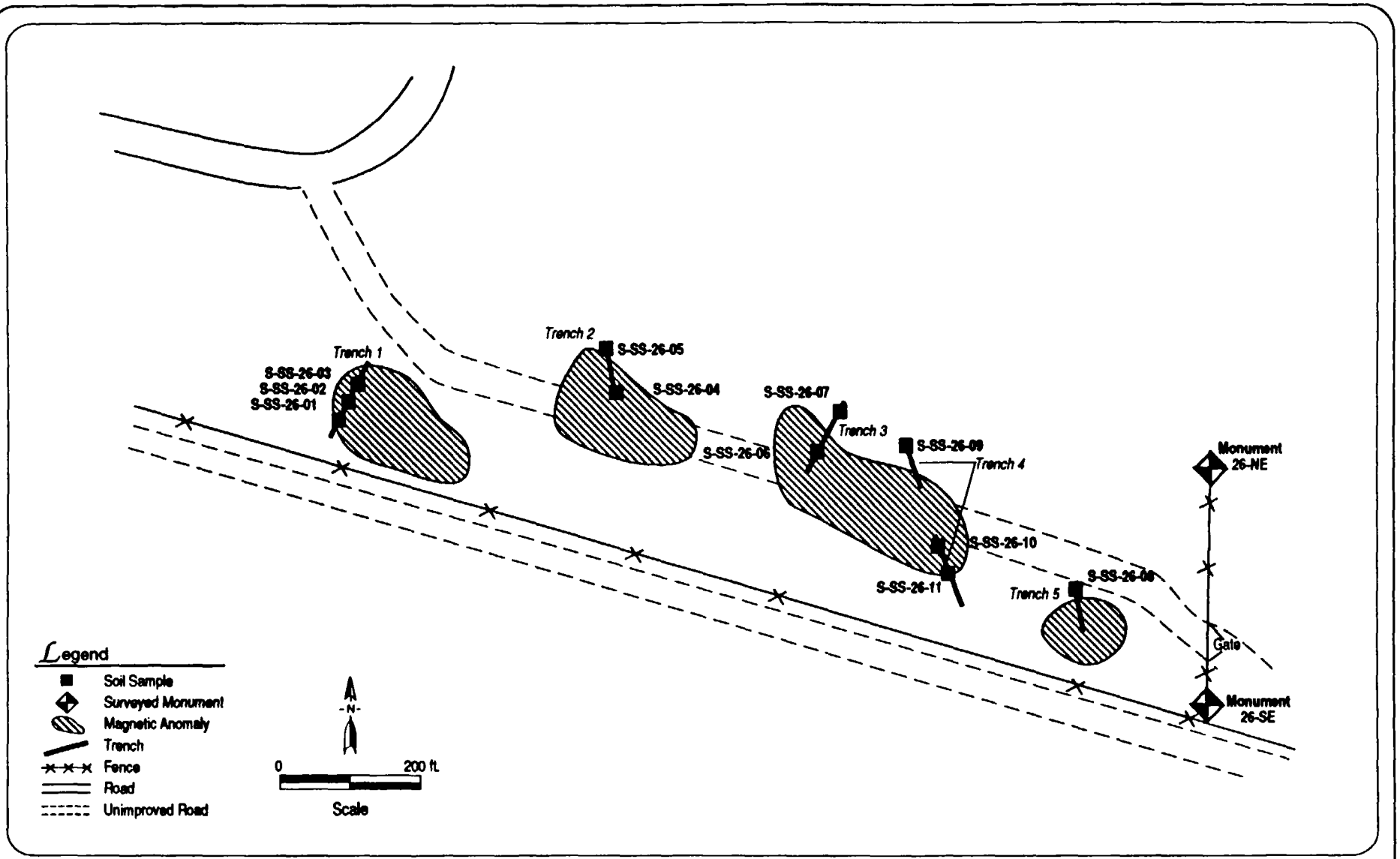


Figure 3.10-2
SWMU 26 - Sanitary Landfill Trenches
Magnetic Anomalies

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

EBASCO

Table 3.10-1 • SWMU 26 Trench Descriptions

Trench No.	Dimensions (ft)	Average Depth (ft)	Trend	Lithology	Contents
1	3 x 109	8.3	NE - SW	Silty gravelly sand with clay fill	Charred wood, 5-gallon paint drum, liquor bottles, paper, and batteries
2	N: 3 x 52 S: 3 x 18	11.1	N - S	Sand with silty gravel, clay fill	5-gallon paint can, scrap metal, paper, tire, porcelain, wire, and minor sludge
3	3 x 95	9.9	NE - SW	Silty gravelly sand with clay fill	55-gallon drum top with ring, glass bottles, asphalt, wood, steel cable, leather, and corroded metal
4	N: 3 x 60 S: 3 x 80	9.8	N - S	Silty gravelly sand	30-gallon drum top, metal, canvas, wood, paper, shoes , cosmetics, and liquor bottles
5	3 x 56	10.4	N - S	Sand with gravel and minor clay	Bottles and minor trash

N: North portion of trench
S: South portion of trench

3.10.5 Soil Gas Sampling and On-Site Analysis

Soil gas samples were collected at SWMUs 14, 19, and 27. On-site analysis equipment used in the soil gas program also provided field screening chemical analyses of soil samples collected from the excavations at SWMU 26 (see Section 5.16). Soil gas and on-site analytical results are nonquantitative screening data that were used only to guide the placement of soil borings and excavations where volatile and associated contaminants were most likely to be found.

At SWMUs 14, 19, and 27, soil gas samples were collected from a depth of 3 ft. Additional samples were collected according to the results of the initial samples. The soil gas samples were injected into a portable gas chromatograph (Photovac model 10570) and analyzed for trans-dichloroethylene, trichloroethylene, tetrachloroethylene, benzene, toluene, and meta-xylene. The results of these analyses are presented in the characterization sections for SWMUs 14 (Section 5.9), 19 (Section 5.11), and 27 (Section 5.17).

3.10.6 Soil Sampling

Soil samples were collected from SWMUs 5, 8, 14, 19, 22, 23, 26, 27, 29, and 36. Samples collected at all SWMUs except SWMUs 22 and 26 were composites of 3 ft borings collected where potential contamination was most likely. Samples were collected from the bottom of the SWMU 26 trenches and from the entire thickness of the sediments in the SWMU 22 washout basins. The number of soil samples and the analyses appropriate to each SWMU are listed in Table 3.10-2.

At meteorological stations, six samples were collected from the 0- to 6-inch depth interval to analyze for mercury contamination according to analytical methods discussed in Section 3.10.10. The meteorological stations are discussed in Section 5.26.

In addition to soil samples from inside the SWMUs, 10 soil samples were collected in uncontaminated areas near SWMUs 5, 8, 9, 14, 19, 22, 23, 26, 27, and 29 to characterize background metal concentrations. These samples were also composites collected from the 0 to 3 ft depth interval. Results for these samples are presented in Section 5.0 for each SWMU and in a discussion of background metal concentrations in Section 4.1. Section 4.1 shows that this number of background samples was adequate to calculate statistically significant background metal concentrations at the site. Additional background samples have been collected as part of the known releases RFI.

3.10.7 Well Installation and Sampling

Forty-one groundwater monitoring wells were installed at TEAD-S (Plate 1). The groundwater monitoring wells were installed to monitor the uppermost part of the unconfined or semiconfined aquifer upgradient and downgradient of selected SWMUs. Some wells originally planned in the RFI-Phase I (EBASCO 1991) were not drilled. Well S-52-90 was not drilled because the locations of wells S-51-90 and S-53-90 were moved closer together, eliminating the need for S-52-90. Wells S-72-90 and S-73-90 were planned at SWMU 31, but were canceled because open detonation of explosives at this SWMU would have destroyed the wells. Groundwater flow

Table 3.10-2 • Soil Sampling

SWMU No.	No. of Samples	Sample Depth (Ft)	VO	SVO	TPH	ABP	TDG	EXP	MTL	HG
5	3	3		•			•		•	
8	2	3		•	•			•	•	
14	3	3	•	•	•				•	
19	2	3	•	•	•				•	
22	6	3						•	•	
23	4	3				•		•		
26	10	NA	•	•				•	•	
27	1	3	•	•		•		•	•	
29	6	3	•	•				•	•	
36	4	3	•	•				•	•	
BKD	10	3							•	
MET	48	0.5								•

BKD - Background
MET - Meteorological Stations
NA - Samples collected from bottom of trenches
VO - Volatile Organics (Priority Pollutant GC/MS Scan)
SVO - Semivolatile Organics (Priority Pollutant GC/MS Scan)
ABP - Agent Breakdown Products (Thiodiglycol, Fluoroacetic Acid, Isopropylmethyl Phosphonic Acid)
TDG - Thiodiglycol only
EXP - Explosives (2,4,6-TNT; 1,3,5-TNB; 1,3-DNB; 2,4-DNT; 2,6-DNT; NB; RDX; HMX; Tetryl)
MTL - Metals (Ag, As, Be, Cd, Cr, Cu, Hg, Na, Ni, Pb, Sb, Se, Tl, Zn)
TPH - Total Petroleum Hydrocarbons
HG - Mercury only

directions were uncertain in some areas; therefore, five piezometers were planned. Two of these piezometer boreholes were dry at the depth of interest, and were subsequently abandoned. Table B-1 (Appendix B) presents the specifications of the wells and piezometers that were installed, and includes similar information for previously installed wells.

In general, subsurface stratigraphy was characterized by collecting 1-ft-long cores at 5-ft or 10-ft intervals and by describing cuttings where rotary drilling methods were used. A representative group of samples was selected from each SWMU and analyzed for geotechnical parameters.

As described in the Phase I Data Collection Quality Assurance Plan (EBASCO 1991), wells were constructed of threaded polyvinyl chloride (PVC) casing with a nominal 4-inch diameter, and piezometers were constructed of threaded PVC with a nominal 2-inch diameter. Wells were generally constructed with 10-ft-long, 0.010-inch slotted screens, but 20-ft-long screens were used where the water bearing zone could not be confidently identified within a 10-ft interval. A dedicated PVC bailer was installed in each well. Each bailer was cleaned by a certified laboratory before entering the well. Appendix B illustrates the general construction of each well.

Groundwater samples were obtained from each monitoring well at the site and analyzed for the following suite of analytes:

- Volatile Organics – Priority Pollutant gas chromatograph/mass spectrophotometer (GC/MS) scan
- Semivolatile Organics – Priority Pollutant GC/MS scan
- Agent Breakdown Products – thiodiglycol, fluoroacetic acid, and isopropylmethyl phosphonic acid
- Explosives – 2,4,6-trinitrotoluene, 1,3,5-trinitrobenzene, 1,3-dinitrobenzene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, nitrobenzene, cyclonite, cyclotetramethylene tetranitramine, and nitramine
- Metals – antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, silver, selenium, sodium, thallium, and zinc
- Inorganics – chloride, fluoride, and bromide
- Radiological parameters – gross alpha, gross beta, and uranium

The analytical methods used are summarized in Section 3.10.10.

3.10.8 Well and Other Surveying

Each monitoring well and piezometer was surveyed for horizontal and vertical con Surveyed monuments were also installed at selected SWMUs to facilitate mapping and to ensure that the locations can be recovered if surface evidence is removed. The surveyed well and monument locations are illustrated on Plate 1 and have been used in the preparation of all maps in this report, wherever applicable. Soil sample locations, however, were not surveyed and were estimated by tape and compass during sampling.

Survey monuments were placed at:

- SWMU 1 – Northernmost corner of the fence
- SWMU 3 – North ar ith ends of the covered trench
- SWMU 8 – West end of east-west trench and north end of north-south trench
- SWMU 23 – Northwest corner
- SWMU 25 – West and east ends of windrows ortheast corner of the fence
- SWMU 26 – Four corners of the geophysical survey area

3.10.9 Other Field Operations

Certain SWMUs included in the field investigation have histories of munitions disposal, including munitions containing chemical agents. For this reason, field operations required surface clearance and subsurface location of UXO. The SWMUs that required UXO clearance were SWMUs 1, 2, 3, 8, 15, 23, 25, and 31. Surface clearance was both visual and with MK 26 and White Eagle II nonferrous alloy detectors. The MK 26 was used for downhole clearance during drilling operations. The MK26 and White Eagle II nonferrous alloy detectors were also used for surface clearance of UXO and buried utilities at each soil boring or well drilling location.

Groundwater elevations were measured in April, August, and October 1990, and February 1991. The sampling periods beginning in August include data from the wells and piezometers installed during the RFI-Phase I field program, which was conducted in May through August 1990.

3.10.10 Chemical Analytical Program

RFI-Phase I samples were analyzed for volatile and semivolatile organic compounds, metals, anions, explosives, agent breakdown products, radiological parameters and, in some cases, total petroleum hydrocarbons (TPHs) and RCRA characteristics. The methods used in these analyses are listed in Table 3.10-3 and include USATHAMA certified methods for all analyses except uranium, radionuclides, and TPH.

Table 3.10-3 • Summary of USATHAMA Certified Methods and EPA Equivalents

Method Name	EPA SW 846 Method Numbers Extraction/Analysis	USATHAMA Method No.	Laboratory
Soil			
Volatiles	5030/8240	LM16	A.D. Little
Semivolatiles	3550/8250	LM15	A.D. Little
Explosives	None	LW26	A.D. Little
Agent Breakdown Products			
FC2A, IMPA	None	AAA9	ESE
Thiodiglycol	None	LW18	ESE
Total Petroleum Hydrocarbons	418.1	None	A.D. Little
ICP Metals	3005/6010	None	A.D. Little
Arsenic	3050/7060	JD13	A.D. Little
Lead	3050/7421	None	A.D. Little
Mercury	7471/7471	JB03	A.D. Little
Selenium	3050/7740	None	A.D. Little
Silver	3050/7760	None	A.D. Little
Groundwater			
Volatiles	5030/8240	UM17	A.D. Little
Semivolatiles	3570/8250	UM16	A.D. Little
Explosives	None	UW26	A.D. Little
Anions	None	TT08	A.D. Little
Radionuclides	9310	None	ESE
Agent Breakdown Products			
FC2A, IMPA	None	UT02	ESE
Thiodiglycol	None	UW22	ESE
ICP Metals	3005/6010	SS10	ESE
Arsenic	3050/7060	SD22	ESE
Lead	3050/7421	SD20	ESE
Mercury	7470/7470	SB01	ESE
Selenium	3050/7740	SD21	ESE
Thallium	3005/7840	SD09	ESE

Method Name	EPA SW 846 Method Numbers Extraction/Analysis	USATHAMA Method No.	Laboratory[1]
Water Supply Well			
Volatiles	5030/8240	UM12	metaTRACE
Semivolatiles	3550/8250	UM13	metaTRACE
Explosives	None	UW05	metaTRACE
Anions	None	TT06	metaTRACE
Radionuclides	9310	None	metaTRACE
Total Petroleum Hydrocarbons	418.1	None	DataChem
ICP Metals	3005/6010	SS06	metaTRACE
Antimony	3050/7041	SD11	metaTRACE
Arsenic	3050/7060	SD11	metaTRACE
Mercury	7470/7470	SB10	metaTRACE
Selenium	3050/7740	SD11	metaTRACE
Grab Samples			
Semivolatiles	3550/8250	LM11	metaTRACE
Anions	None	KT03	metaTRACE
ICP Metals	3005/6010	JS05	metaTRACE
Antimony	3050/7041	JD11	metaTRACE
Arsenic	3050/7060	JD11	metaTRACE
Mercury	7471/7471	JB09	metaTRACE
Selenium	3050/7740	JD11	metaTRACE
Cyanide	9012	KF12	metaTRACE
Flashpoint	1010	None	metaTRACE
Herbicides	3550/8150	None	metaTRACE
Moisture	3500	None	metaTRACE
pH	9040	None	metaTRACE
Oil and Grease	9070	None	metaTRACE
Organophosphorous Pesticides	3550/8140	None	metaTRACE
Sulfide	9035	None	metaTRACE

FC2A - Fluoroacetic acid
IMPA - Isopropylmethyl phosphonic acid
None - No certified USATHAMA method

[1] MetaTrace has been decertified by USATHAMA

The USATHAMA certified methods are developed by independent laboratories for use in their laboratory only. These methods are developed from EPA methods, employing similar extraction and analytical techniques and achieving similar detection limits for the same priority pollutant analyte list. EPA SW-846 methods 8240, 8270, 6010, and 7000 were used as a basis for the development of USATHAMA methods used for volatile and semivolatile organics and metals. Since no EPA methods exist for explosives or agent breakdown products, USATHAMA methods for these analyses were developed independently. The uranium and radionuclide analyses were performed using modified EPA method 9310. The TPH was analyzed by a modified EPA method 418.1.

USATHAMA method detection limits are established during the method certification process. The detection limits for SW-846 methodologies are established by the individual laboratories with EPA guidance. Method detection limits for USATHAMA methods are comparable and may be slightly lower than SW-846 detection limits (Appendix F, Tables F-2 and F-3). However, method detection limits are always dependent upon sample matrix.

3.10.11 Additional Sampling Program

The RFI-Phase I Additional Sampling Program was conducted in June 1992. It included a collection of additional and replacement samples at SWMUs where the original Phase I program was insufficient to support a recommendation of either no action or a Phase II investigation. Ten SWMUs were investigated as part of the Additional Sampling Program.

Soil or sediment samples were collected from SWMUs 19, 22, 23, 27, and 33. At SWMU 19, soil samples were collected at various depths between railroad tracks and in and below sumps where contaminant releases could have occurred. Samples from SWMUs 22 and 23 were composites of 3-ft borings near the original Phase I locations. At SWMU 27, two soil borings were drilled and sampled at 0 to 6 inches, 1 to 2 feet, and 2 to 3 feet. Samples were collected from the entire thickness of sediments in the SWMU 22 washout basins and surface soil samples (0- to 6-inch depth) were collected from the floor of Building 536 (SWMU 33). The number of soil samples and the analyses appropriate to each SWMU are listed in Table 3.10-4.

Other samples collected include one sludge sample from the SWMU 20 septic tank and one surface water sample from the SWMU 27 lagoon. The analyses requested for these samples are presented in Table 3.10-4.

Groundwater samples were obtained from monitoring wells at SWMUs 2, 15, 26, and 28. The number of wells sampled at each SWMU and number of analyses are listed in Table 3.10-5. All work during the Additional Sampling Program was conducted according to the procedures outlined in the Final Health and Safety Plan (EBASCO 1990) as revised in 1992. Certain SWMUs included in the Additional Sampling Program have histories of munitions disposal, including munitions containing chemical agents. For this reason, surface clearance for munitions and buried utilities was conducted at each soil boring location similar to the Phase I investigation.

Table 3.10-4 • RFI Phase I Additional Soil and Surface Water Sampling

		Number and Depths of Samples					Analyses										Surveys and Support	
SWMU No.	Area	No. of Borings	Depth (ft.)	Samples per Boring	Total No. Samples	Composite	VO	BNA	IMPA, FC2A	TDGCL	MTL	EXP	PCB	RAD	RCRA Characteristics	Waste Line, Sumps, and Historical Survey	UXB Clearance	Agent Monitoring
19	Building 533	3	1-2.5	1-2	5		•						•			•	•	
20	Septic Tank (Sludge)				1		•	•	•	•	•							•
21, 22	Ditch	2	3	1	2	•						•		•			•	
	Basins (Sediment)				1	•									•			
	Basin (Surface water)				1										•			
23		4	3	1	4	•						•					•	
27	Ditch	2	3	3	6		•	•			•						•	
	Northern Lagoon (Surface water)				1		•	•			•							
33	Building 536 Floor		0.5		6				•	•	•						•	•

VO Volatile Organics (Priority Pollutant GC/MS Scan)
BNA Base Neutral/Acid Extractable/Semivolatile Organics (Priority Pollutant GC/MS Scan)

Agent Breakdown Products
IMPA - Isopropylmethyl Phosphonic Acid
FC2A - Fluoroacetic Acid
TDGCL - Thiodiglycol

MTL Metals (Ag, As, Be, Cd, Cr, Cu, Hg, Ni, Pb, Sb, Se, Tl, Zn)
EXP Explosives (2,4,6-TNT; 1,3,5-TNB; 1,3-DNB; 2,4-DNT; 2,6-DNT; NB; RDX; HMX; Tetryl)
PCB Polychlorinated Biphenyls
RAD Radionuclides

Table 3.10-5 • RFI Phase I
Additional Groundwater Sampling

SWMU No.	Existing Wells	Analyses: VC	BNA	IMPA, FC2A	EXP	Total No. Samples
2	S-3, S-46-90	•		•	•	2
15	S-47-90, S-48-90, S-49-90	•				3
26	S-36-90, S-37-90, S-38-90, S-39-90, S-40-90, S-41-90		•			6
28	S-32-90, S-33-90, S-34-90	•	•		•	3

VO	Volatile Organics (Priority Pollutant GC/MS Scan)
BNA	Base Neutral/Acid Extractable/Semivolatile Organics (Priority Pollutant GC/MS Scan)
Agent Breakdown Products	IMPA - Isopropylmethyl Phosphonic Acid
	FC2A - Fluoroacetic Acid
EXP	Explosives (2,4,6-TNT; 1,3,5-TNB; 1,3-DNB; 2,4-DNT; 2,6-DNT; NB; RDX; HMX; Tetryl)

Refer to Table 3.10-4 for soil boring locations requiring surface clearance. Monitoring for Army chemical agents was performed during sample activities at SWMUs 20 and 33 due to the potential presence of chemical agents. The samples from these SWMUs were cleared for agent contamination by the installation laboratory prior to leaving the site.

3.10.12 Field Quality Assurance/Quality Control

Field quality control (QC) samples were collected at the time of sampling in accordance with the Phase I Data Collection Quality Assurance Plan (EBASCO 1991). These 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, while equipment rinse blanks are a check on sampling device decontamination procedures. The field QC samples were analyzed in the same manner as actual samples regardless of the analytical methodologies; therefore, no bias should exist in the analyses.

3.10.12.1 Trip Blanks

Six trip blanks were analyzed for the Phase I sampling program, one for volatiles in soil and five for volatiles in water, including a trip blank matrix spike/matrix spike duplicate (MS/MSD). Five trip blanks were analyzed for the additional sampling program. All trip blanks and the MS/MSDs contained trace levels of methylene chloride ranging from 6.0 to 11 micrograms per liter (µg/l) for the water method and 0.011 microgram per gram (µg/g) for the soil method (Table 3.10-6). These low-level detections of methylene chloride are likely a result of laboratory contamination and indicate that little or no contamination of volatile organic samples occurred during transport of samples from the field to the laboratory.

The trip blank MS/MSD was deliberately spiked in the laboratory with 1,1-dichloroethylene, benzene, chlorobenzene, toluene, and trichloroethlyene to determine analytical precision. The analytical precision for the MS/MSD is determined by the relative percent difference (RPD) between analytes detected in the MS/MSD. The RPDs for the MS/MSD are 0, 1.6, 3.6, 1.6, and 2.4, respectively, signifying a very high level of precision in the method for volatiles in water.

3.10.12.2 Rinse Blanks

Water used during drilling and decontamination operations was obtained from the water supply well 2-S in the northeast corner of TEAD-S. The water was collected from the well prior to treatment processes, and transported to the drilling and decontamination locations by truck. A sample of this water was collected in August 1989 and analyzed for the same suite of analyses planned for the field samples (Section 3.10.11, Table 3.10-3). No organic analytes were detected; however, the laboratory that analyzed the 1989 samples was decertified. The same well was sampled and analyzed again in April 1990, and TPH were detected (Table 3.10-7). A second sample of this water was therefore collected during April 1990 after plumbing was installed which led outside of the pumphouse. The second sample was analyzed only for TPH, and no TPH was detected, indicating the TPH contamination occurred through exposure of the first sample to fuel vapors inside the pumphouse.

TABLE 3.10-6 **Summary of Analytical Results for Field Quality Assurance/Quality Control Samples: Trip Blanks**

Analytical Group and Analytes Detected	S-3	S-20-88	S-32-90	S-44-90	S-49-90	S-68-90	S-SW-27-01
Volatile Organics: (µg/l)							
Methylene chloride (CH2CL2)	9.2	7.3	11	6	8.5	6.6	11

Analytical Group and Analytes Detected	S-SS-26-01	S-SS-19-06
Volatile Organics: (µg/kg)		
Methylene chloride (CH2CL2)	10	9.7
Unknowns	12	

µg/l Microgram per liter
ug/kg Milogram per kilogram

GROUNDWATER (µg/l)

Analytical Groups and Analytes Detected	2-S 1989**	2-S 1990
Volatile Organics:		
Unknowns		11
Metals:		
Lead (Pb)	NA	5.3
Mercury (Hg)	0.17	LT 0.24
Sodium (Na)	NA	23,000
Anions:		
Bromide (Br)	70	LT 50
Chloride (Cl)	6000	79,000
Fluoride (F)	NA	170
Radionuclides (pCi/l):		
Gross alpha (ALPHAG)	NA	330*
Gross beta (BETAG)	NA	LT 0.30
Uranium (U)	4.0	21*
Total Petroleum Hydrocarbons:	NA	1000***

* Detected in associated method blank
** 1989 data decertified by USATHAMA
*** Detection occurred before outside plumbing installed. Not detected in subsequent sample.
NA Not analyzed
µg/l Microgram per liter
pCi/l Picocurie per liter

Equipment rinse blanks were collected for all analytical methods in the Phase I and additional sampling programs, in the Phase I and additional sampling programs to ensure that decontamination of field sampling equipment was achieved. The rinse blanks for explosives, agent breakdown products, metals, anions, and radionuclides for the Phase I sampling program revealed that there was no evidence of contamination carryover from the equipment used for collecting samples for these analyte groups.

The rinse blanks for semivolatiles, explosives, agent breakdown products, PCBs, and radionuclides for the resampling program show no evidence of equipment contamination. The analysis of Phase I rinse blanks for semivolatile and volatile organics showed detections of butyl benzyl phthalate, chloroform, and chloromethane at trace levels, with detections of acetone and methylene chloride at levels of 12 to 27 µg/l. The detections of these analytes indicate sample contamination carryover may have occurred on some of the sampling equipment used in sampling these analyte groups. Alternatively, these contaminants were introduced into the samples through air contamination. There were also eight unknowns detected for semivolatiles and six for volatiles in the rinse blank collected at site S-RB-26-01, and seven unknowns at site S-RB-36-04, further indicating some equipment contamination may have occurred (Table 3.10-8).

The volatile rinse blanks for the additional sampling program show laboratory background levels of methylene chloride. This analyte is a known laboratory contaminant, indicating no equipment contamination occurred during sampling.

Eight rinse blanks collected for metals in the Phase I sampling program and one collected during the additional sampling program revealed very high levels of sodium, ranging from 21,000 to 89,000 µg/l (Table 3.10-8). These sodium levels occur naturally in the groundwater used for decontamination. There were also three detections of zinc in the same rinse blanks at levels ranging from 25 to 130 µg/l. Lead, arsenic, chromium, copper, and nickel were found at trace levels in seven of the eight Phase I rinse blanks and the one additional rinse blank. These detections are not of concern, however, because the contamination levels are less than five times the lower certified reporting limits (CRLs).

Three rinse blanks were analyzed for anions. Detections of chloride at 320 µg/l, bromide at 74 µg/l, and fluoride at 160 µg/l were found in the blank collected at well S-SBR-1. At well S-71-90 a detection of 72,000 µg/l of chloride was found in another rinse blank. Since there were no anions detected in the blank collected at well S-49-90, it appears the contamination is carryover from sampling equipment contamination.

Uranium and radionuclides were detected in four of the Phase I rinse blanks and the rinse blank for the additional sampling, as shown in Table 3.10-8. However, radionuclides occur naturally in the groundwater used during decontamination. Therefore these detections may not be an indication that contamination of sampling equipment occurred.

TABLE 3.10-8 Summary of Analytical Results for Field Quality Assurance/Quality Control Samples: Rinse Blanks

Analytical Group and Analytes Detected	S-49-90-RB	S-71-90-RB	S-SBR-1-RB	S-RB-19-02	S-RB-19-06	S-RB-23-08	S-RB-26-01	S-RB-27-01	S-RB-36-04
Volatile Organics: (µg/l)				NA		NA		NA	
Acetone (ACET)	LT 10	LT 10	22		LT 10		19		LT 10
Chloroform (CHCL3)	LT 0.83	LT 0.83	LT 0.83		LT 0.83		2.1		LT 0.83
Chloromethane (CH3CL)	LT 1.6	LT 1.6	LT 1.6		LT 1.6		8.3		LT 1.6
Methylene chloride (CH2CL2)	12	LT 5.4	27		7.8		LT 5.4		LT 5.4
Unknowns							34		
Semivolatile Organics: (µg/l)	NA	NA		NA	NA	NA		LT 10	
Butylbenzyl phthalate (BBZP)			LT 10				11		LT 10
Unknowns							100		300
Explosives:	NA	NA	NA	NA	NA		NA	NA	ND
1,3-Dinitrobenzene (13DNB)						1.7			
Anions:	NA			NA	NA	NA	NA	NA	NA
Bromide (Br)		LT 50	74						
Chloride (Cl)		72,000	320						
Fluoride (F)		LT 1400	160						
Total Petroleum Hydrocarbons:									
None detected									

NA Not analyzed
LT Less than
µg/l Microgram per liter

TABLE 3.10-8 **Summary of Analytical Results for Field Quality Assurance/Quality Control Samples: Rinse Blanks**

Analytical Group and Analytes Detected	S-49-90-RB	S-49-90-RB (FILTERED)	S-71-90-RB	S-71-90-RB (FILTERED)	S-SBR-1-RB	S-SBR1-RB (FILTERED)	2-S	S-RB-08-06	S-RB-19-02 (FILTERED)	S-RB-27-01	S-RB-36-04
Metals: (µg/l)											
Arsenic (As)	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	LT 2.5	3.7	LT 2.5
Chromium (Cr)	LT 6.0	LT 6.0	LT 6.0	LT 6.0	LT 6.0	LT 6.0	LT 6.0	11	LT 6.0	8.5	LT 6.0
Copper (Cu)	LT 8.1	[illegible]	LT 8.1	LT 8.1	LT 6.0	13	120	LT 8.1	LT 8.1	6.1	LT 8.1
Lead (Pb)	1.4	4.2	1.7	2.0	LT 1.3	2.0	7.1	3.5	5.5	LT 4.7	1.6
Nickel (Ni)	LT 34	LT 34	LT 34	LT 34	LT 34	LT 34	LT 34	LT 34	LT 34	13	LT 34
Sodium (Na)	23,000	24,000	23,000	24,000	24,000	24,000	21,000	21,000	32,000	89,000	31,000
Zinc (Zn)	LT 21	LT 21	LT 21	LT 21	80	100	460	130	25	LT 19	LT 21

LT Less than
µg/l Microgram per liter

Analytical Group and Analytes Detected	S-49-90-RB	S-71-90-RB	S-SBR-1-RB	2-S	*S-RB-22-10 (mg/l)
Agent Breakdown Products:					
None detected					
Radionuclides: (pCi/l)					
Gross alpha (ALPHAG)	18	31	72	24	8.8
Gross beta (BETAG)	LT 0.30	LT 0.30	LT 0.30	15	10
Uranium (U)	54	3.6	6.8	1.2	0.002

* Uranium results in mg/g
NA Not analyzed
LT Less than
pCi/l Picocurie per liter
µg/l Microgram per liter

3.10.12.3 Field Sample Duplicates

Thirteeen field sample duplicates were collected during the Phase I and additional sampling programs. These samples were collected from wells, surface water, bores, septic tank, and the grease/sludge disposal area. The purpose of the field duplicates was to determine whether the samples being analyzed were homogenous by comparing the sample analysis data to that of another sample taken at the same location.

Two discrepancies were noted in duplicate samples from well S-20-88. Chloride was found in the duplicate but was not detected in the sample. Since the detection limit and the level of chloride reported are within 3[illegible] µg/l, this difference does not indicate a problem. There was also a discrepancy in the measured levels of radionuclides, with the alpha activity twice as high in the duplicate as in the sample. This could be related to sampling equipment carryover or imprecision in the analytical method.

The well S-3 sample and duplicate results for semivolatile organics and radionuclides were also inconsistent. The semivolatile organics included an unknown at 7.0 µg/l in the sample which was not detected in the duplicate. Two hits in the volatile organics of 1,1-dichloroethene and chloroform were not detected in the duplicate. However, the detected levels may be too close to the detection limit to show good reproducibility. Also in well S-3, the alpha radioactivity did not duplicate well. None was detected in the sample, but 71 picocuries per liter (pCi/l) were measured in the duplicate.

The sample and duplicate results from the septic tank area collected during the additional sampling program exhibit inconsistent recoveries for metals and semivolatile organics due to the 70 percent moisture content of the sample. However, the detected analytes are present in both the sample and the duplicate.

Duplicate samples from well S-44-90, and two soil samples did not exhibit any inconsistencies. Overall, the field sample duplicate results indicate a high level of precision was achieved in both the field sampling procedures and the analytical methodologies.

3.10.13 Laboratory Quality Assurance/Quality Control

Laboratory QC samples were analyzed with the actual samples to estimate and evaluate the information content of analytical data and to determine the necessity of corrective action for analytical procedures. Two types of QC samples were employed to satisfy both USATHAMA and SW-846 protocols.

3.10.13.1 USATHAMA Method QA/QC

The QC samples associated with the USATHAMA 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 QC spike samples are analytical samples which have known amounts of control analytes added to standard matrices (determined by USATHAMA) to verify method

performance and to provide precision and accuracy data. Three USATHAMA QC spikes per analytical batch are required by the individual methods. One spike concentration is at a level two times the lower CRL, and the other two concentrations are duplicate spikes at ten times the lower CRL. USATHAMA samples and QC spikes are analyzed in a specific order to assure 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 USATHAMA methodologies is the decision of USATHAMA. This decision is based on the control charted QC data and recommendations of the EBASCO Quality Assurance/Quality Control (QA/QC) Coordinator.

Other QA/QC acceptance criteria for USATHAMA methods include assuring that sample holding times are met. All sampling and analysis dates were compared to method-specific holding times. Eleven lots analyzed using USATHAMA methods missed holding times. These lots are IBV, IBW, and ICA for anions in water; ECJ, ECK, and ECL for explosives in water; VDF and VDH for volatile organics in water; FGO for arsenic in soil; VDE for volatile organics in soil; and SDU for semivolatile organics in soil. The specific samples affected in these lots can be found in Tables 3.10-9 (water) and 3.10-10 (soil). The fact that the listed samples were not analyzed within the method-specific holding times lends uncertainty to the data associated with these samples.

Several lots of soil samples were analyzed for metals by a method which had not yet been certified by USATHAMA. These lots were FGM, FGN, FGP, MCH, and MCI. The control spike recoveries and MS/MSD recoveries meet acceptable criteria; therefore, the data in these lots should be considered valid (see Section 3.10.12.2).

3.10.13.2 Matrix Spike and Matrix Spike Duplicate Evaluation

QC for SW-846 methodologies consists of blanks, MS, MSD, and replicate samples. The laboratory blank is a reagent blank which is analyzed with every batch of samples to assure 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 which are split three ways into a 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 USATHAMA spikes. The control samples were analyzed to determine actual background analytes which 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 is 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 SW-846 methodologies are not control charted due to the numerous different types of sample matrices. MS/MSDs were analyzed with both USATHAMA and SW-846 methodologies to provide information regarding sample matrices and the capability of the analytical methods to

Table 3.10-9 • Analytical Data Quality Control Deficiencies by Lot Designation for Water

Water			
Site ID	SWMU	Sample Lot	Comments
Anions			
S-2	5	IBV	Missed Holding Time
S-12		IBV	Missed Holding Time
S-22		IBV	Missed Holding Time
S-21		IBV	Missed Holding Time
S-19	25	IBV	Missed Holding Time
S-24		IBV	Missed Holding Time
S-46	2	IBV	Missed Holding Time
S-17-MS		IBW	Missed Holding Time
S-17-MSD		IBW	Missed Holding Time
S-66	25	ICA	Missed Holding Time
S-71	1	ICA	Missed Holding Time
Volatiles			
S-36-04-RB	36	VDF	Missed Holding Time
S-12		VDF	Missed Holding Time
S-22		VDF	Missed Holding Time
S-2	5	VDF	Missed Holding Time

FD - Field Duplicate
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RB - Rinse Blank

Table 3.10-10 • Analytical Data Quality Control Deficiencies by Lot Designation for Soil

Soil		
Site ID	Sample Lot	Comments
Arsenic		
S-SS-26-01	FGO	Missed Holding Time
S-SS-26-03	FGO	Missed Holding Time
S-SS-26-04	FGO	Missed Holding Time
S-SS-26-05	FGO	Missed Holding Time
S-SS-26-06	FGO	Missed Holding Time
S-SS-26-07	FGO	Missed Holding Time
S-SS-26-08	FGO	Missed Holding Time
S-SS-26-09	FGO	Missed Holding Time
S-SS-26-10	FGO	Missed Holding Time
S-SS-26-11	FGO	Missed Holding Time
S-SS-26-05-MS	FGO	Missed Holding Time
S-SS-26-05-MSD	FGO	Missed Holding Time
Volatiles		
S-SS-29-03	VDE	Missed Holding Time
S-SS-19-02	VDE	Missed Holding Time
S-SS-19-02-MS	VDE	Missed Holding Time
S-SS-19-02-MSD	VDE	Missed Holding Time
S-SS-29-01	VDA	TRCLE recoveries outside 95% confidence limit
S-SS-29-06	VDA	TRCLE recoveries outside 95% confidence limit
S-SS-29-02	VDA	TRCLE recoveries outside 95% confidence limit
S-SS-29-05	VDA	TRCLE recoveries outside 95% confidence limit
S-SS-29-04	VDA	TRCLE recoveries outside 95% confidence limit
S-SS-14-01	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-14-02	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-14-03	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-36-01	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-36-02	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-36-03	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-36-04	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-27-01	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-27-01-FD	VDB	TRCLE recoveries outside 95% confidence limit
S-SS-29-03	VDE	TRCLE recoveries outside 95% confidence limit
S-SS-19-02	VDE	TRCLE recoveries outside 95% confidence limit

Soil		
Site ID	Sample Lot	Comments
Semivolatiles		
S-SS-08-01	SDU	Missed Holding Time
S-SS-08-01	SDU	Missed Holding Time
S-SS-08-01	SDU	Missed Holding Time
S-SS-08-02	SDU	Missed Holding Time
S-SS-08-02	SDU	Missed Holding Time
S-SS-08-02	SDU	Missed Holding Time
S-SS-08-02-MS	SDU	Missed Holding Time
S-SS-08-02-MSD	SDU	Missed Holding Time
Explosives		
S-SS-22-05	EBY	246TNT RPD > 20
S-SS-23-04	EBY	246TNT RPD > 20
S-SS-27-01	EBY	246TNT RPD > 20
S-SS-22-06	EBY	246TNT RPD > 20
S-SS-23-01	EBY	246TNT RPD > 20
S-SS-23-02	EBY	246TNT RPD > 20
S-SS-23-03	EBY	246TNT RPD > 20
S-SS-29-01	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-29-02	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-29-03	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-29-04	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-29-05	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-29-06	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-BK-08	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-08-01	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-08-02	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-36-01	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-36-02	EBV	TETRYL recoveries outside 95% confidence limit
S-SS-36-03	EBV	TETRYL recoveries outside 95% confidence limit
Total Petroleum Hydrocarbons		
S-SS-08-02	ZGY	Recoveries outside 95% confidence limit. RPD > 20.
S-SS-08-01	ZGY	Recoveries outside 95% confidence limit. RPD > 20.

FD - Field Duplicate
MS - Matrix Spike
MSD - Matrix Spike Duplicate
RPD - Relative Percent Difference
TRCLE - Trichloroethylene
246TNT - 2,4,6-Trinitrotoluene

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 and MSDs. The EPA ranges for SW-846 methodologies can be found within each method. However, for the most part these ranges have 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 if the results meet the performance characteristics of the method. A basic statistical approach for environmental data is the use of plus or minus 2 standard deviations from the mean to yield a 95 percent confidence level for data. USATHAMA also utilizes this approach for establishing upper and lower control chart limits. The analytical precision as plotted for USATHAMA methods is analyte and method specific and ranges between 10 and 30 percent. For the purposes of assessing the MS/MSDs for this project an RPD of 20 percent will be allowed to account for sample matrix effects.

Only three analyte groups were not analyzed using USATHAMA certified methods: TPHs, uranium, and radionuclides. The methods utilized for these analytes do not have precision and accuracy data available. Therefore, USATHAMA guidelines of plus or minus 2 standard deviations for accuracy and 20 percent upper limit for percent RPD were followed for the assessment of all MS/MSD data.

Four MS/MSDs were analyzed in the Phase I sampling program by method LW26 for explosives in soil. An MSD recovery for lot EBV was above the upper CRL and was reported as a greater than value. The other recoveries for lot EBV are acceptable. Three of the ten MSD recoveries for lot EBY were outside of the acceptable range. The other seven were on the low end of being acceptable. Two values were above the 20 RPD limit. These are the tetryl recovery for lot EBV, and the 2,4,6-trinitrotoluene value for lot EBY. The two values also had poor recoveries outside of the plus or minus 2 standard deviation range.

One MS/MSD was analyzed in the additional sampling program for explosives in soil. The percent recovery and RPD for sample S-SS-23-08 are within the acceptable limits, signifying a high level of precision and accuracy for this method.

Six MS/MSDs were analyzed in the Phase I sampling program for semivolatiles in soil. The MS/MSD recoveries were all within the acceptable limits for standard deviation, although the varying recoveries indicated definite sample matrix effects on the spiked compounds. The RPDs for four MS/MSDs were above the 20 percent limit, indicating possible precision problems associated with the analysis of lots SCL, SDL, and SDU. The MS/MSD recoveries for this method exhibited sample matrix interferences; however, the accuracy and precision met sufficient standards to provide valid data.

Six MS/MSDs were analyzed in the Phase I sampling program for volatiles in soil. The recovery values for trichloroethylene for in soil samples S-SS-29-01, S-SS-36-04, and S-SS-19-02 ranged from 172 percent to 196 percent. The actual samples had two trichloroethylene detections below the CRL and one hit just above the detection limit. Therefore, the high recoveries could not have been caused by levels of trichloroethylene in the samples. This renders the data questionable for any hits of trichloroethylene in analysis lots VDA, VDB, and VDE. The other volatile recoveries for the method met acceptable limits for standard deviation and RPD.

One MS/MSD was analyzed in the additional sampling program for volatiles. Four of four recoveries for lot VKI are within the acceptable limits for percent recovery and RPD, signifying a high level of precision and accuracy for this lot and method.

Two MS/MSDs were analyzed in the Phase I sampling program by Inductively Coupled Plasma (ICP) for metals in soil. The recoveries for beryllium, cadmium, nickel, antimony, and thallium were consistently low at less than 40 percent. However, this can be attributed to sample matrix effects since the RPDs for the MS/MSDs were less than 20 percent. The sodium MS/MSD recoveries were variable at 211 percent and 54 percent. This is due to the high levels of sodium found at some of the sampling sites.

One MS/MSD was analyzed in the additional sampling program for ICP metals in soil. Three of the analytes in lot MFN were spiked at concentrations too low to be recovered. Four of the nine RPD values for lot MFN were outside the acceptable limit, indicating sample matrix interferences. The MS/MSD recoveries for the rinse blank in lot MFM are within the acceptable limits with the sodium recoveries variable due to the high levels of sodium found at the sampling site.

Three MS/MSDs were analyzed in the Phase I sampling program for silver, lead, and selenium in soil by graphite furnace atomic absorption (GFAA). The silver MS/MSD recoveries in soil samples S-SS-36-BK and S-SS-26-01 were extremely high at 187 percent, 160 percent, 162 percent, and 161 percent, respectively. This recovery indicates sample matrix affected the recoveries, enhanced by the detection of silver. The RPD for lead in samples from S-SS-36-BK was 43 between the MS and MSD, signifying poor analytical accuracy between the two spikes and a possible analytical problem with lot FGM for lead. However, the poor recoveries of these analytes were caused by high background levels in the samples. The MS/MSD recoveries for this method, therefore, exhibit obvious sample matrix interferences resulting in accuracy and precision problems.

One MS/MSD was analyzed in the additional sampling program for graphite furnace metals in soil. The silver and selenium MS/MSD were spiked at concentrations too low to be recovered. The lead MS/MSD recovery for lot FOT was diluted out of quantitation range due to the concentration of lead in the actual sample for S-SS-33-02. Therefore, no MS/MSD recovery data exists for graphite furnace metals in soil.

Three MS/MSDs were analyzed in the Phase I sampling program for arsenic in soil. The recoveries were within the acceptable limits for standard deviation and RPD, signifying a high level of precision and accuracy for this method.

One MS/MSD was analyzed in the additional sampling program for arsenic in soil. The RPD for the arsenic MS/MSD for lot FOR is outside the acceptable limit, indicating sample matrix interference and method inconsistency.

Five MS/MSDs were analyzed in the Phase I sampling program for mercury in soil. Five of the MS/MSD recovery values were greater than the upper CRL. This could be due to actual mercury levels present in the samples. Therefore, these recovery values are invalid for assessing data quality for the analytical lot DBW. The MS/MSDs for sites S-SS-26-05 and S-SS-29-06 exhibited recoveries within the standard deviation and RPD acceptance limits. This signifies a high level of precision and accuracy for lots DBK and DBV.

One MS/MSD was analyzed in the additional sampling program for mercury in soil. The recoveries for lot DER are within the acceptable limits for percent recovery and RPD, signifying a high level of precision and accuracy for this lot and method.

One MS/MSD was analyzed in the Phase I sampling program for the agent breakdown products fluoroacetic acid, isopropylmethylphosphonic acid, and methylphosphonic acid in soil. The recoveries were within the acceptable limits for standard deviation and RPD. This signifies a high level of precision and accuracy for this method.

Two MS/MSDs were analyzed in the additional sampling program for agent breakdown products in soil. Two of two recoveries are within the acceptable limits for percent recovery and RPD, signifying a high level of precision and accuracy for this method.

One MS/MSD was analyzed in the Phase I sampling program for thiodiglycol in soil. The MS/MSD recovery values were within the acceptance limits for standard deviation and RPD. This indicates a high level of precision and accuracy for this method.

One MS/MSD was analyzed in the additional sampling program for thiodiglycol in soil. The percent recoveries and RPD for S-SS-33-02 were inconsistent, signifying possible matrix interference and/or method imprecision.

One MS/MSD was analyzed in the Phase I sampling program for TPHs in soil. The recovery data for this analysis showed poor precision and accuracy for this method with an RPD greater than 80 percent and recoveries of 105 percent and less than 44 percent for the same sample. Other accuracy data reported for TPH were also poor at 39 percent and 63 percent recoveries. The fact that the precision and accuracy were poor indicates a possible extraction or analysis problem in this method. Since this method is not a USATHAMA certified method, the MS/MSDs were the only QC available for assessing the TPH data.

Nine MS/MSDs were analyzed in the Phase I sampling program for explosives in water. Seven of the nine MS recoveries for lot ECB were above the 20 percent RPD limit. This indicates an analytical problem associated with this sample and possibly with lot ECB. The MSD recoveries for lot ECB were within the standard deviation acceptance limits. The tetryl MSD recovery for lot EBW was below the standard deviation lower limit, and the RPD was high at 28 percent. The other recoveries for the MS/MSD for lot EBW were within the acceptable range for standard deviation and RPD.

Two MS/MSDs were analyzed in the additional sampling program for explosives in water. Percent recoveries and RPD for wells S-46-90 and S-33-90 are within the acceptable limits, signifying a high level of precision and accuracy for the method.

Eleven MS/MSDs were analyzed in the Phase I sampling program for semivolatiles in water. Recoveries for dinitrotoluene and nitro-di-n-propylamine in well S-45-90 were below the lower acceptance limit for standard deviation. Six of the eleven MS/MSD values for the same well were also above the 20 percent RPD limit. This indicates poor precision for lot SDT. Five of the eleven MS/MSD values for well S-47-90 were above the 20 percent RPD limit. This indicates questionable precision for lot SDR as well. There are also two MS/MSD values above the RPD acceptance limits for lot SDP. The MSD data for lot SDV, six MSD values for lot SDX, and the MS data for lot SOW were not reported by the laboratory. Therefore, it is not possible to assess RPD for these lots. The MS/MSD recoveries for this method exhibit imprecision in lots SDP, SDR, and SDT. The recovery values for the remaining eight lots meet precision and accuracy criteria.

Two MS/MSDs were analyzed in the additional sampling program for semivolatiles in water. Three of the 11 MS/MSD RPD values for lot SKG, and 1 RPD value for lot SKO were greater than 20 percent. The actual spike recovery values for all compounds are within the acceptable range indicating slight inconsistency with the method and sample matrix.

Five MS/MSDs were analyzed in the Phase I sampling program for volatiles in water. The MSD recovery for 1,1-dichloroethylene for well S-5 is below the lower acceptance limit for standard deviation at 41 percent. The RPD for this MS/MSD was above 20 percent as well, indicating poor accuracy and precision for 1,1-dichloroethylene in lot VDG. The MSD data for lot VDH was not reported by the laboratory. Therefore, it is not possible to assess RPD for lot VDH. The MS/MSD recovery values for trichloroethylene were high at 136 percent to 145 percent, signifying background levels of this analyte or sample matrix interference. The other volatile recoveries for method UM17 met acceptable limits for standard deviation and RPD.

One MS/MSD was analyzed in the additional sampling program for volatiles in water. Five of the five recoveries for lot VKH are within the acceptable limits for percent recovery and RPD, signifying a high level of precision and accuracy for this lot and method.

Four MS/MSDs were analyzed in the Phase I sar ng program for bromide and fluoride in water. There were no fluoride values reported by laboratory for lot IBZ or for the MS for lot ICA. Chloride was not reported due to the high background levels found in the samples. The bromide recoveries for lot IBZ were high at 188 percent and 163 percent. This is an indication of sample matrix interference or an extraction and analysis problem. The other recovery values are within the acceptable limits for standard deviation and RPD.

Four MS/MSDs were analyzed in the Phase I sampling program for mercury in water. All recovery values were within the acceptable limits for standard deviation and RPD. However, values for lot SNL were low at 28 percent while values for the other three lots were at 60 to 72 percent. Since all recoveries were low but reproducible, they indicate interference by sample matrices. The accuracy and precision met sufficient standards to provide valid data.

One MS/MSD was analyzed in the additional sampling program for mercury in water. The percent recoveries and RPD for sample S-SW-27-01 are within the acceptable limits, signifying a high level of precision and accuracy for the method.

Nine MS/MSDs were analyzed in the Phase I sampling program for thallium in water. Thallium was below CRL in five of the nine MS/MSDs and, therefore, could not be assessed. This is an indication of sample matrix interference or possible extraction and analysis problems. The other four MS/MSD values show acceptable recoveries for standard deviation and RPD.

Eight MS/MSDs were analyzed in the Phase I sampling program for lead in water. The recoveries were within the acceptable limits for standard deviation and RPD. This signifies a high level of precision and accuracy for this method.

Eleven MS/MSDs were analyzed in the Phase I sampling program for selenium in water. Recoveries for this method varied between 24 and 88 percent, although all values were within the acceptable limits for standard deviation and RPD. The MS/MSD recoveries for this method exhibit sample matrix interferences; however, the accuracy and precision met sufficient standards to provide valid data.

Nine MS/MSDs were analyzed in the Phase I sampling program for arsenic in water. All recoveries were within the acceptable limits of standard deviation and RPD. These recoveries indicate a high level of precision and accuracy for this method.

One MS/MSD was analyzed in the additional sampling program for lead, selenium, silver, and arsenic in water. The percent recoveries and RPD for samples S-SW-27-01 and S-RB-27-01 are within the acceptable limits, signifying a high level of precision and accuracy for the method.

Seven MS/MSDs were analyzed in the Phase I sampling program for metals in water. The silver MS/MSD recoveries in lot TGG, the sodium MS/MSD recoveries in lot TGH, and the sodium MSD recovery in lot TGE were not reported by the laboratory. The sodium MS/MSD recoveries

in lots TGA and TGF were not accurate or precise at 4,400 percent and less than 1,000 percent. This result may be due to the high background levels of sodium in the actual sample. The other recovery values were within the acceptable limits for standard deviation and RPD.

One MS/MSD was analyzed in the additional sampling program for ICP metals in water. The percent recoveries and RPD for sample S-RB-27-01, with the exception of sodium are within the acceptable limits, signifying a high level of precision and accuracy for the method. The sodium recoveries are variable due to the high levels of sodium found at the sampling site and carryover into the rinse blank.

Five MS/MSDs were analyzed in the Phase I sampling program for agent breakdown products, fluoracetic acid, and isopropylmethyl phosphonic acid in water. The recoveries were within the acceptable limits for standard deviation and RPD, signifying a high level of precision and accuracy.

Two MS/MSDs were analyzed in the additional sampling program for agent breakdown products in water. Two of two spike recoveries are within the acceptable limits for percent recovery and RPD, signifying a high level of precision and accuracy for this method.

Six MS/MSDs were analyzed in the Phase I sampling program for thiodiglycol in water. Recoveries for this method varied between 56 and 136 percent, although all values were within the acceptable limits for standard deviation and RPD. The MS/MSD recoveries for this method exhibited sample matrix interferences; however, the accuracy and precision met sufficient standards to provide valid data.

Five MS/MSDs were analyzed in the Phase I sampling program for uranium in water. The recoveries were within the acceptable limits for standard deviation and RPD. This signifies a high level of accuracy and precision in this method.

Five MS/MSDs were analyzed in the Phase I sampling program for radionuclides in water (gross alpha and beta particles). The MSD recovery for lot SZC for alpha particles was above the standard deviation limit at 192 percent. The RPD for this lot was above 20 as well, indicating an analytical problem with the accuracy of the MSD recovery. There was also an analytical problem with the beta MS recovery for lot SZE at 1 percent. The MSD recovery for lot SZE was acceptable, indicating another problem associated with the analysis. The remaining recoveries were within the acceptable limits for standard deviation and RPD.