

FINAL



FORSUM

SAMPLING AND ANALYSIS PLAN



3d Inf Div (Mech)

for
Corrective Action Plan-Part A and B Investigations at
Former Underground Storage Tank Sites
Hunter Army Airfield, Georgia

Prepared for



U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT

Contract No. DACA21-95-D-0022
Delivery Order 0019

May 1999

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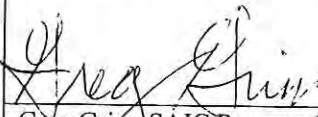
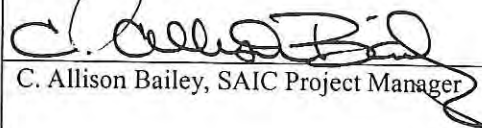


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AT
FORMER UNDERGROUND STORAGE TANK SITES
HUNTER ARMY AIRFIELD, GEORGIA
CONTRACT NUMBER DACA21-95-D-0022
DELIVERY ORDER NUMBER 0019**

May 1999

COMMITMENT TO IMPLEMENT THE ABOVE SAMPLING AND ANALYSIS PLAN	
 Greg Grim, SAIC Program Manager	5/12/99 Date
 C. Allison Bailey, SAIC Project Manager	05/12/99 Date

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Prepared for:

U.S. Army Corps of Engineers
Savannah District
Under Contract DACA21-95-D-0022
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Prepared by:

Science Applications International Corporation
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37831

May 1999

The undersigned certifies that they are a qualified groundwater scientist who has received a baccalaureate or post-graduate degree in the natural sciences or engineering, and have sufficient training and experience in groundwater hydrology and related fields, as demonstrated by Georgia state registration and completion of accredited university courses, that enable them to make sound professional judgments regarding groundwater monitoring and contaminant fate and transport.

William P. Kegley

William P. Kegley, P.G.
Technical Manager
SAIC



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LIST OF ABBREVIATIONS AND ACRONYMS

%R	percent recovery
ACE	Anderson Columbia Environmental, Inc.
ASTM	American Society for Testing and Materials
BLS	below land surface
BTEX	benzene, toluene, ethylbenzene, and xylene
CAP	Corrective Action Plan
CCQC	Contractor Chemical Quality Control
CLP	Contract Laboratory Program
COC	chain of custody
CQC	Chemical Quality Control
CWM	clear wide mouth glass jar
CX	Center of Expertise
DCQCR	Daily Chemical Quality Control Report
DOT	U.S. Department of Transportation
DPW	Directorate of Public Works
DQCR	Daily Quality Control Report
DQO	data quality objective
DRO	diesel range organics
EPA	U.S. Environmental Protection Agency
FCO	field change order
FID	flame ionization detector
FSP	Field Sampling Plan
GC	gas chromatograph
GEL	General Engineering Laboratories
GEPD	Georgia Environmental Protection Division
GFAA	graphite furnace atomic absorption
GRO	gasoline range organics
GSV	glass septa vial
GUST	Georgia Underground Storage Tank
HAAF	Hunter Army Airfield
HDPE	high density polyethylene
HPLC	high performance liquid chromatography
HTRW	Hazardous, Toxic, and Radioactive Waste
ICP	inductively coupled plasma
ID	inside diameter
IDW	investigation-derived waste
LCS	laboratory control sample
LIMS	Laboratory Information Management System
M&TE	Material and Testing Equipment
MDL	method detection limit
Mogas	motor pool gas
MRD	Missouri River District
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level

INTRODUCTION

This document represents the Sampling and Analysis Plan (SAP) for the Corrective Action Plan - Part A Investigation activities to be performed by Science Applications International Corporation (SAIC) at 16 Former Underground Storage Tank (UST) Sites at Hunter Army Airfield, Georgia. In 1996, Fort Stewart/Hunter Army Airfield (HAAF) contracted Anderson Columbia Environmental, Inc. (ACE) to remove USTs that were used to store diesel, gasoline (Mogas), waste oil, and heating oil. Analytical results from the tank closure activities indicated that 16 of the former UST sites located at HAAF must be investigated further.

The following six sites require further investigation because total petroleum hydrocarbon concentrations were detected above the 10 mg/kg allowable level in soil: Building 1336, Tank 111; Building 1327, Tank 110; Building 8629, Tank 104; Building 1346, Tank 108; Air National Guard Building 8570-2, no number assigned; and Air National Guard Building 8571, no number assigned. Initially, these six sites will be investigated to determine if groundwater contamination exists. If the groundwater is found not to be contaminated, as defined by the Georgia Underground Storage Tank (GUST) rules, then the site is eligible to qualify for a No Further Action Required (NFAR) status. However, if soil contamination is found to exist in excess of the levels specified in the GUST rules, or groundwater contamination is found to exceed federal and state maximum contaminant levels (MCLs), then a CAP-Part A investigation will be conducted for the affected site.

The following 10 sites must be investigated intensively for soil and groundwater contamination to prepare a CAP- Part A and possibly a CAP- Part B Report: Building 8464, Tank 112; Building 1310, Tank 109; Building 8059, Tanks 27 and 28; Building 9002, Tank 116; Building 7002, Tank 117; Building 1327, Tanks 21 and 22, Building 725, Heating Oil Tank (no number assigned); Building 850, 2 Heating Oil Tanks (no numbers assigned), Air National Guard Building 8582, no number assigned; and Air National Guard Building 8593-1, no number assigned.

The SAP for the CAP-Part A UST investigations at HAAF consists of two parts: the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP). The Site Safety and Health Plan (SSHP) for the project is a separate, stand-alone document. The FSP provides guidance and rationale for field work by defining the project purpose, scope, and objectives; environmental setting; data quality objectives; description of proposed field activities and chemical testing; and the project schedule and milestones. The QAPP describes the policy, organization, functional activities, and quality assurance/quality control protocols necessary to achieve the project data quality objectives.

This SAP has been prepared in accordance with the requirements as defined in the U.S. Army Corps of Engineers (USACE) guidance EM-200-1-3 (September 1, 1994). The contents of this plan have been prepared by Science Applications International Corporation in accordance with the project scope of work developed by USACE-Savannah District for Delivery Order No. 0019, under contract DACA21-95-D-0022.

Although the FSP and QAPP are included in this SAP, each plan has been prepared as a stand-alone document. In cases where similar information is required in one or more plans, the information is presented in detail within only one plan and is subsequently referenced as required in the other plan. References in the FSP and QAPP are presented in Appendix A of each document. A listing of abbreviations and acronyms used throughout the FSP and QAPP are presented in the front matter of the SAP. Appendix B of the QAPP contains the Data Management Plan.

**FIELD SAMPLING PLAN
FOR THE
CORRECTIVE ACTION PLAN - PART A INVESTIGATIONS FOR
FORMER UNDERGROUND STORAGE TANK SITES
AT
HUNTER ARMY AIRFIELD, GEORGIA**

March 1998

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1.0 PROJECT DESCRIPTION

This document represents the Field Sampling Plan (FSP) for the Corrective Action Plan (CAP) Part A Underground Storage Tank (UST) to be performed by Science Applications International Corporation (SAIC) at 16 separate sites located at Hunter Army Airfield (HAAF), Georgia. In 1996, Fort Stewart/HAAF contracted Anderson Columbia Environmental, Inc. (ACE) to remove USTs that were used to store diesel, gasoline (Mogas), waste oil, and heating oil. Analytical results from the tank closure activities conducted from August through October 1996 indicated that 16 of the former UST sites located at HAAF must be investigated further.

The following six sites require further investigation because total petroleum hydrocarbon concentrations were detected above the 10 mg/kg allowable level in soil: Building 1336, Tank 111; Building 1327, Tank 110; Building 8629, Tank 104; Building 1346, Tank 108; Air National Guard Building 8570-2, no number assigned; and Air National Guard Building 8571, no number assigned. Initially, these sites will be investigated to determine if groundwater contamination exists. If the groundwater is found not to be contaminated, as defined by the Georgia Underground Storage Tank (GUST) rules, then the site is eligible to qualify for a No Further Action Required (NFAR) Status. However, if soil contamination is found to exist in excess of the levels specified in the GUST rules or groundwater contamination is found to exceed federal and state maximum contaminant levels (MCLs), then a CAP-Part A investigation will be conducted for the affected site.

The following 10 sites must be investigated extensively for soil and groundwater contamination to prepare a CAP-Part A and possibly a CAP-Part B Report: Building 8464, Tank 112; Building 1310, Tank 109; Building 8059, Tanks 27 and 28; Building 9002, Tank 116; Building 7002, Tank 117; Building 1327, Tanks 21 and 22, Building 725, Heating Oil Tank (no number assigned); Building 850, 2 Heating Oil Tanks (no numbers assigned), Air National Guard Building 8582, no number assigned; and Air National Guard Building 8593-1, no number assigned.

The FSP has been prepared in accordance with the requirements as defined in the U.S. Army Corps of Engineers (USACE) guidance EM-200-1-3 (September 1, 1994) and presents the environmental setting, site history and contaminants, data quality objectives, and sampling rationale. The FSP further provides specific details of the proposed field activities and chemical testing, and the procedures to be used in executing the field activities. Site history and background information along with past data collection activities and existing site data are contained in Section 1.0 of this FSP. Primary project organization and responsibilities are presented in Section 2.0, while the project scope and objectives are found in Section 3.0. Sampling design, procedures, methods, and rationales are discussed in detail in Section 4.0. Sample matrix types, analytical parameters, and analytical methods can also be found in Section 4.0. The remaining chapters summarize requirements for chain-of-custody documentation, sample packaging and shipping, management of investigation-derived wastes, quality control, project schedule, and instrumentation.

Appendix A of this FSP presents the references cited in the text. Resumes of key field personnel are presented in Appendix B. Appendix C presents maps showing proposed soil boring/temporary piezometer locations. A listing of abbreviations and acronyms used throughout the FSP are presented in the front matter of the SAP.

1.1 ENVIRONMENTAL SETTING

1.1.1 Demographics

HAAF is located in Chatham County, Georgia, on the south side of Savannah, Georgia (Figures 1.1 and 1.2). The investigation sites are scattered around the installation (Figure 1.3 through 1.10). Savannah, Georgia is the nearest city, bordering the base to the north.

The total population of Chatham County, taken from the 1990 census, is 216,935. There are 8,111 houses with approximately 12.5 houses per square mile. However, the area surrounding the airfield is largely commercial. Two retail malls, gasoline stations, and service-oriented businesses are situated near the Airfield. The majority of these facilities are located along Abercorn Expressway.

1.1.2 Topography

HAAF is located near the Georgia Coast toward the north end of the Georgia Barrier Island Sequence District. Area topography consists of step like terraces (remnants of sea level fluctuations) with decreasing altitude toward the Atlantic Coast (Clark and Zisa 1976). The topographic relief base-wide ranges from approximately 2 to 42 feet above mean sea level (amsl).

1.1.3 Regional Geology

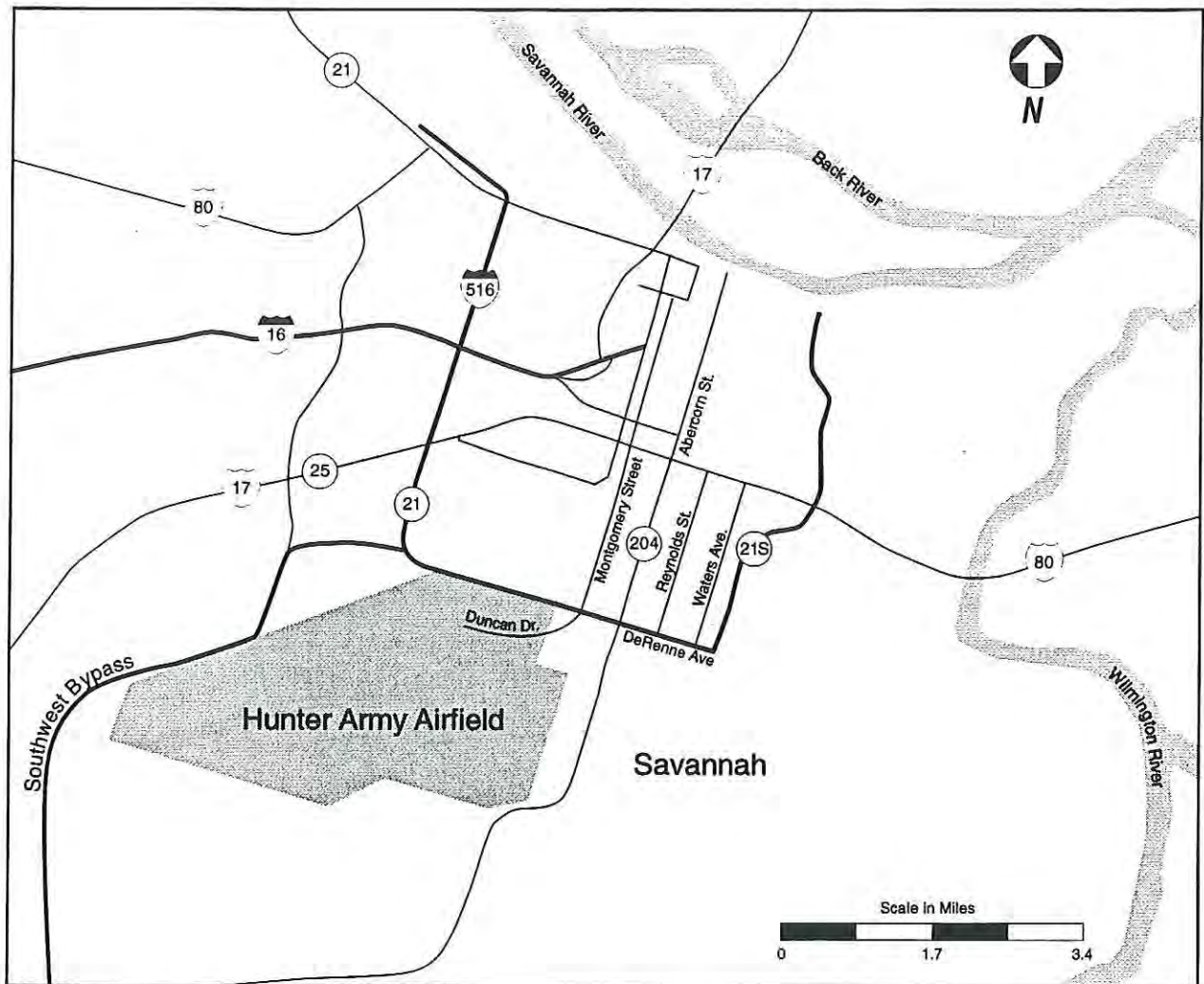
The HAAF is located within the coastal plain physiographic province and is approximately 20 miles west of the Atlantic coast. This province is typified by nine southeastward dipping strata that increase in thickness from zero feet at the fall line located approximately 350 miles inland from the Atlantic coast, to approximately 4200 feet at the coast.

The total thickness of the dipping strata in the Savannah area is around 4000 feet (Miller 1990). The geologic formations that make up the Coastal Plain consist of unconsolidated sand and clay, limestone, and dolomite. The Coastal Plain formations generally strike northeast-southwest and dip to the southeast. Specifically, the formations underlying the HAAF area to approximately 600 feet below land surface (BLS) consist of (shallow to deep) undifferentiated surficial sand, undifferentiated alluvial deposits, Cypresshead Formation, Hawthorn Group, and Suwannee and Ocala Limestone. A generalized stratigraphic column showing predominant Cenozoic lithologic units is provided in Figure 1.11.

The undifferentiated surficial sand is late Pleistocene to Holocene in age and underlies the local soil profiles. These deposits consist of massive-bedded, structureless, well to moderately well-sorted, fine- to medium-grained, white to buff colored sand; ranging in thickness from 0 to 10 feet (Huddleston 1988).

The undifferentiated alluvial deposits are Pleistocene in age and occur throughout the drainage systems of the Coastal Plain and consist of floodplain deposits and river terrace deposits. These deposits are predominantly sand with a little clay and range in thickness from 20 to 50 feet (Huddleston 1988).

The undifferentiated surficial sands and alluvial deposits are underlain by the Cypresshead Formation. The Cypresshead Formation is early Pleistocene in age. The Cypresshead Formation generally consists of quartz sand with prominent clay beds in some down dip areas. Two lithofacies are dominant in this unit. The up dip facies generally consist of fine-to coarse-grained, well to poorly



31-102797-063

Figure 1.2. Location Map for the HAAF, Savannah, Georgia

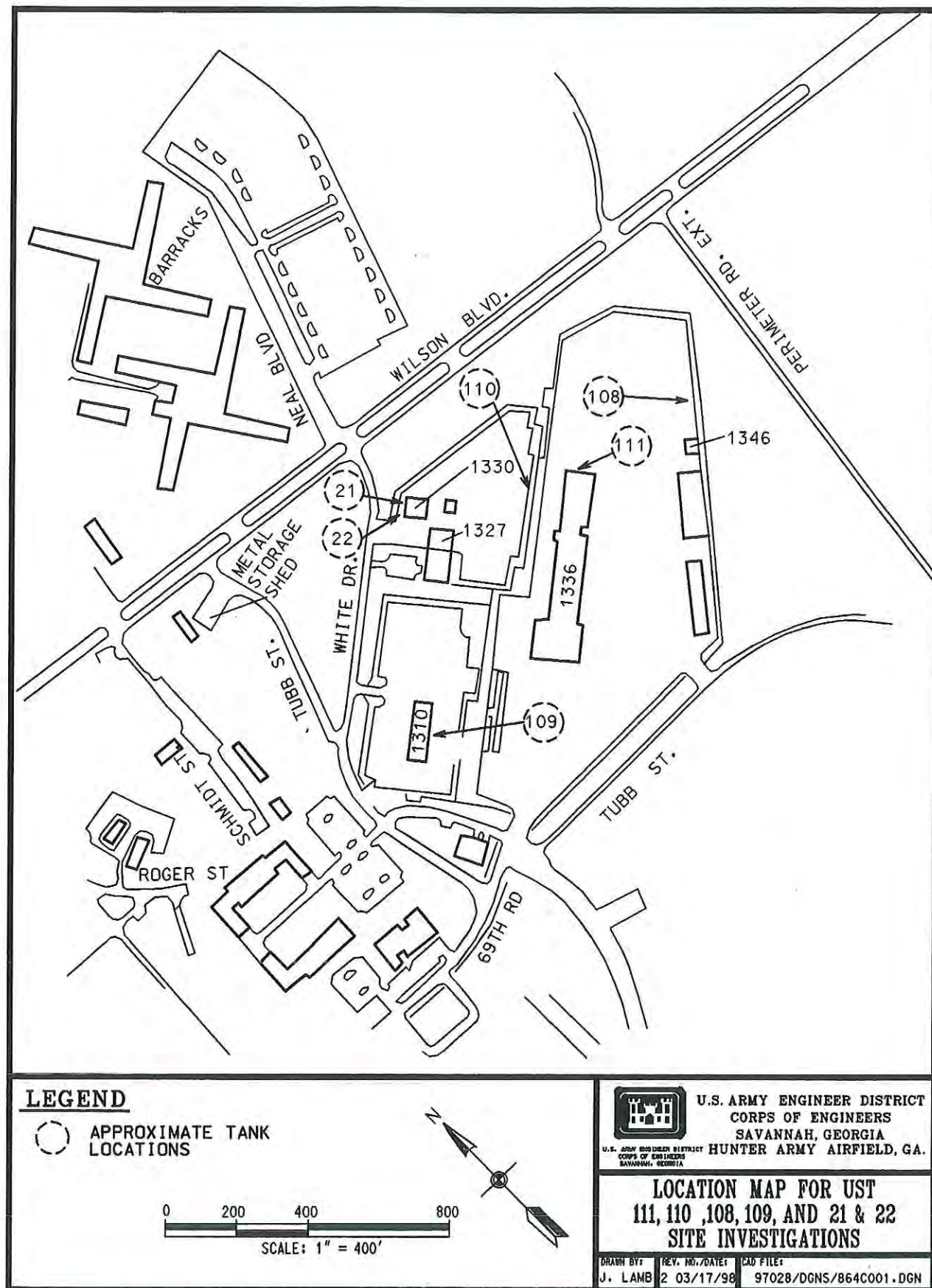


Figure 1.3. Location Map for UST Investigation Sites 111, 110, 108, 109, and 21 & 22

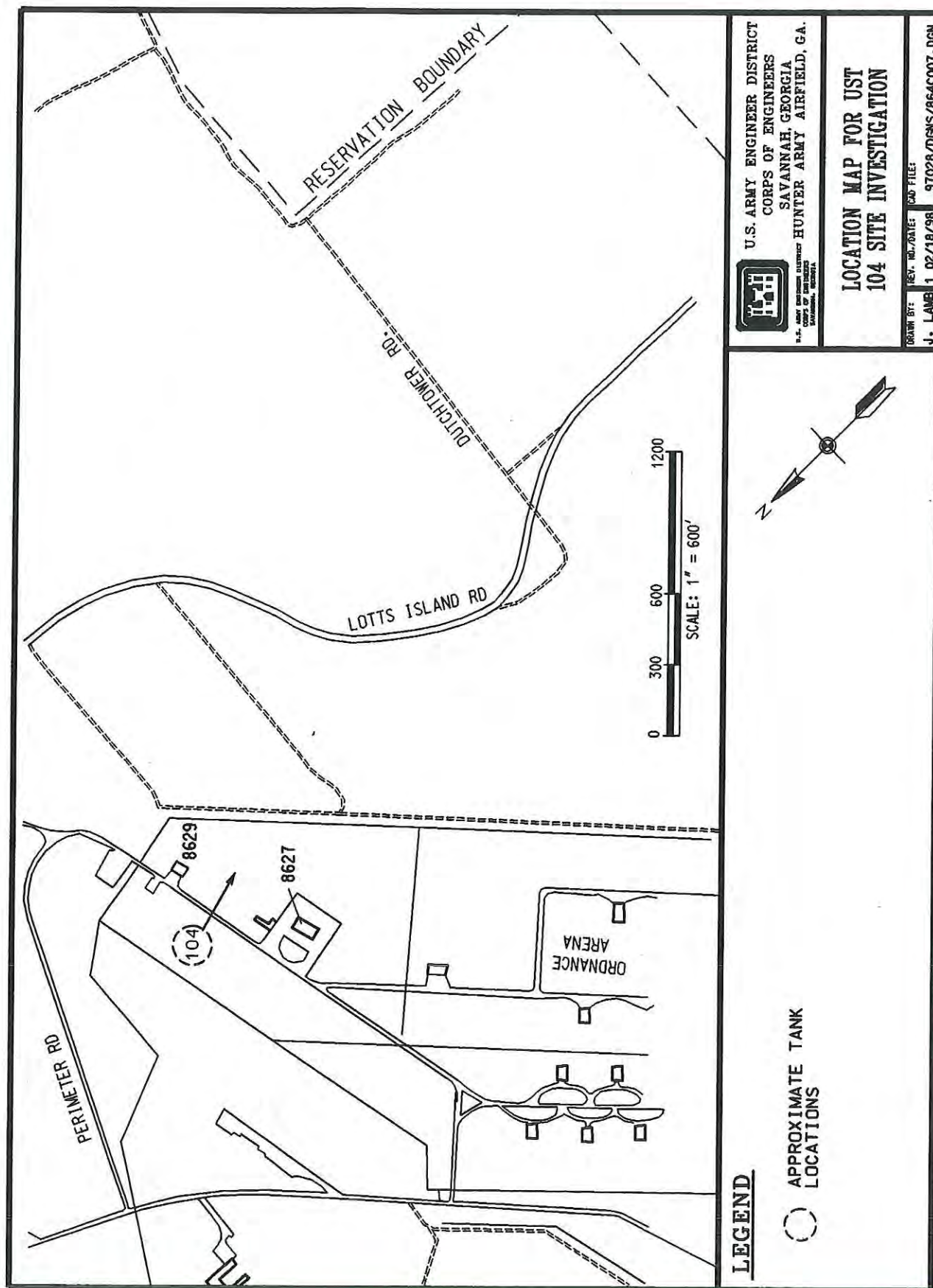


Figure 1.4. Location Map for UST Investigation Site 104

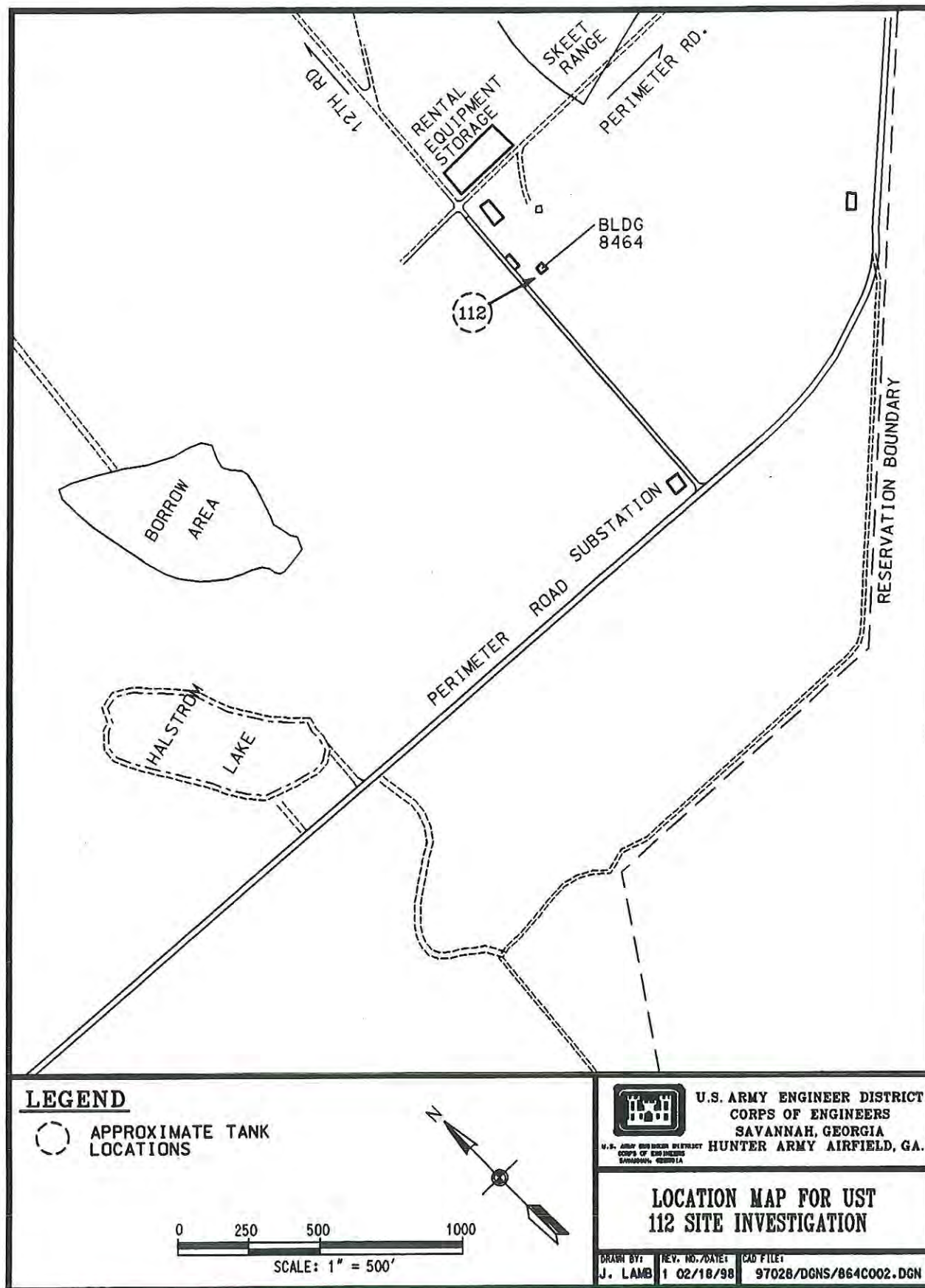


Figure 1.5. Location Map for UST Investigation Site 112

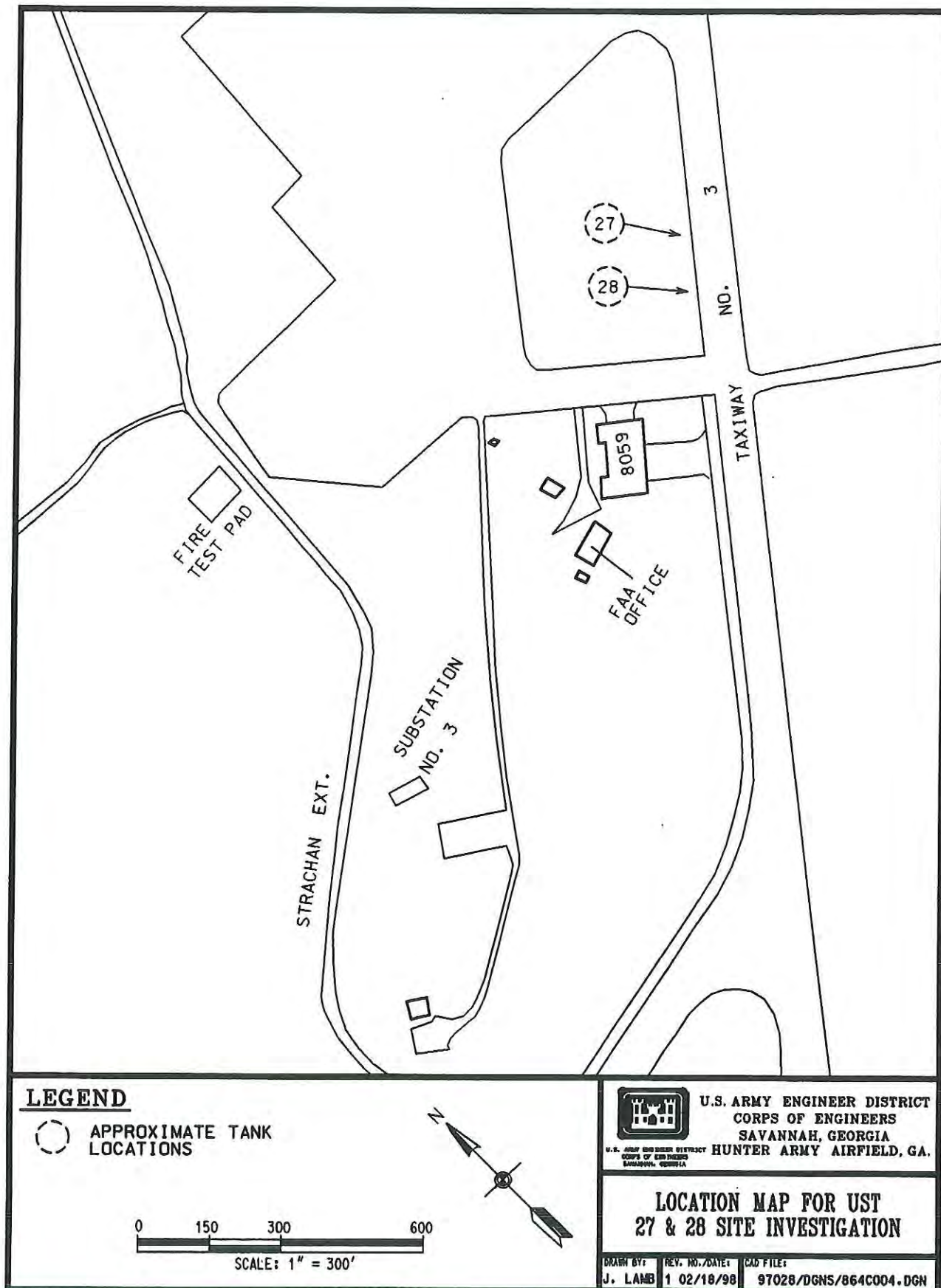


Figure 1.6. Location Map for UST Investigation Sites 27 & 28

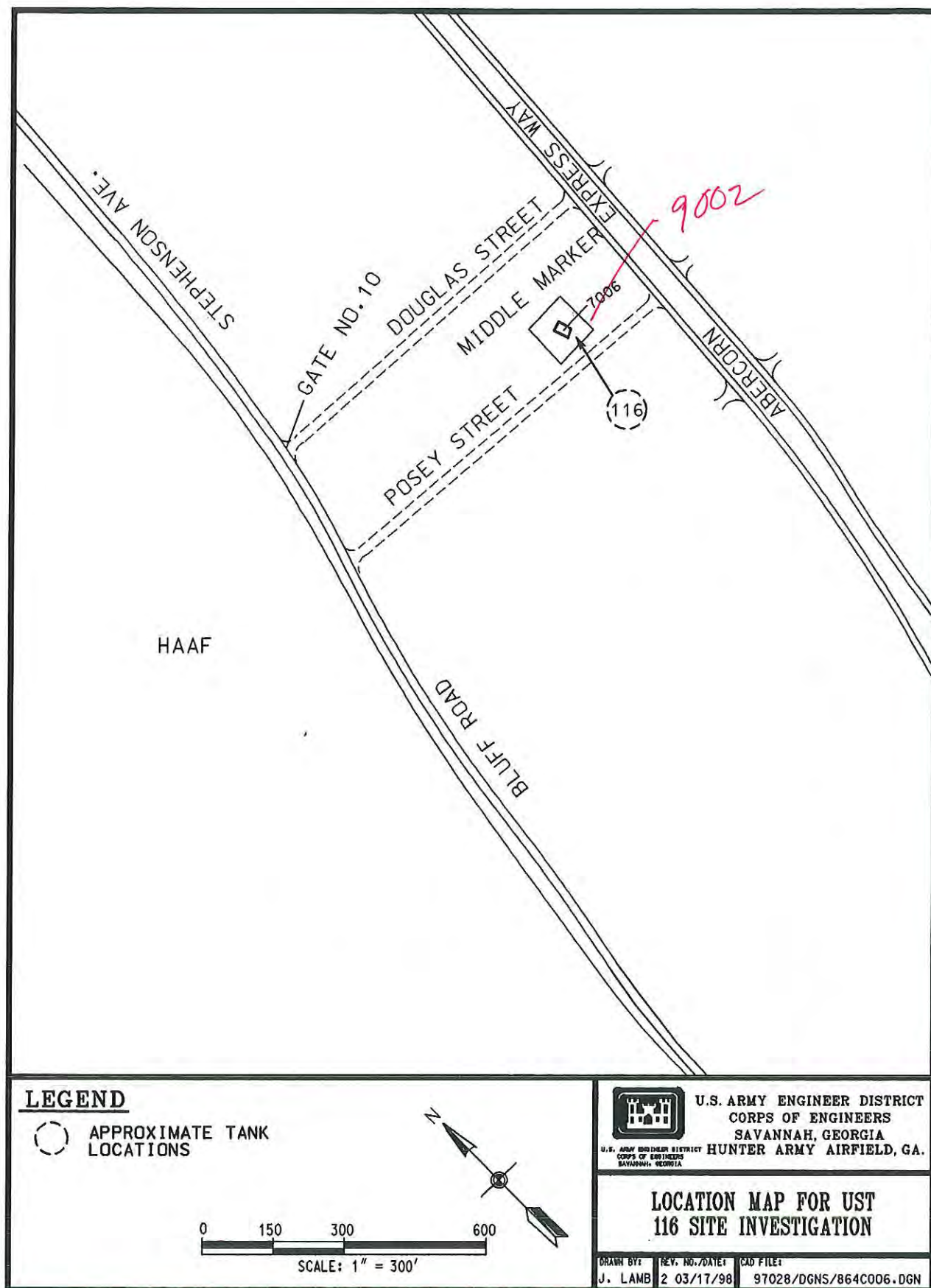


Figure 1.7. Location Map for UST Investigation Site 116

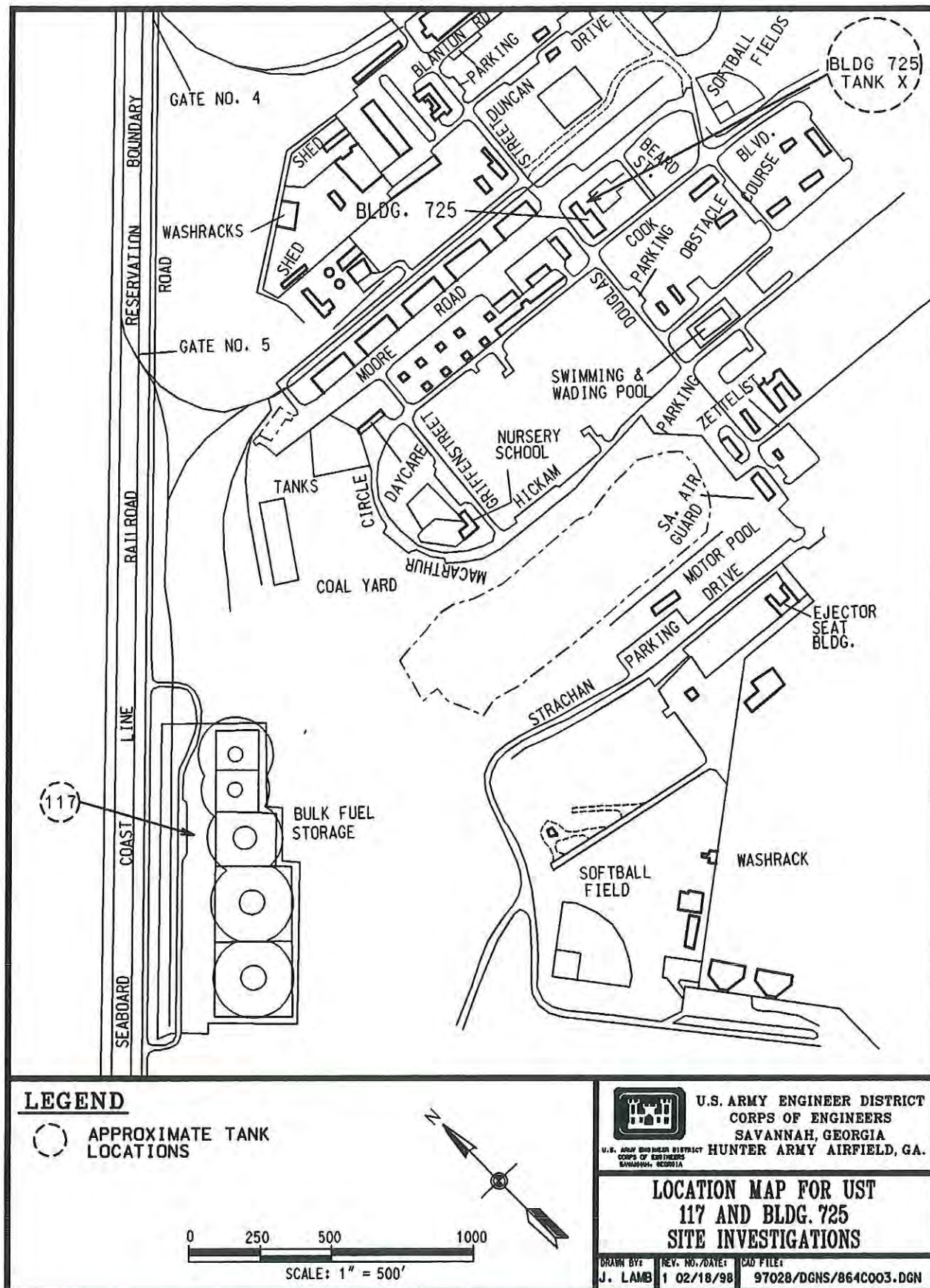


Figure 1.8. Location Map for UST Investigation Sites 117 and Building 725

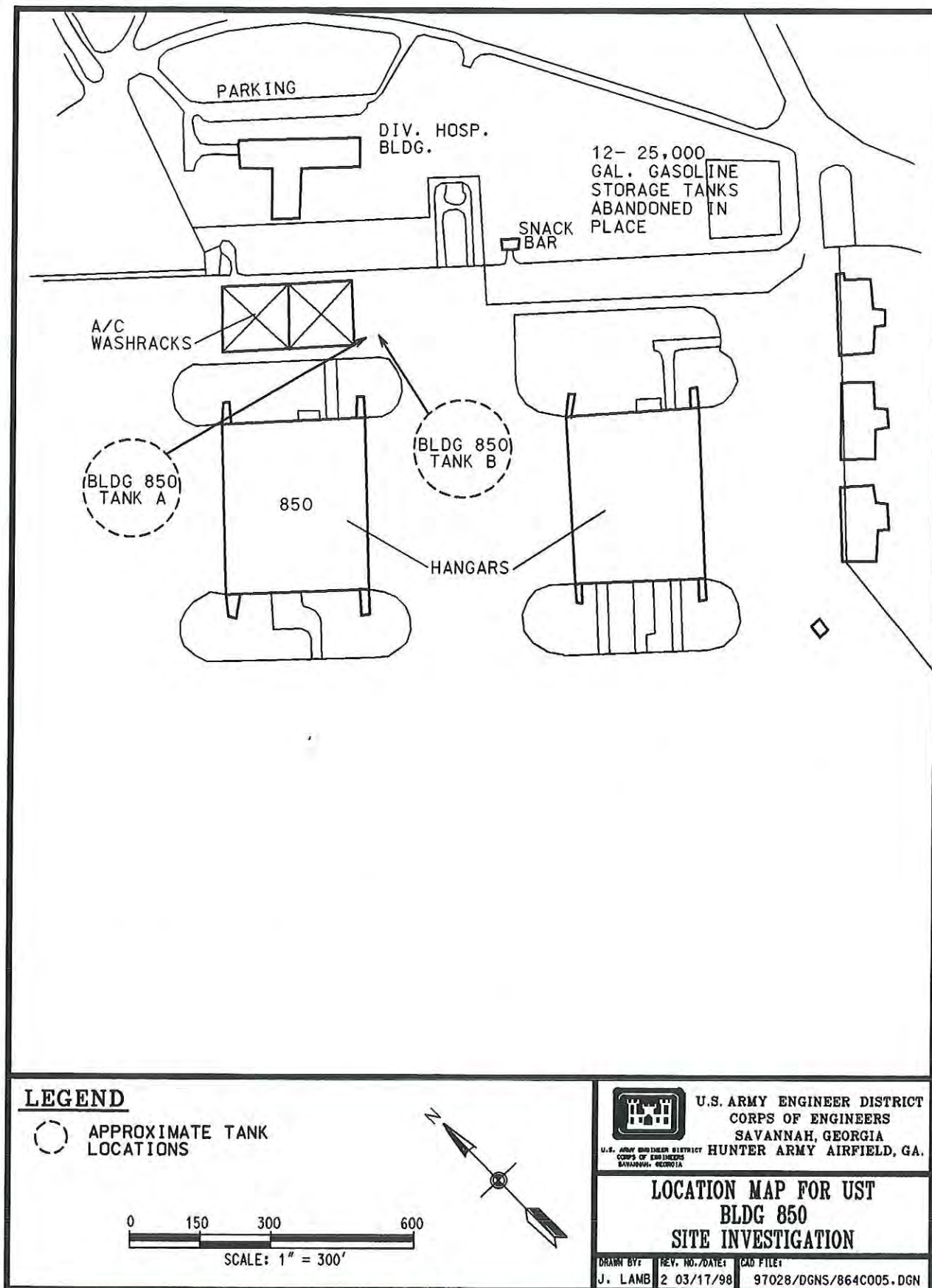


Figure 1.9. Location Map for UST Investigation Sites A & B at Building 850

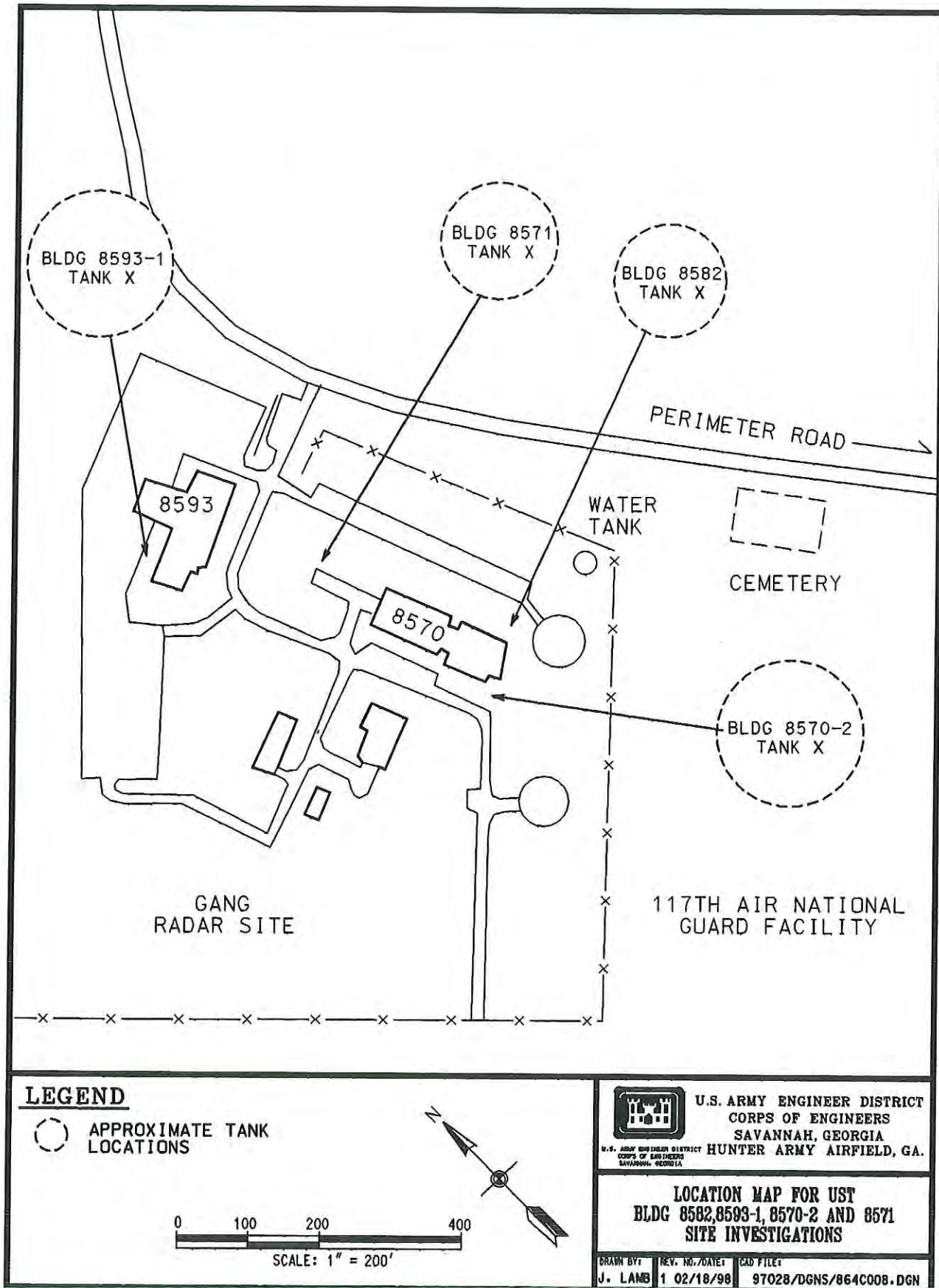


Figure 1.10. Location Map for UST Investigation Sites Located
at the 117th Air National Guard Facility

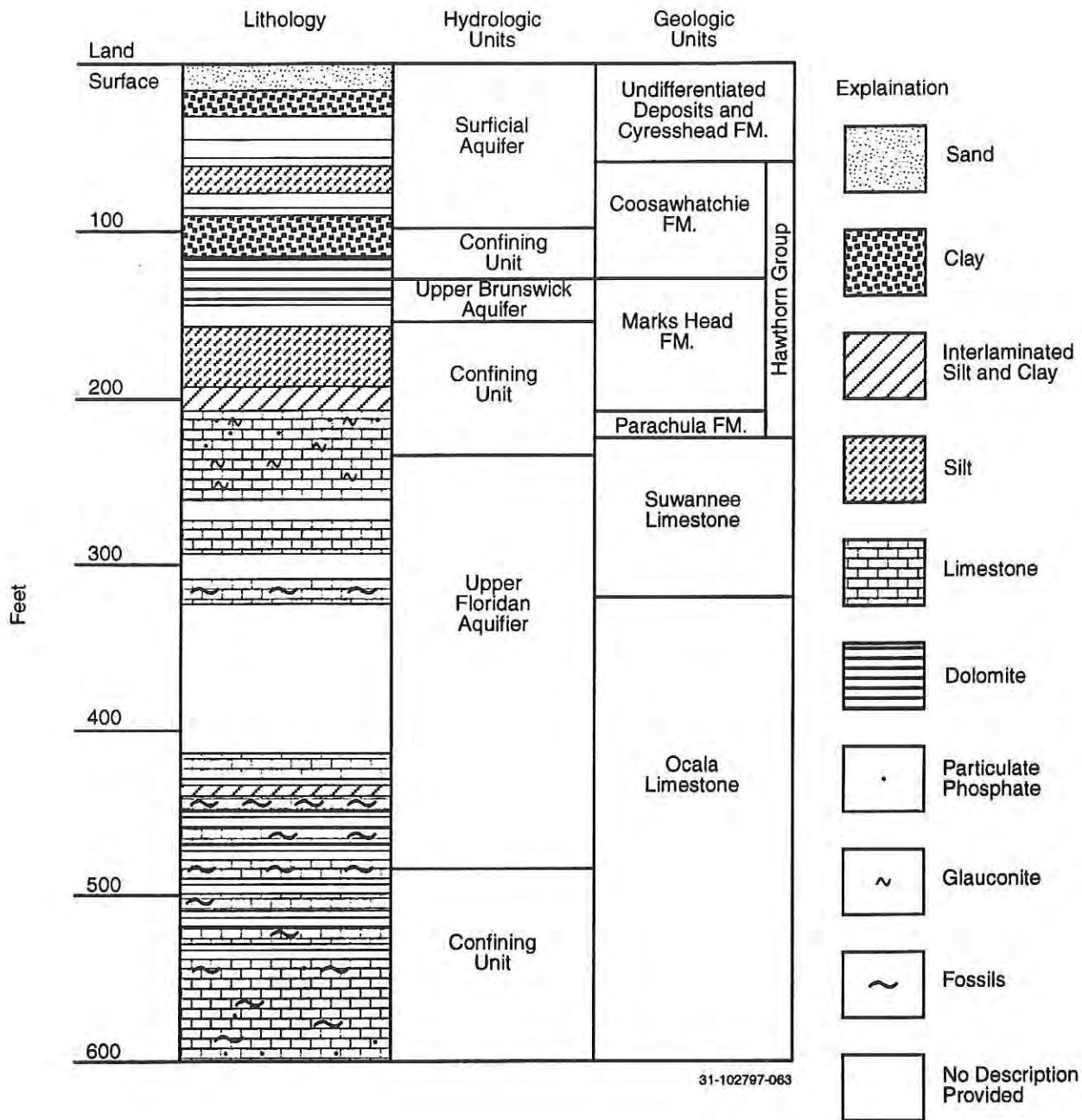


Figure 1.11. Generalized Hydrogeologic Stratigraphic Geologic Column for the HAAF

sorted sand with scattered gravel stringers. The down dip facies generally consist of fine-grained, well sorted sand with thin layers of clay. The Cypresshead Formation disconformably overlies the Coosawhatchie Formation of the Hawthorn Group (Huddleston 1987).

The Hawthorn Group is of Miocene age and generally consists of a basal calcareous unit, a middle clastic unit, and an upper unit that is a mixture of clastic and carbonate rocks (Miller 1986). The Hawthorn Group has been divided into three formations: Coosawhatchie Formation, Markshead Formation, and the Parachula Formation, which are listed here from youngest to oldest (Huddleston 1987).

The Coosawhatchie Formation is composed predominantly of clay, but also has sandy clay, argillaceous sand, and phosphorite units. This formation is approximately 170 feet thick in the Savannah area. This unit disconformably overlies the Markshead Formation and is distinguished from the underlying unit by dark phosphatic clays or phosphorite in the lower part and fine-grained sand in the upper part (Huddleston 1987).

The Markshead Formation is approximately 70 feet thick in the Savannah area and consists of light colored phosphatic, slightly dolomitic, argillaceous sand to fine-grained sandy clay with scattered beds of dolostone, limestone, and siliceous, and dolomitic and less calcareous (Huddleston 1987).

The Parachula Formation consists of sand, clay, limestone, and dolomite, and is approximately 10 feet thick in the Savannah area. The Parachula Formation generally overlies the Suwannee Limestone in Georgia (Huddleston 1987).

The Suwannee Limestone of Oligocene age consists of a cream or tan, crystalline, highly vuggy limestone and is approximately 100 feet thick in the Savannah area (Miller 1986) and overlies the Ocala Limestone. The Ocala Limestone of late Eocene age is a gray to cream, dense, highly fossiliferous limestone (Furrow 1969).

1.1.4 Local Geology

State geologic records describe a probable petroleum exploration well (the No. 1 Jelks-Rogers) located in the region as encountering crystalline basement rocks at a depth of 4254 feet below land surface. This well provides the most complete record for Cretaceous, Tertiary, and Quaternary sedimentary strata. The Cretaceous section was found to be approximately 1970 feet in thickness and dominated by clastics. The Tertiary section was found to be approximately 2170 feet in thickness and dominated by limestone with a thick cap of dark green phosphatic clay. This clay is regionally extensive and is known as the Hawthorn Group. The interval from approximately 110 feet to the surface is Quaternary in age and composed primarily of sand with interbeds of clay or silt. This section is undifferentiated into separate formations (Metcalf and Eddy 1996).

1.1.5 Surface Drainage

The principal surface water body accepting drainage from the HAAF is the Little Ogeechee River, which drains much of the south western portion of the HAAF and also forms the western border of the facility.

1.1.6 Hydrogeology

Water in the Coastal Plain aquifers is present primarily in intergranular pore spaces between sand grains and secondarily in solution cavities in carbonate rocks. The two principal aquifer systems of the Georgia Coastal Plain are the surficial (or water table) aquifer and the Principal Artesian aquifer system, known elsewhere as the Floridan aquifer.

The Principal Artesian

The Principal Artesian aquifer is the lower most hydrologic unit and is regionally extensive from South Carolina through Georgia, Alabama, and most of Florida. This aquifer is composed primarily of Tertiary age limestone including the Bug Island Formation, the Ocala Group, and the Suwannee Limestone. These formations are approximately 800 feet in thickness, and groundwater from this aquifer is primarily used for drinking water (Arora 1984). The confining layer for the Principal Artesian aquifer is the phosphatic clays of the Hawthorn Group, which are regionally extensive. There are minor occurrences of aquifer material within the Hawthorn Group, however, they have limited utilization (Miller 1990). The principal source of groundwater in the HAAF area is the Upper Principal Artesian aquifer that occurs in the Savannah area at approximately 200 feet bgs. Other sources of groundwater include the Miocene aquifer system and the surficial aquifer.

Surficial Aquifer

The uppermost hydrologic unit is the surficial aquifer, which is a thin, widespread layer of unconsolidated sand beds that commonly contain shells and limestone with varying amounts of silt and clay ranging from 55 to 150 feet in thickness. In some places, clay beds divide the system into two or three aquifers. This aquifer is primarily used for domestic lawn and agricultural irrigation. The top of the water table ranges from 2 to 10 feet below ground level (Geraghty and Miller 1992).

In the HAAF area, the surficial aquifer system consists of undifferentiated surficial sand, alluvial deposits, the Cypress head Formation and the Coosawhatchie Formation of the Hawthorn Group. A dense phosphatic silty clay of the Coosawhatchie acts as a basal confining unit. Generally, the surficial aquifer system is under unconfined or water table conditions. Locally, thin beds of clay create confined or semi-confined conditions. Water in the aquifer system flows east to the coast, and the water level near the coast is influenced by tidal changes. The thickness of the aquifer in the HAAF area is about 65 feet.

Wells in the shallow aquifer reportedly yield 2 to 180 gallons per minute (gpm). In Chatham County, wells yield 10 to 40 gpm, and the aquifer has an estimated hydraulic conductivity of 2 to 65 feet per day and a transmissivity of 14 to 1,100 square feet per day in the unconfined water bearing zone, and a hydraulic conductivity of 40 to 400 feet per day and a transmissivity of 150 to 6,000 square feet per day in the lower semi-confined water bearing zone (Clarke et al. 1990).

The lower confining unit (phosphatic silty clays of the Coosawhatchie formation) ranges in thickness from 15 to 90 feet and is approximately 30 feet in the Savannah area. In the Brunswick area, the vertical hydraulic conductivity of this confining unit ranges from 5.3×10^{-5} to 1.30×10^{-4} feet per day (Clark et al. 1990).

1.1.7 Soils

HAAF is underlain by the following soil associations:

- Chipley-Leon-Ellabelle,
- Ogeechee-Ellabelle,
- Ocilla-Pelham-Albany, and
- Pooler-Cape Fear.

The Chipley-Leon-Ellabelle soil association consists of moderately well drained and poorly drained, sandy soil on broad, low ridges and very poorly drained soils that have loamy underlying layers in depressions and drainageways. Slopes range from about 0 to 2 percent. This association is comprised of about 30 percent Chipley soils, 25 percent Leon soils, 20 percent Ellabelle soils, and 25 percent minor soils (Olustee, Ocilla, Pelham soils).

The Chipley soils are a fine sand that extend to a depth of 6 feet or more. In many places within the HAAF, the soil profile has been altered by cutting, filling, grading, and landscaping, and identification of the native soil types is impractical.

1.1.8 Ecology

The HAAF is located in Chatham County within the city of Savannah, covers approximately 5,400 acres, and is bounded on the north by lightly populated areas, on the east and south by residential and light commercial areas, and on the west by the Little Ogeechee River.

The climate in the vicinity of HAAF is moist and temperate year round. Average temperatures are typically in the range from about 52 degrees Fahrenheit in winter to 80 degrees Fahrenheit in summer. Annual rainfall averages 48 inches. The heaviest rainfall normally occurs in June through September, with July and August being the wettest months (6.6 inches on average). The driest months are October and November, with November having a monthly average of 2.0 inches of precipitation.

Vegetation at HAAF consists of grasses, shrubs, and scrub tree (oak growth) as well as pine forest areas that are composed of slash pine, loblolly pine, and longleaf pine. In addition, HAAF also contains river bottom lands and swamp areas whose major species include the tupelo, other gum trees, water oak, and bald cypress trees.

Aquatic habitats include natural and man-made ponds and lakes, bottom land swamps and pools, Lott Island, and the Little Ogeechee River that borders the installation along its southwestern boundary. Organic detritus contents are high, and dark coloring of the water is not unusual. Dense growths of aquatic vegetation are also typical, especially during the summer months.

Both terrestrial and aquatic fauna are abundant in the unimproved areas of HAAF. Major game species that may be found on the installation include white-tailed deer, feral hog, wild turkey, rabbit, squirrel, and bobwhite in addition to other numerous mammal, bird, reptile, and amphibian species. Dominant fish include bluegill, large mouth bass, crappie, sunfish, channel catfish, minnows, and shiners.

1.2 SITE HISTORY AND CONTAMINANTS OF THE 16 USTs

The Hunter Army Airfield is located within the southwest portion of the city of Savannah, Georgia in Chatham county and covers approximately 5,400 acres. The installation was originally established in June 1940 as an anti-aircraft artillery training center and became a subinstallation to the Fort Stewart Military installation, which is located 40 miles to the southwest, in 1967. Currently the HAAF serves as an aircraft support base for Fort Stewart, housing a variety of combat and transport helicopters.

The facility served as a prisoner-of-war camp for a brief period prior to being deactivated in September 1945. The installation was reactivated as an anti-aircraft training facility in 1953 for units training for the Korean Conflict. The facility was used as a flight training center beginning in 1966 and continuing through 1973.

In 1967, HAAF was acquired by Fort Stewart from the U.S. Air Force to support the increased need for helicopter pilot training during the Vietnam Conflict. Aviation training was discontinued at Fort Stewart in 1973. Fort Stewart became a training and maneuver area upon activation of the 1st Battalion, 75th Infantry on January 21, 1974. Support and training for weapons systems, including tank, field artillery, helicopter gunnery, and small arms was carried out for regular Army and National Guard units. The 24th Infantry Division was permanently stationed at Fort Stewart in 1975 and was active in the Persian Gulf war crisis of 1991. Aircraft based at HAAF currently include a variety of combat and transport helicopters. Additionally, the airfield was used for mobilization of troops and weapons during recent U.S. military operations in the Persian Gulf and Somalia.

In 1996, numerous USTs used to store diesel, Mogas, waste oil, and heating oil were removed by ACE, Inc. Analytical results from the tank removal/closure activities indicated that at 16 of the former UST sites located at HAAF further investigation was warranted. The analytical results are summarized in Table 1.1 and tank closure sampling locations are depicted on the site maps (Figures 1.12 through 1.27). Details regarding the tank removal/closure activities for each of the 16 sites is provided below.

This FSP addresses the investigation activities to be accomplished at the 16 former UST sites and is designed to meet the project objectives of determining the horizontal and vertical extent of contamination at the sites, determining whether contaminants present constitute a threat to human health or the environment, determining the need for further actions and/or no further action. At the completion of the field investigations and analysis of all data, site closure letters will be prepared for the groundwater investigation sites classified as having a No Further Action Required (NFAR) status. Corrective Action Plan-Part A Reports will be prepared for each of the remaining sites.

1.2.1 Building 1336, Tank 111

Tank 111, a 550 gallon tank, was located 16 to 20 feet northeast of Building 1336. The tank was used to store waste oil (Figure 1.12). On September 18, 1996, an excavation 10 feet × 15 feet was extended to the base of the tank and the tank was removed. One soil sample was collected from approximately 16 ft bgs from the center of the tank pit and analyzed for volatile organic compounds (VOCs), including benzene, toluene, ethylbenzene, and xylene (BTEX), and total petroleum hydrocarbons (TPH). The analytical results presented in Table 1.1 indicated elevated concentrations of TPH were present in the soil.

Table 1.2. Analytical Results for Soil and Groundwater Samples Collected During Tank Closure Activities

Site Identification	Sample Type	Sample ID	Sample Depth (ft bgs)	Analytical Results							
				TPH-DRO (ppm)	TPH-GRO (ppm)	TPH (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	FID/PID (ppm)
Bldg 1336, Tank 111	Soil	8102-TK111-S1	16	NA	NA	222	BDL	BDL	BDL	BDL	NA
Bldg 1327, Tank 110	Soil	8102-TK110-S1	8	NA	NA	167	BDL	BDL	BDL	BDL	NA
Bldg 8629, Tank 104	Soil	8102-B8629-TK104	BOTP	649	NA	NA	BDL	BDL	BDL	BDL	NA
	Soil		1	2 NA	NA	NA	NA	NA	NA	NA	2
	Soil		2	3 NA	NA	NA	NA	NA	NA	NA	3
	Soil		3	4 NA	NA	NA	NA	NA	NA	NA	0
	Soil		4	6 NA	NA	NA	NA	NA	NA	NA	7
	Soil		5	3.5 NA	NA	NA	NA	NA	NA	NA	50
	Soil		6	2.5 NA	NA	NA	NA	NA	NA	NA	0
	Soil		7	3.5 NA	NA	NA	NA	NA	NA	NA	25
	Soil		8	3 NA	NA	NA	NA	NA	NA	NA	2
	Soil		9	3 NA	NA	NA	NA	NA	NA	NA	200
	Soil		10	3 NA	NA	NA	NA	NA	NA	NA	460
Bldg 1346, Tank 108	Soil	8102-TK-108-S1	10	889	NA	NA	BDL	BDL	BDL	BDL	NA
Bldg 8464, Tank 112	Soil	8102-TK112-S1	6	2486	NA	NA	BDL	BDL	BDL	BDL	NA
	Soil	8102-TK112-S2	?	6842	NA	NA	BDL	BDL	BDL	BDL	NA
	Soil		1	5 NA	NA	NA	NA	NA	NA	NA	140
	Soil		2	3 NA	NA	NA	NA	NA	NA	NA	30
	Soil		3	3 NA	NA	NA	NA	NA	NA	NA	110
	Soil		4	4 NA	NA	NA	NA	NA	NA	NA	330
	Soil		5	3 NA	NA	NA	NA	NA	NA	NA	30
Bldg 1310, Tank 109	Soil	8102-TK109-S1	12	NA	NA	1604	BDL	0.27	0.97	9.66	NA
	Soil		1	4 NA	NA	NA	NA	NA	NA	NA	2600
	Soil		2	6 NA	NA	NA	NA	NA	NA	NA	2000
	Soil		3	6 NA	NA	NA	NA	NA	NA	NA	1500
	Soil		4	7 NA	NA	NA	NA	NA	NA	NA	1600
	Soil		5	10 NA	NA	NA	NA	NA	NA	NA	1900
	Soil		6	10 NA	NA	NA	NA	NA	NA	NA	1200

Table 1.2 (continued)

Site Identification	Sample Type	Sample ID	Sample Depth (ft bgs)	Analytical Results							
				TPH-DRO (ppm)	TPH-GRO (ppm)	TPH (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	FID/PID (ppm)
Bldg 8509, Tanks 27 & 28	Soil	8102-TK28-S1	14	205	NA	NA	BDL	BDL	BDL	BDL	NA
	Soil	8102-TK28-S2	12	BDL	NA	NA	BDL	BDL	BDL	BDL	NA
	Soil	8102-TK27-S1	4	NA	1110	NA	BDL	13.3	12.6	103.6	NA
	Soil		1	4 NA	NA	NA	NA	NA	NA	NA	3
	Soil		2	4 NA	NA	NA	NA	NA	NA	NA	0
	Soil		3	7 NA	NA	NA	NA	NA	NA	NA	0
	Soil		4	7 NA	NA	NA	NA	NA	NA	NA	0
	Soil		5	8 NA	NA	NA	NA	NA	NA	NA	8
	Soil		6	10 NA	NA	NA	NA	NA	NA	NA	0
	Soil		7	8 NA	NA	NA	NA	NA	NA	NA	0
	Soil		8	3 NA	NA	NA	NA	NA	NA	NA	0
	Soil		9	3 NA	NA	NA	NA	NA	NA	NA	1
	Soil		10	6 NA	NA	NA	NA	NA	NA	NA	3
	Soil		11	3 NA	NA	NA	NA	NA	NA	NA	0
	Soil		12	7 NA	NA	NA	NA	NA	NA	NA	0
	Soil		13	3 NA	NA	NA	NA	NA	NA	NA	0
	Soil		14	6 NA	NA	NA	NA	NA	NA	NA	350
	Soil		15	4 NA	NA	NA	NA	NA	NA	NA	3
	Soil		16	4 NA	NA	NA	NA	NA	NA	NA	0
	Soil		17	8 NA	NA	NA	NA	NA	NA	NA	0
Bldg 9002, Tank 116	Soil	8102-TK116-S1	12	BDL	NA	NA	BDL	BDL	BDL	BDL	NA
	GW	8102-TK116-GW	12	NA	NA	NA	0.88	5.63	1.41	9.49	NA
	Soil		1	5 NA	NA	NA	NA	NA	NA	NA	0
	Soil		2	4 NA	NA	NA	NA	NA	NA	NA	0
	Soil		3	4 NA	NA	NA	NA	NA	NA	NA	1
	Soil		4	4 NA	NA	NA	NA	NA	NA	NA	0
	Soil		5	3 NA	NA	NA	NA	NA	NA	NA	0
	Soil		6	5 NA	NA	NA	NA	NA	NA	NA	0
	Soil	8102-TK117-S1	5	NA	NA	163	0.01	0.003	0.006	0.005	NA
	Soil	8102-TK21/22-D1-ES	?	BDL	BDL	NA	BDL	BDL	BDL	BDL	NA
Bldg 1327, Tanks 21 & 22	Soil	8102-TK21/22-D2-WS	?	2675	229	NA	BDL	BDL	0.42	0.62	NA

Table 1.2 (continued)

Site Identification	Sample Type	Sample ID	Sample Depth (ft bgs)	Analytical Results							
				TPH-DRO (ppm)	TPH-GRO (ppm)	TPH (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	FID/PID (ppm)
	GW	8102-TK21/22-GW	10 NA	NA	NA	NA	BDL	1 BDL	10.5 NA		
	Soil		4 NA	NA	NA	NA	NA	NA	NA	NA	>5000
	Soil		1.5 NA	NA	NA	NA	NA	NA	NA	NA	160
	Soil		2 NA	NA	NA	NA	NA	NA	NA	NA	210
	Soil		7 NA	NA	NA	NA	NA	NA	NA	NA	2200
Bldg 725, No Tank ID. #	Soil	8102-B725-TK1-7	7	13200 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil	8102-B725-TK1-11	11	79 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil		1	2 NA	NA	NA	NA	NA	NA	NA	0
	Soil		2	3 NA	NA	NA	NA	NA	NA	NA	0
	Soil		3	4 NA	NA	NA	NA	NA	NA	NA	460
	Soil		4	2 NA	NA	NA	NA	NA	NA	NA	70
	Soil		5	3 NA	NA	NA	NA	NA	NA	NA	240
	Soil		6	4 NA	NA	NA	NA	NA	NA	NA	1600
Bldg 850, No Tank ID #s	Soil	8102-B850-TKA-N	BOTP	751 NA	NA	NA	NA	NA	NA	NA	NA
	Soil	8102-B850-TKA-S	BOTP	4400 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil	8102-B850-TKA-C	BOTP	690 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil	8102-B850-TKB-N	BOTP	7030 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil	8102-B850-TKB-S	BOTP	141100 NA	NA	NA	BDL	NA	NA	NA	NA
	Soil		6 NA	NA	NA	NA	NA	NA	NA	NA	>50
	Soil		2	9 NA	NA	NA	NA	NA	NA	NA	40
	Soil		3	7 NA	NA	NA	NA	NA	NA	NA	50
	Soil		4	10 NA	NA	NA	NA	NA	NA	NA	160
	Soil		5	11 NA	NA	NA	NA	NA	NA	NA	160
	Soil		6	9 NA	NA	NA	NA	NA	NA	NA	270
	Soil		7	8 NA	NA	NA	NA	NA	NA	NA	350
	Soil		8	4 NA	NA	NA	NA	NA	NA	NA	50
	Soil		9	7 NA	NA	NA	NA	NA	NA	NA	110
	Soil		10	4 NA	NA	NA	NA	NA	NA	NA	20
	Soil		11	3 NA	NA	NA	NA	NA	NA	NA	20
	Soil		12	12 NA	NA	NA	NA	NA	NA	NA	1100
	Soil		13	2 NA	NA	NA	NA	NA	NA	NA	50

Table 1.2 (continued)

Site Identification	Sample Type	Sample ID	Sample Depth (ft bgs)	Analytical Results							
				TPH-DRO (ppm)	TPH-GRO (ppm)	TPH (ppm)	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Xylene (ppb)	FID/PID (ppm)
	Soil	.	14	7 NA	NA	NA	NA	NA	NA	NA	100
	Soil		15	10 NA	NA	NA	NA	NA	NA	NA	1700
Bldg 8582, No Tank ID #s	Soil	E. Bot.		9 NA	NA	8.2 BDL	BDL	BDL	BDL	BDL	NA
	Soil	W. Bot.		9 NA	NA	3400 BDL	BDL	BDL	1.1	2.42	NA
	Soil	NEC		6.5 NA	NA	5100 BDL	BDL	0.15	1.2	2.2	NA
Bldg 8593-1, No Tank ID #s	Soil	Piping		3 NA	NA	<5.0	BDL	BDL	BDL	BDL	NA
	Soil	North		10 NA	NA	7549	0.02 BDL	BDL	2.4	2.12	NA
	Soil	South		10 NA	NA	BDL	BDL	BDL	BDL	0.008	NA
	Soil	East		10 NA	NA	214 BDL	BDL	BDL	0.36	0.26	NA
	Soil	West		10 NA	NA	350	0.004	0.07	0.58	0.44	NA
Bldg. 8570-2, No Tank ID #s	Soil	S. Bot.		11 NA	NA	<5.0	BDL	BDL	BDL	BDL	NA
	Soil	N. Bot.		11 NA	NA	<5.0	BDL	BDL	BDL	BDL	NA
	Soil	N. Bot.		8 NA	NA	260 BDL	BDL	BDL	0.01	0.003	NA
Bldg. 8571	Soil	S. Bot.		12 NA	NA	15 U	U	U	U	U	7.8
	Soil	N. Bot.		12 NA	NA	U	U	U	U	U	2
		West		11 NA	NA	U	U	U	U	U	0.2

Analytical results obtained from UST Removal and Closure Reports, ACE, Inc., December 1996 and January 1997 and Geosciences Inc., Report #9701104-1, 9701105-2 and 9701236-3

TPH-DRO- Diesel Range Organics, Method 8015A

TPH-GRO-Gasoline Range Organics, Method 8015A

TPH - Total Petroleum Hydrocarbons, Method 418.1

BETX - Benzene, Ethylbenzene, Toluene, Xylene, Method 8020

FID - Flame Ionization Detector. ACE, Inc. used a Heath PORTA-FID II, Model No. 8000 FID fitted with a methane

filter to conduct soil vapor headspace analyses.

PID - Photo Ionization Detector

bgs - Below ground surface

BOTP - Bottom of tank pit. The sample depth was not reported, only reported as being collected at the bottom of tank pit.

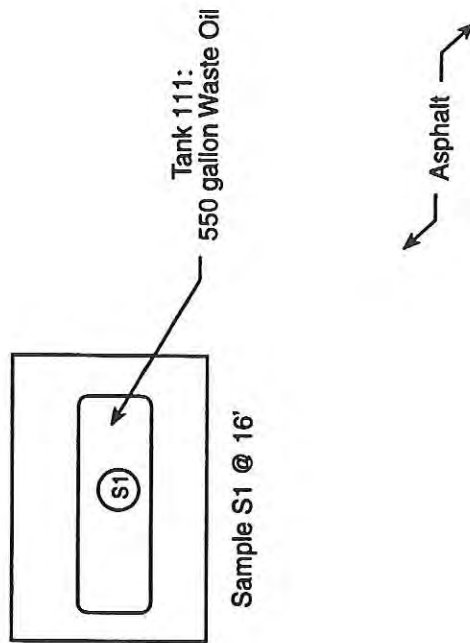
NA - Not applicable/Not analyzed for

BDL - Below method detection limits

GW - Groundwater

U - Unknown

Building 1336



Legend

(S1) Location of Closure Sample

Scale : 1" = 10'



Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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Building 1336, Tank 111

Figure 1.12. Tank Closure Sampling Map Building 1336, Tank 111, HAAF, Savannah, Georgia

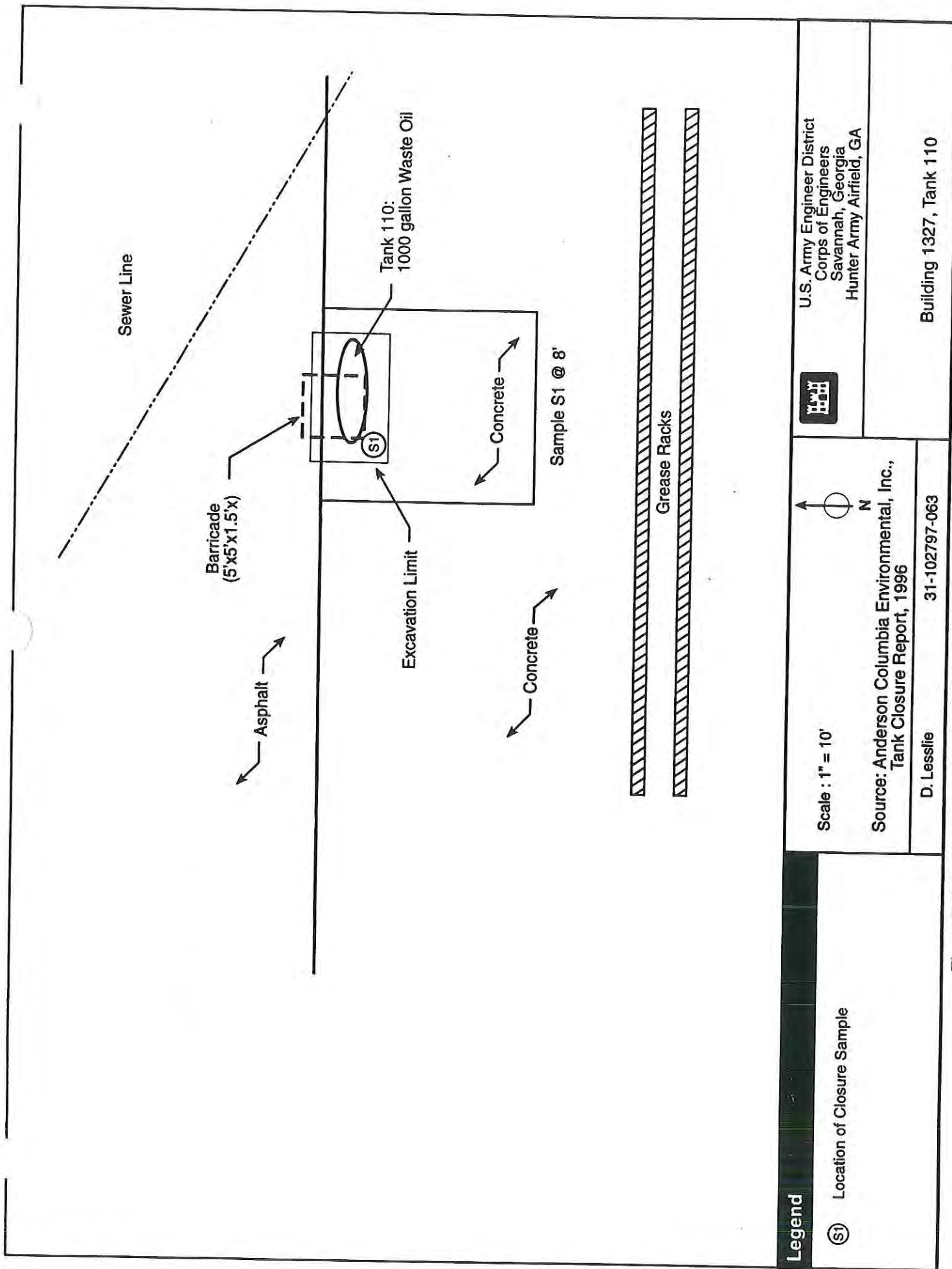
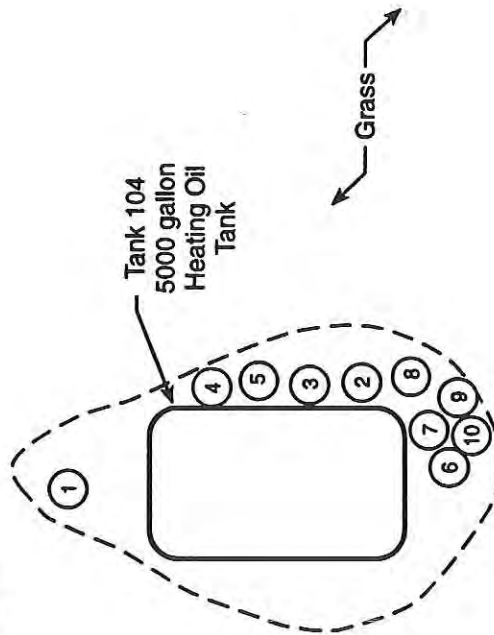


Figure 1.13. Tank Closure Sampling Map - Building 1327/33, Tank 110, HAAF, Savannah, Georgia



Excavation Limit



Sample	Depth	FID
1	2'	2
2	3'	3
3	4'	0
4	6'	7
5	3.5'	50
6	2.5'	0
7	3.5'	25
8	3'	2
9	3'	200
10	3'	460 (75 ppm methane)

Legend

- ① Location of Closure Sample
- ④ Flame Ionization Detector (FID) Sample Location



Scale : 1" = 10'

Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

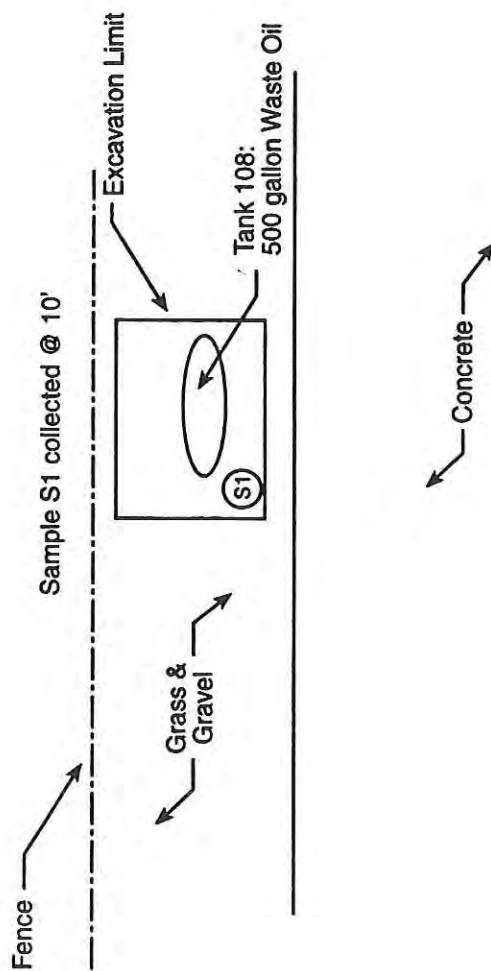
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Building 8629, Tank 104

Figure 1.14. Tank Closure Sampling Map - Building 8629, Tank 104, HAAF, Savannah, Georgia



Legend

(S1) Location of Closure Sample



Scale : 1" = 10'

Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

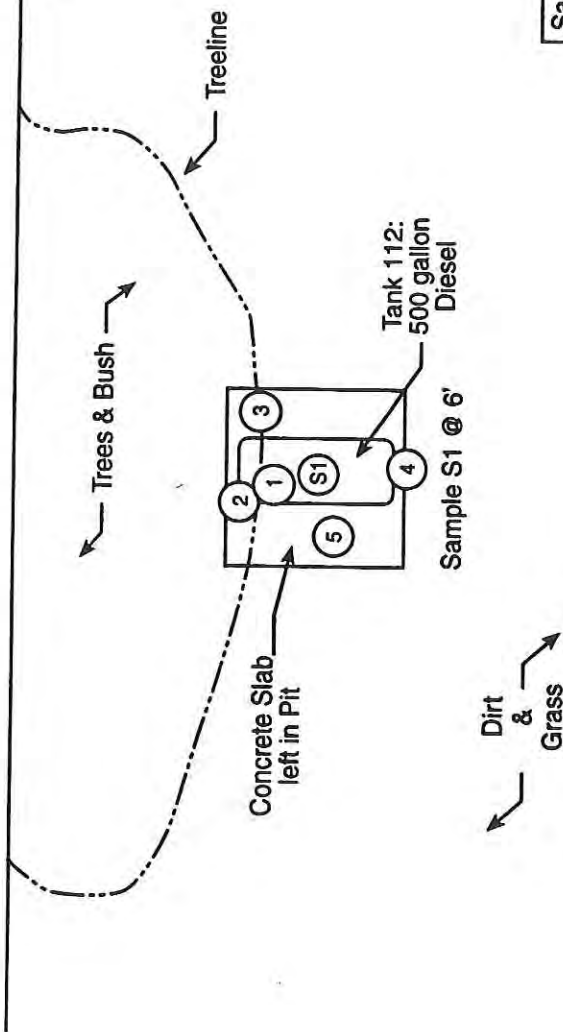
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Building 1346, Tank 108

Figure 1.15. Tank Closure Sampling Map - Building 1346, Tank 108, HAAF, Savannah, Georgia

Roadway



Sample Depth	FID
1	5' 140
2	3' 30
3	3' 110
4	4' 330
5	3' 30

Legend

- (S1) Location of Closure Sample
- (4) Flame Ionization Detector (FID) Sample Location



Scale : 1" = 10'

Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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Building 8464, Tank 112

Figure 1.16. Tank Closure Sampling Map - Building 8464, Emergency Generator Tank #112, HAAF, Savannah, Georgia

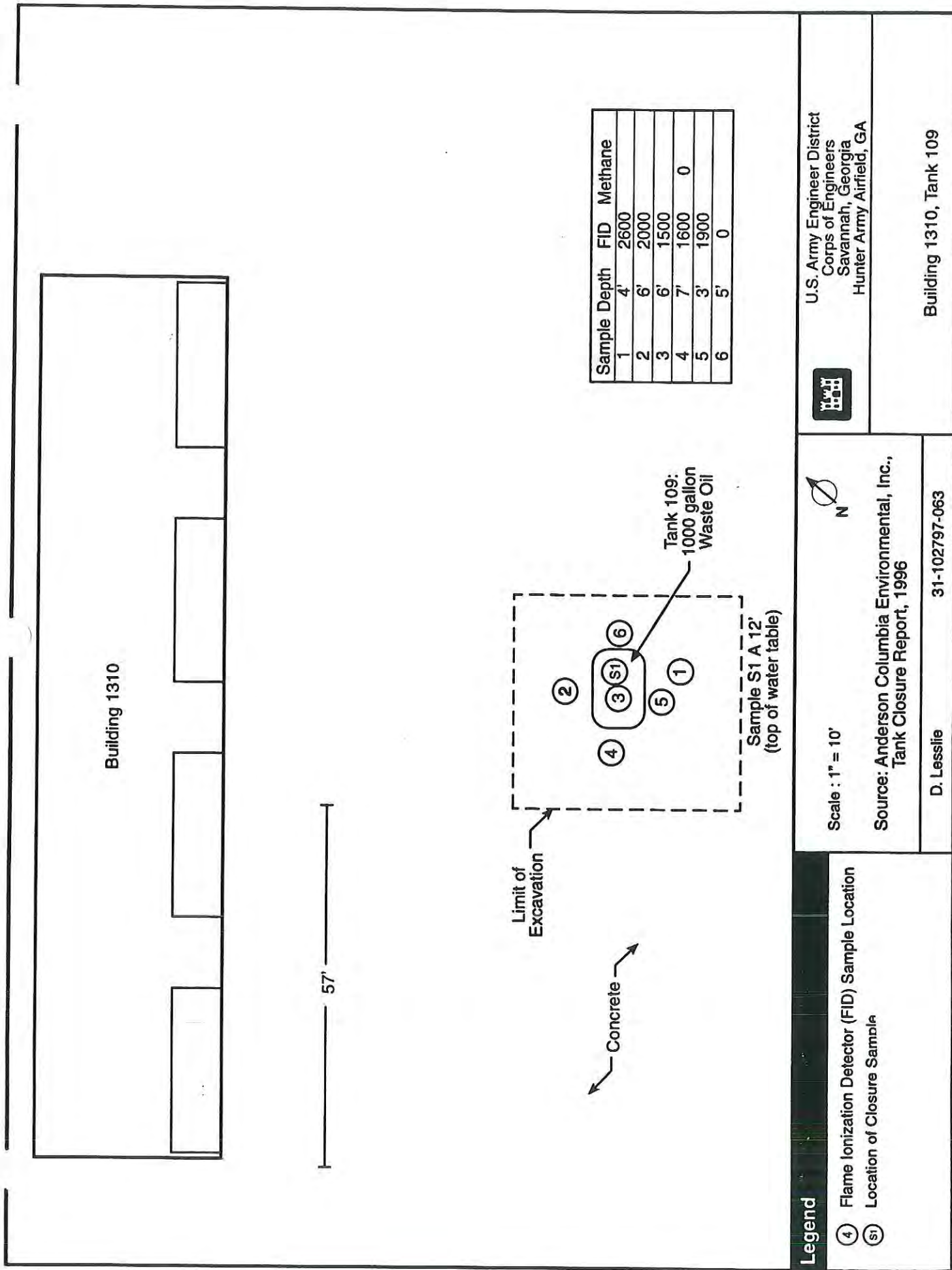
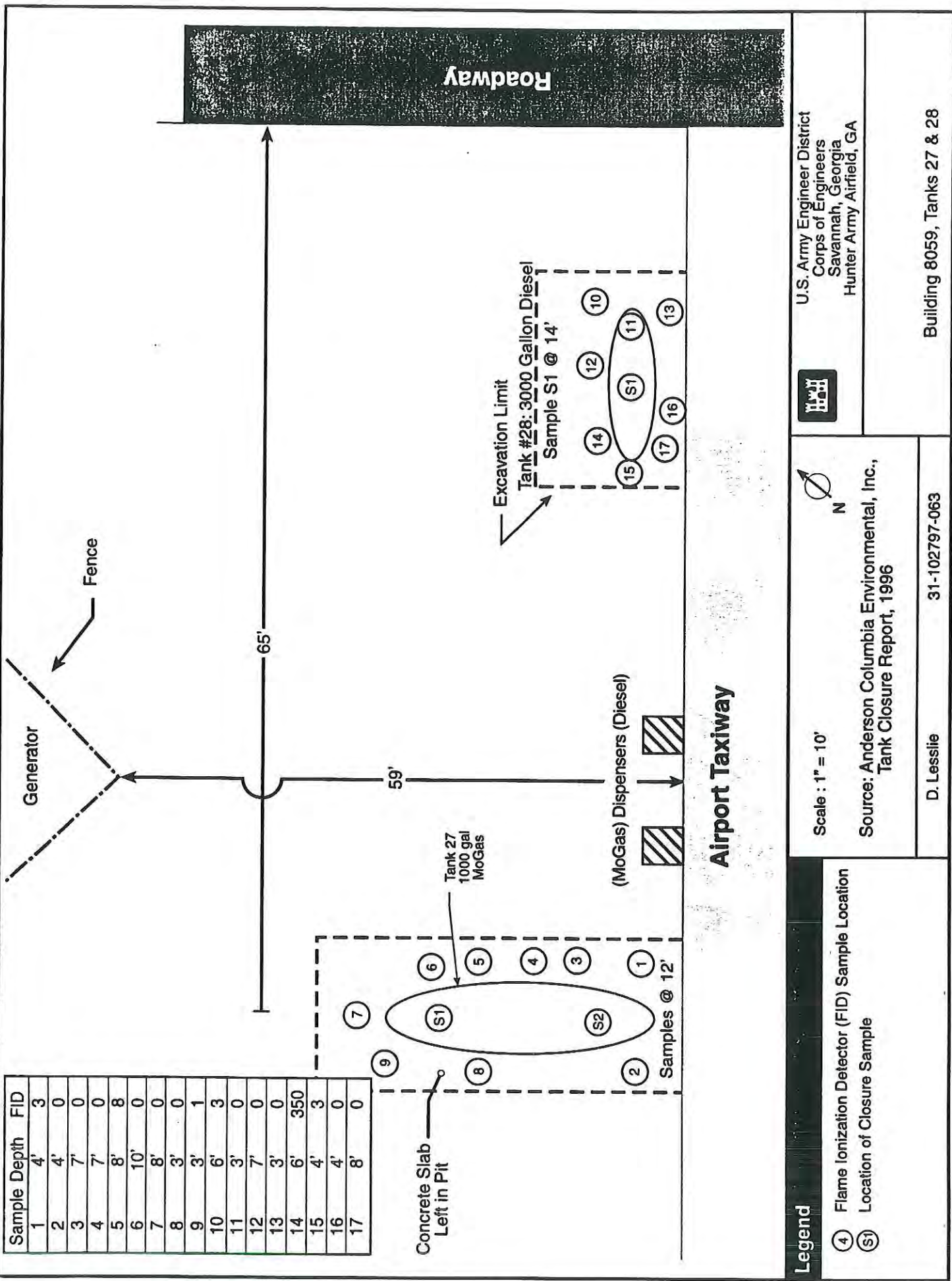


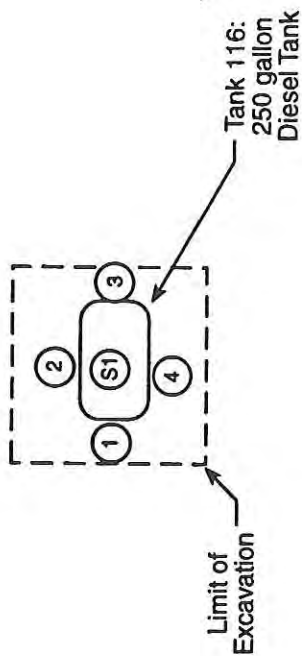
Figure 1.17. Tank Closure Sampling Map - Building 1310, Tank 109, HAAF, Savannah, Georgia



Legend (4) Flame Ionization Detector (FID) Sample Location (S1) Location of Closure Sample	Scale : 1" = 10' Source: Anderson Columbia Environmental, Inc., Tank Closure Report, 1996	U.S. Army Engineer District Corps of Engineers Savannah, Georgia Hunter Army Airfield, GA
	D. Lesslie 31-102797-063 Building 8059, Tanks 27 & 28	

Figure 1.18. Tank Closure Sampling Map - Building 8059, Firehouse - Tanks 27 & 28, HAAF, Savannah, Georgia

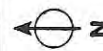
Sample Depth	FID	Methane
1 5'	0	
2 4'	0	
3 4'	1	
4 4'	0	0
5 3'	0	
6 5'	0	



Legend

- ④ Flame Ionization Detector (FID) Sample Location
- Ⓢ① Location of Closure Sample

Scale : 1" = 10'



Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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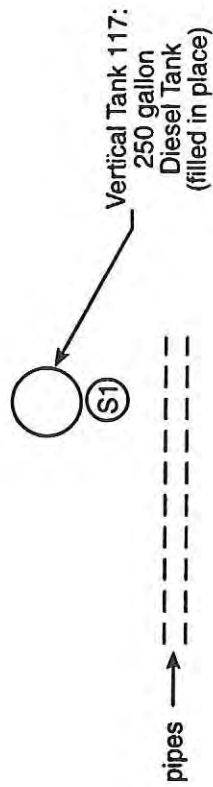


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Building 9002, Tank 116

Figure 1.19. Tank Closure Sampling Map - Building 9002, Wilmington Island: Tank 116, HAAF, Savannah, Georgia

Building 7002



Sample S1 collected @ 5'

Legend

(S1) Location of Closure Sample

Scale : 1" = 10'



Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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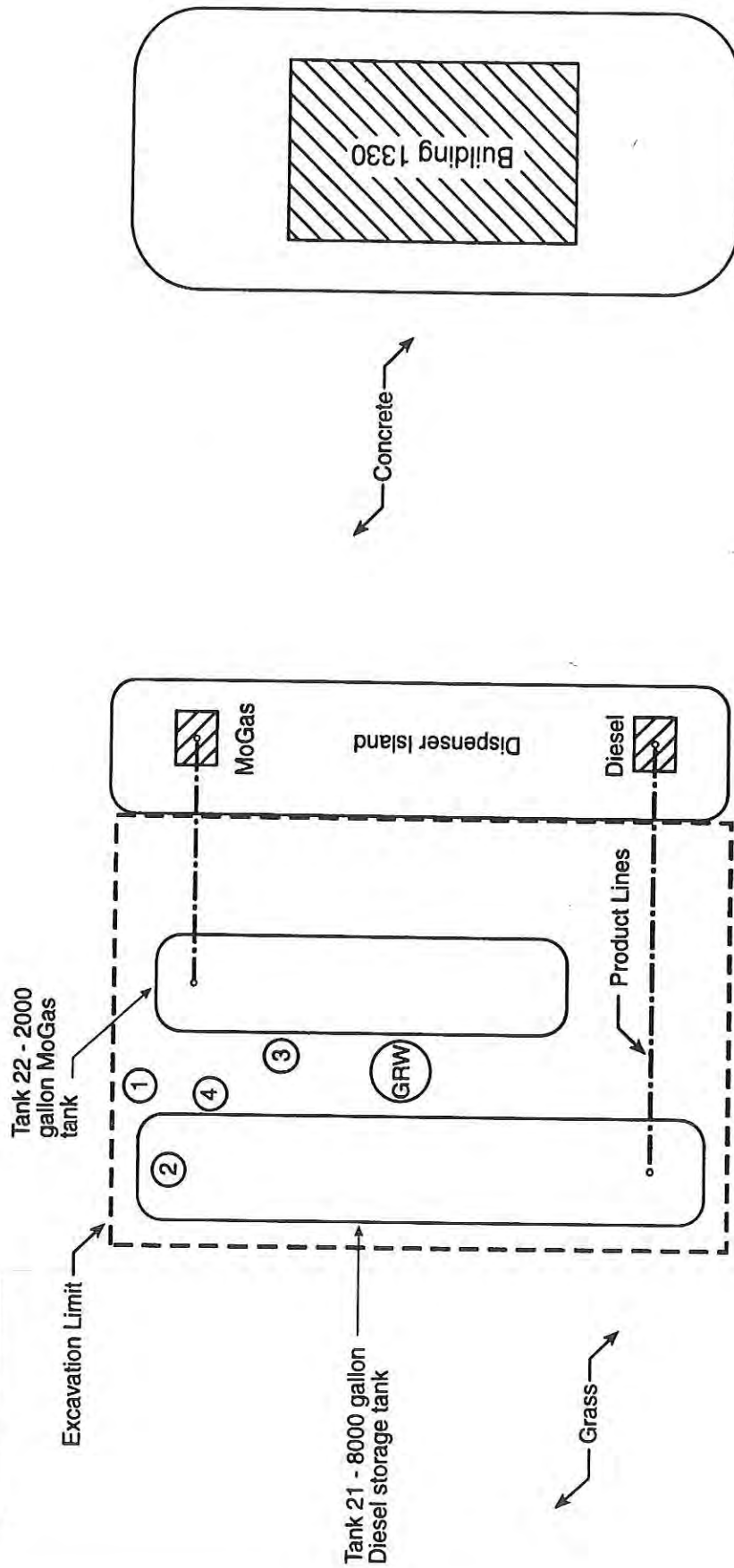
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Building 7002, Tank 117

Figure 1.20. Tank Closure Sampling Map - Building 7002, Tank 117, HAAF, Savannah, Georgia

Sample Depth	FID
1 4'	>5000
2 1.5'	160
3 2'	210
4 7'	2200



Legend

- ④ Flame Ionization Detector (FID) Sample Location
- ⊙ GRW Location of Closure Sample

Scale : 1" = 10'

Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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Building 1327, Tanks 21 & 22

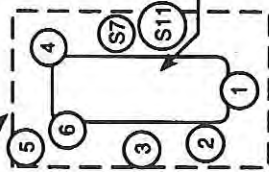
Figure 1.21. Tank Closure Sampling Map - Building 1327, Tanks 21 and 22, HAAF, Savannah, Georgia

Sample Depth	FID
1	2' 0
2	3' 0
3	4' 460
4	2' 70
5	3' 240
6	4' 1600

(75 ppm methane)

Water Tower

Excavation Limit



Tree

1000 gallon
Heating Oil
Tank

Grass

Parking Lot

Legend

- (S7) Location of Closure Sample
- (4) Flame Ionization Detector (FID) Sample Location

Scale : 1" = 10'

N



Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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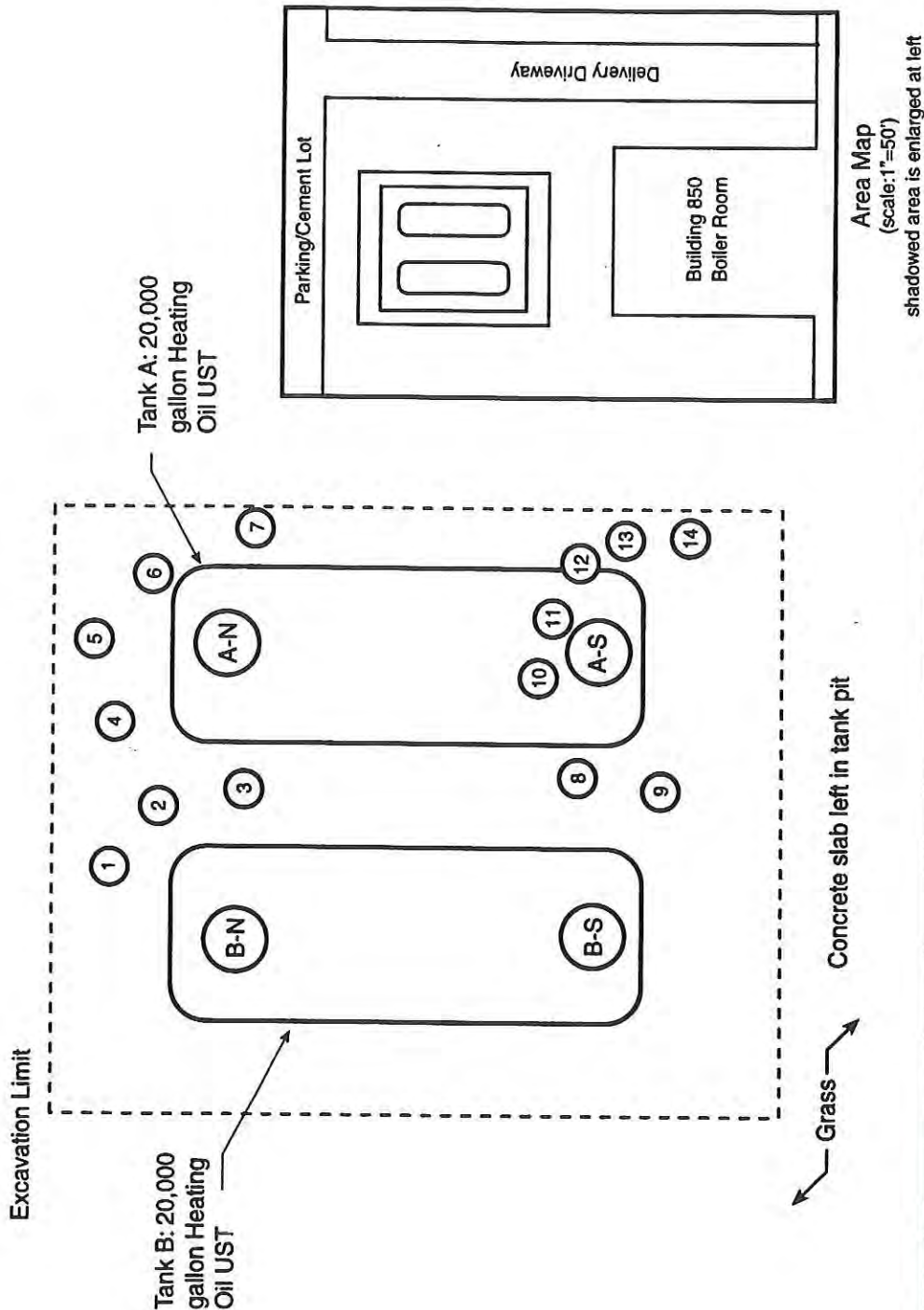


Building 725, Tank X

Figure 1.22. Tank Closure Sampling Map - Building 725, Tank Not Assigned, Savannah, Georgia

Sample Depth	FID
1	6' >50
2	9' 40
3	7' 50
4	10' 160
5	11' 160
6	9' 270
7	8' 350
8	4' 50
9	7' 110
10	4' 20
11	3' 20
12	12' 1100
13	2' 50
14	7' 100
15	10' 1700

(150 methane)
(some FID sample locations have been approximated)



Legend

- ④ Flame Ionization Detector (FID) Sample Location
- ⓑ Location of Closure Sample (Tank- Direction)

Scale : 1" = 10'

Source: Anderson Columbia Environmental, Inc.,
Tank Closure Report, 1996

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Building 850, Tanks A & B

Figure 1.23. Tank Closure Sampling Map - Building 850, Tanks A and B, HAAF, Savannah, Georgia

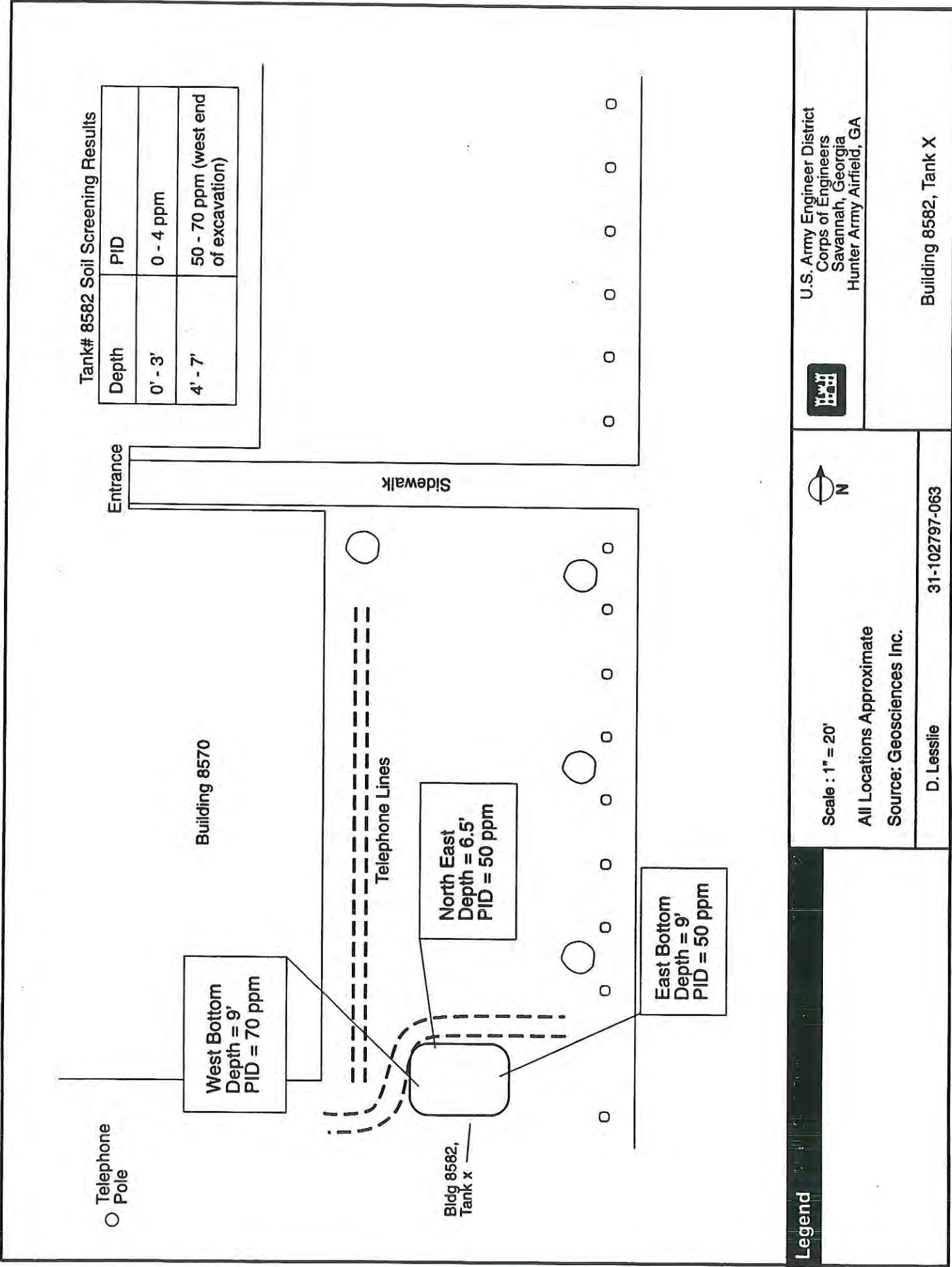


Figure 1.24. Tank Closure Sampling Map - Building 8582, Tank Not Assigned, HAAF, Savannah, Georgia

1.2.2 Building 1327, Tank 110

Tank 110, a 1,000 gallon tank, was located adjacent to the grease racks north of Building 1327. The tank was installed in January 1987 and was used to store waste oil (Figure 1.13). On September 17, 1996, an excavation 6 feet $\times$ 11 feet was extended to the base of the tank and the tank was removed. One soil sample was collected from 8 feet bgs from the southwest corner of the tank pit and analyzed for TPH and VOCs, including BTEX. The analytical results presented in Table 1.1 indicated elevated levels of TPH in the soil.

1.2.3 Building 8629, Tank 104

Tank 104, a 5,000 gallon tank, was located approximately 12 to 25 feet south of the electrical substation adjacent to Building 8629 and was used to store heating oil (Figure 1.14). On October 31, 1996, an irregularly shaped excavation, approximately 25 feet $\times$ 15 feet was extended to the base of the tank and the tank was removed. During excavation, grab samples of the surrounding soil were collected for head space analysis using a flame ionization detector (FID). The results are presented in Table 1.1. After the tank was removed, one soil sample was taken from approximately 2 feet below the center of the former tank and analyzed for TPH-diesel range organics (DRO) and VOCs, including BTEX. The analytical results are presented in Table 1.1 and indicate elevated concentrations of TPH in the soil.

1.2.4 Building 1346, Tank 108

Tank 108, a 500 gallon tank installed in January 1987, was located south of Building 1346 and between Building 1346 and the base perimeter fence. The tank was used to store waste oil (Figure 1.15). On September 19, 1996, a 10 feet $\times$ 6 feet excavation was made to the base of the tank and the tank removed. One soil sample was collected from 10 feet bgs from the southwest corner of the tank pit and analyzed for TPH and VOCs, including BTEX. The analytical results, presented in Table 1.1, indicated elevated levels of TPH in the soil.

1.2.5 Building 8464, Tank 112

Tank 112, a 500 gallon diesel tank installed in January 1954, was located approximately 20 feet south east of Building 8464 (Figure 1.16). On September 24, 1996, an excavation 9 feet $\times$ 9 feet was made to the base of the tank and the tank was removed. The tank closure report indicated that approximately 37.5 tons of contaminated soil were removed. During the excavation, grab samples of the surrounding soil were collected for head space analysis using a FID. The results are presented in Table 1.1. After the tank was removed, two soil samples were collected and analyzed for TPH-DRO and VOCs, including BTEX. The analytical results indicated elevated levels of TPH were present in the soil.

1.2.6 Building 1310, Tank 109

Tank 109, a 1,000 gallon waste oil tank installed in January 1987, was located approximately 30 feet Northwest of Building 1310 (Figure 1.17). On September 11, 1996, a approximately 18 feet $\times$ 17 feet excavation was made to the base of the tank and the tank removed. During excavation activities, grab samples of the surrounding soil were collected for head space analysis with an FID. The results are presented in Table 1.1. After the tank was removed, one soil sample was collected from approximately 12 feet bgs, noted as being immediately above the water table, and analyzed for TPH

and VOCs, including BTEX. The results, presented in Table 1.1, indicated that elevated concentrations of TPH were present in the soil.

1.2.7 Building 8059, Tanks 27 and 28

Tanks 27 and 28 were located along an airport taxiway, approximately 100 to 150 feet southeast of Building 8059 (Figure 1.18). Tank 27, a 1000 gallon gasoline tank, and Tank 28, a 3000 gallon diesel tank, were both installed in 1945. The two tanks were removed from the ground, from separately excavated pits through the period of August 24 and 25, 1996. During excavation, grab samples of the surround soil were collected for head space analysis with an FID. The results are presented in Table 1.1. One soil sample was collected from tank pit 27 and analyzed for VOCs, including BTEX and TPH-gasoline range organics (GRO). Two soil samples were collected from tank pit 28 and analyzed for VOCs, including BTEX and TPH-DRO. Soil samples from tank pit 27 indicated elevated concentrations of TPH-GRO, toluene, and ethylbenzene were present. Analytical results from tank pit as indicated elevated levels of TPH-DRO were present. The samples were analyzed for VOCs, including BTEX. The results are presented in Table 1.1.

1.2.8 Building 9002, Tank 116

Tank 116, a 250 gallon diesel tank installed in 1952, was located approximately 7 to 10 feet south of Building 9002 (Figure 1.19). On September 26, 1996, an excavation measuring 10 feet $\times$ 10 feet was extended to the base of the tank and the tank was removed. The tank closure report indicated that approximately 51.6 tons of contaminated soil were removed. During the excavation, grab soil samples were collected from the surrounding soil for headspace analysis using an FID. The results are presented on Table 1.1. One soil sample was collected from 12 feet bgs from the center of the tank pit and analyzed for TPH-DRO and VOCs, including BTEX. In addition, a groundwater sample was collected when groundwater invaded the tank pit and was analyzed for VOCs, including BTEX. The analytical results, presented in Table 1.1, indicated elevated concentrations of benzene, toluene, and ethylbenzene were present in the groundwater.

1.2.9 Building 7002, Tank 117

Tank 117, a vertically oriented 250 gallon waste oil tank, was installed in January 1963 and located approximately 50 to 55 feet east of Building 7002 (Figure 1.20). The tank top protruded above ground surface and had a removable lid. The tank was closed in place on September 30, 1996 by filling the empty tank to the top with cement grout. One soil sample was collected at a depth of 5 feet bgs from alongside the closed tank and analyzed for TPH and VOCs, including BTEX. The results indicated elevated concentrations of TPH and benzene were present in the soil.

1.2.10 Building 1327, Tanks 21 and 22

Tank 21, an 8,000 gallon tank, installed in February 1985, was used to store diesel fuel. The tank was located approximately 50 feet west of Building 1327. Tank 22, a 2,000 gallon gasoline tank installed in February 1986, was located approximately 40 feet west of Building 1327 (Figure 1.21). The tanks were removed from a communal excavation that was 35 feet $\times$ 35 feet on September 12, 1996. The closure report indicted that approximately 235 tons of contaminated soil were removed. During excavation, grab samples of the surrounding soil were collected for headspace analysis using an FID. The results are presented in Table 1.1. Two soil samples were collected from the sides of the excavation and analyzed for TPH-DRO/GRO and VOCs, including BTEX. A groundwater sample was collected when groundwater invaded the tank pit and analyzed for VOCs, including BTEX. The

analytical results indicated elevated concentrations of both TPH-DRO and GRO in the soil and toluene and xylene in the groundwater.

1.2.11 Building 725, Tank Number Not Assigned

An unnumbered 1,000 gallon tank used to store heating oil, was located approximately 27 to 30 feet west of Building 725 (Figure 1.22). On October 30, 1996, an excavation approximately 8 feet $\times$ 13 feet was extended to the base of the tank and the tank was removed. During excavation grab samples of the surrounding soil were collected for head space analysis with an FID. The results are presented in Table 1.1. After the tank had been removed, two soil samples were collected from the center of the tank pit at approximately 7 and 11 feet bgs. The top of the water table was noted as being encountered at 11 feet bgs; however, a water sample was not collected. The soil samples were analyzed for TPH-DRO and VOCs, including BTEX. The results indicated that elevated levels of TPH-DRO were present in the soil.

1.2.12 Building 850, Two Tanks, Numbers Not Assigned

Two unnumbered 20,000 gallon heating oil tanks were located approximately 28 to 55 feet north of Building 850 (Figure 1.23). On October 31, 1996, the two tanks were removed from a single excavation with the dimensions of 34 feet $\times$ 40 feet. The tank closure report indicated that approximately 125 tons of contaminated soil were removed. During excavation activities, grab soil samples were collected for headspace analysis with an FID. The results are presented in Table 1.1. After the tanks were removed, a total of four soil samples were collected from the bottom of the tank pit and analyzed for TPH-DRO and VOCs, including BTEX. The results indicated elevated concentrations of TPH were present in the soil.

1.2.13 Building 8582, Tank Number Not Assigned

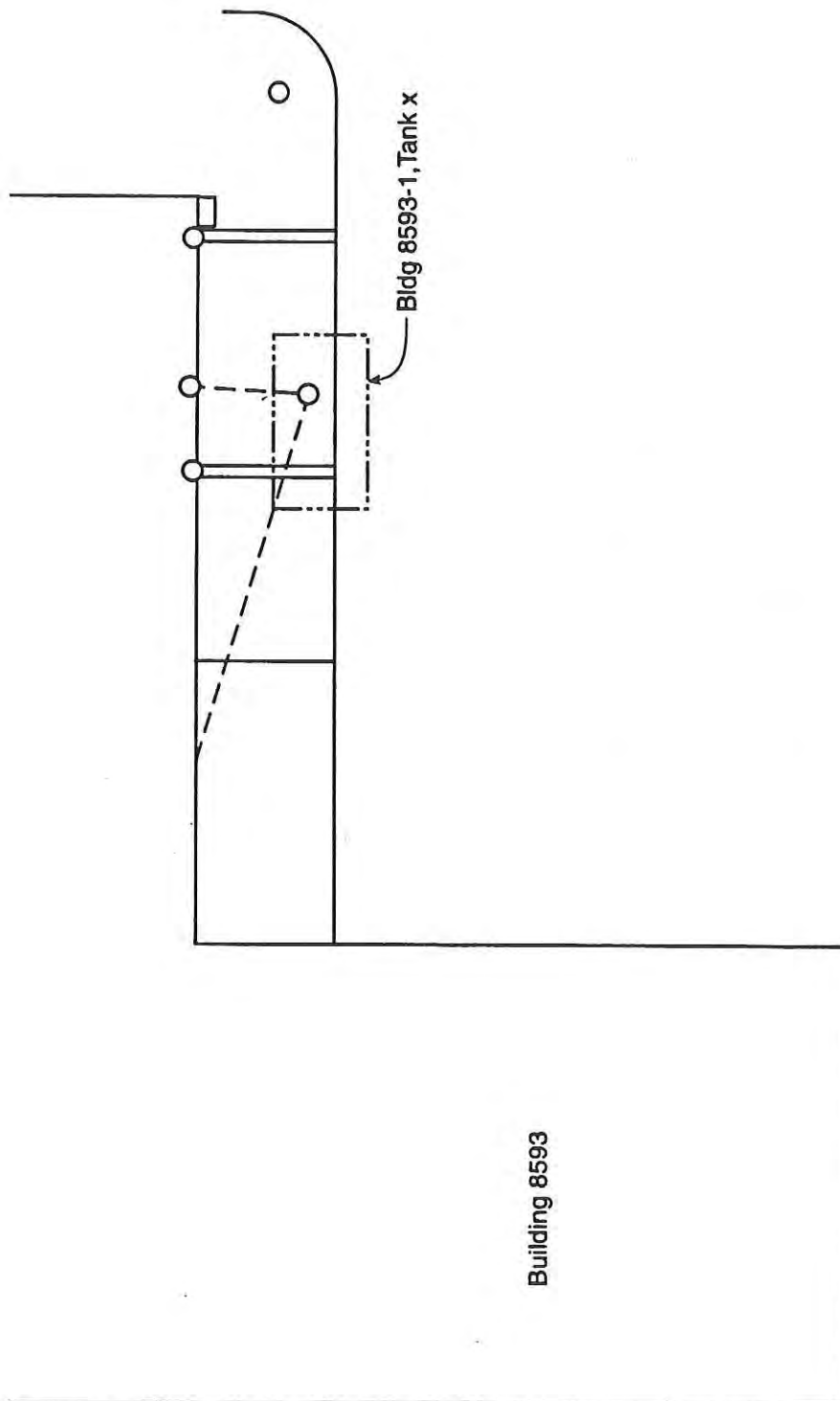
Complete information regarding this site is not available. However, available information indicates that this tank was located at the 117th Air National Guard Facility within HAAF (Figure 1.24). During tank closure activities, soil samples were collected from the bottom of the tank pit and analyzed for TPH and BTEX. Analytical results indicated elevated concentrations of TPH in the soil.

1.2.14 Building 8593-1, Tank Number Not Assigned

Complete information regarding this site is not available. However, available information indicates that this tank was located at the 117th Air National Guard Facility within HAAF (Figure 1.25). During tank closure activities, soil samples were collected from the bottom of the tank pit and analyzed for TPH and BTEX. Analytical results indicated elevated concentrations of TPH in the soil.

1.2.15 Building 8570-2, Tank Number Not Assigned

Complete information regarding this site is not available. However, available information indicates that this tank was located at the 117th Air National Guard Facility within HAAF (Figure 1.26). During tank closure activities, soil samples were collected from the bottom of the tank pit and analyzed for TPH and BTEX. Analytical results indicated elevated concentrations of TPH in the soil.



Building 8593

Legend

Scale : 1" = 20'

All Locations Approximate

Source: Geosciences Inc.

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Building 8593-1, Tank X

Figure 1.25. Tank Closure Sampling Map - Building 5893-1, Tank Not Assigned, HAAF, Savannah, Georgia

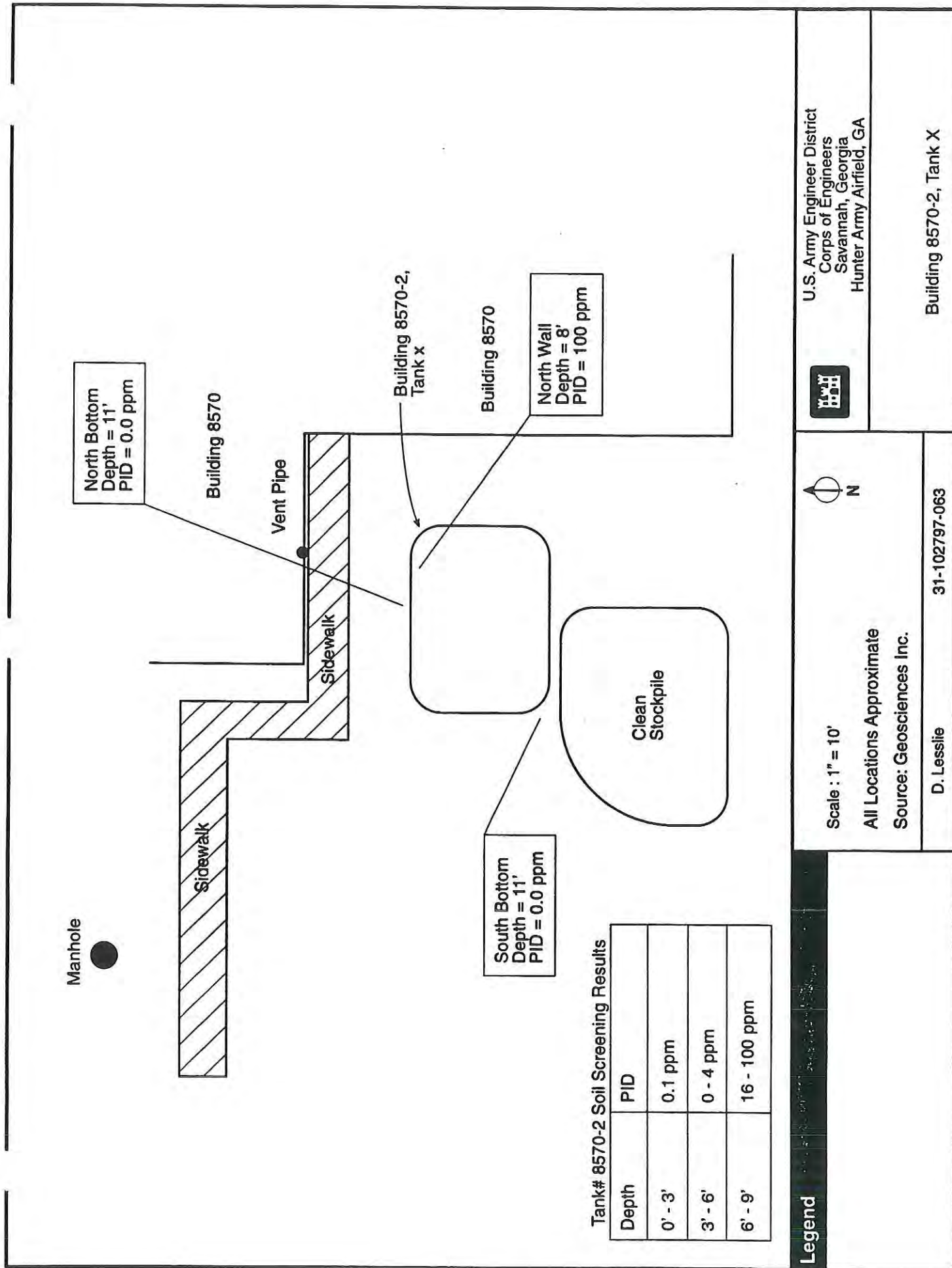


Figure 1.26. Tank Closure Sampling Map - Building 8570-2, Tank Not Assigned, HAAF, Savannah, Georgia

1.2.16 Building 8571, Tank Number Not Assigned

Complete information regarding this tank is not available. However, it is known that this unnumbered tank was located at the 117th Air National Guard Facility within HAAF. During tank closure activities, elevated levels of TPH greater than 15 ppm were detected in the soil (Figure 1.27).

1.3 SITE-SPECIFIC SAMPLING AND ANALYSIS CONSIDERATIONS

The HAAF is an active installation and all of the investigation sites are near operating buildings and/or facilities. The ground surface conditions at the investigation sites range from concrete or asphalt paved to grass-covered/bare soil/gravel surfaces. Three of the sites, Building 725; Building 8629, Tank 104; and Building 1346, Tank 108; present drill rig access problems due to overhead utility lines. In these cases, alternative sampling methods may be used to accomplish the project objectives. Where possible, proposed soil boring/piezometer locations have been chosen in the grass/soil/gravel areas to avoid paved surfaces.

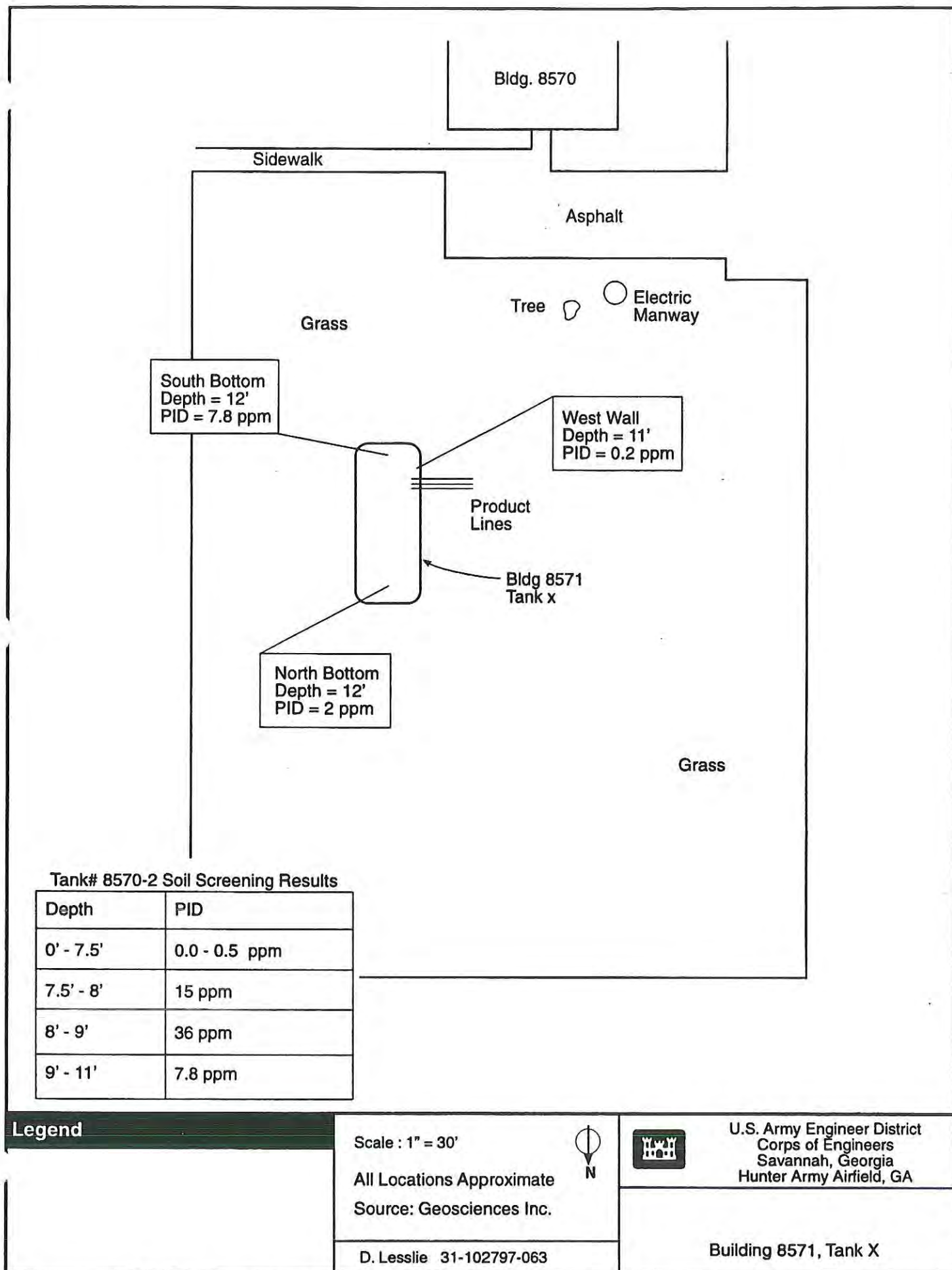


Figure 1.27. Tank Closure Sampling Map - Building 8571-X, HAAF, Savannah, Georgia

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This portion of the project FSP represents the Project Management Plan for project activities to be performed by SAIC at the former UST sites at HAAF. This plan designates the key SAIC and subcontractor personnel that will participate in the project and provides a summary of their responsibilities.

2.1 PROJECT ORGANIZATION

The organization chart illustrated in Figure 2.1 outlines the management structure that will be used to implement the project. The functional responsibilities of key personnel are described in the following parts of this plan. The assignment of personnel to each project position is based on a combination of (1) experience in the type of work to be performed, (2) experience working with government personnel and procedures, (3) a demonstrated commitment to high quality and timely job performance, and (4) staff availability. The key project personnel have been assigned based on the minimum education and qualification requirements for each assigned position, as shown in Table 2.1. In the event that personnel identified in Figure 2.1 and Table 2.1 must be replaced after issuance of these documents, SAIC will provide the names and resumes for the replacement individuals to the USACE — Savannah District Project Manager prior to mobilization for field work.

Identification of additional key personnel associated with the subcontracted laboratory activities for the project, and a summary of their responsibilities, is presented in Section 2.0 of the Quality Assurance Project Plan (QAPP). The subcontractors selected by SAIC to support the project, and the services to be performed by these companies, are as follows:

SAIC - Drilling Services:	Direct push (Geoprobe)
Concrete Coring Company:	Coring through concrete
General Engineering Laboratories, Inc.:	Chemical analytical testing for soil and groundwater
Cranston, Robertson, and Whitehurst:	Topographic and location surveys for boreholes and monitoring wells
Laidlaw Environmental Services, Inc.:	Transport and disposal of investigation-derived wastes

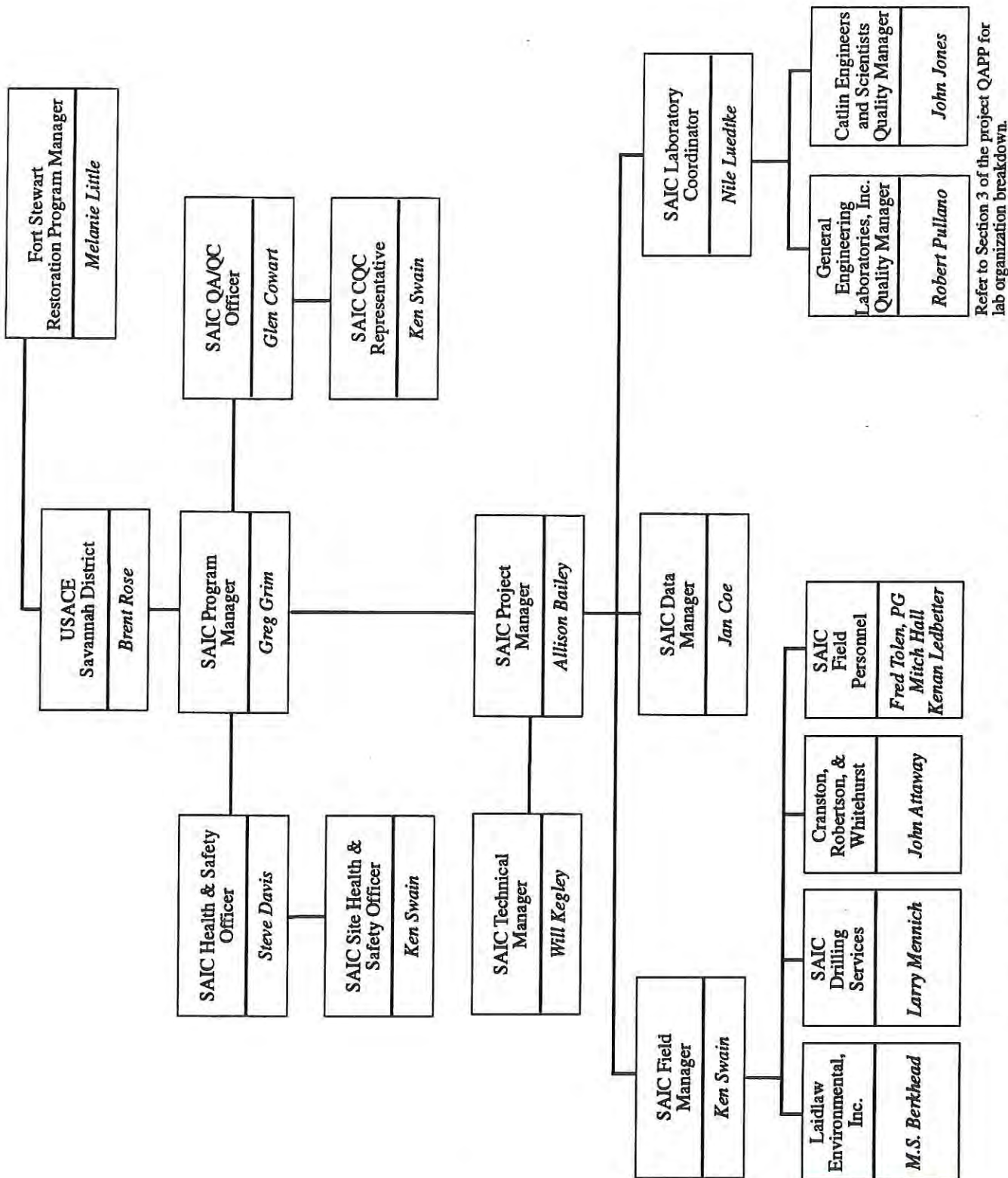


Figure 2-1. Organizational Chart for the Phase II RFI for SWMU 1 at Fort Stewart, Georgia.

Table 2.1. Key Field Personnel Assignments and Qualifications for the CAP-Part A Investigations for Former UST Sites at HAAF, Georgia

Project Assignment	Minimum Degree Requirements	Minimum Qualifications
<u>Project Manager</u> C. Allison Bailey	B.S. Civil Engineering, Geology, or related field	10+ years of experience in HTRW projects including site investigations and related environmental evaluations/studies.
<u>Technical Manager</u> William P. Kegley, P.G.	B.S. Civil Engineering, Geology, or related field	5+ years of experience in HTRW projects including management of field projects for site investigations, remedial investigations, and related environmental evaluations/studies.
<u>Site Safety and Health Officer</u> Ken Swain	B.S. in Safety, Engineering or related field	5+ years of experience in HTRW projects including providing health and safety oversight for site investigations, remedial investigations, and related environmental evaluations/studies.
<u>CQC Representative</u> Ken Swain	A.S. in Science or Engineering Technology or related field or equivalent field work experience	3+ years of experience in HTRW projects including site investigations, remedial investigations, and related environmental evaluations/studies.
<u>Field Manager</u> Ken Swain	B.S., Engineering, Geology, or related field	5+ years of experience in HTRW projects including management of field projects for site investigations, remedial investigations, and related environmental evaluations/studies.
<u>Laboratory Coordinator</u> Nile Luedtke	B.S. Chemistry	7+ years of experience in HTRW projects including laboratory interface for site investigations, remedial investigations, and related environmental evaluations/studies.
<u>Site Geologists</u> Fred Tolen, P.G. John B. Reeves, P.E.	B.S. Civil Engineering, Geology, or related field	3+ years of experience in HTRW projects including soil and rock logging, and monitoring well installation.
<u>Sampling Technicians</u> Mitch Hall Kenan Ledbetter	A.S. in Science or Engineering Technology or related field or equivalent field work experience	3+ years of experience HTRW projects including soil and groundwater sampling, and monitoring well installation.

HTRW = Hazardous, Toxic, and Radioactive Waste

2.2 KEY PERSONNEL RESPONSIBILITIES

2.1.1 SAIC Program Manager

The SAIC Program Manager manages the overall performance and quality of projects under USACE - Savannah District general contract DACA21-95-D-0022. This individual will oversee the SAIC Project Manager in meeting project goals and objectives in a high-quality and timely manner. Quality assurance issues will be addressed by this individual, in coordination with the SAIC Project Manager and Quality Assurance/Quality Control (QA/QC) Officer, including identification of nonconformances and verification of corrective action.

2.2.2 SAIC Project Manager

The SAIC Project Manager has responsibility for oversight of all project activities, including work plan development, field activities, data management, and report preparation. This individual will also provide the overall financial management of the project, and serve as the point of contact with the USACE-Savannah District Project Manager (Mr. Brent Rose) and USACE-Savannah District Technical Manager (Mr. Wes Smith). The SAIC Project Manager will also develop, monitor, and fill project staffing needs, delegate specific responsibilities to project team members, and coordinate with administrative staff to maintain a coordinated and timely flow of project activities. The SAIC Project Manager reports directly to the SAIC Program Manager.

2.2.3 SAIC Technical Manager

The SAIC Technical Manager is a Professional Geologist registered in the state of Georgia and will be responsible for the technical aspects of the project. The SAIC Technical Manager has responsibility for overall technical quality of project deliverables, in coordination with the SAIC Project Manager. The SAIC Technical Manager reports directly to the SAIC Project Manager.

2.2.4 SAIC Health and Safety Officer

The SAIC Health and Safety Officer is responsible for confirming that health and safety procedures designed to protect personnel are maintained throughout the field activities conducted for the project. This will be accomplished by strict adherence to the project SSHP, which is presented in Volume II of the project SAP. This individual, in coordination with the SAIC Site Safety and Health Officer (SSHO), will have the authority to halt field work if health and/or safety issues arise that are not immediately resolvable in accordance with the project SSHP. The SAIC Health and Safety Manager and SSHO report directly to the SAIC Program Manager, but will inform the SAIC Project Manager of all information and decisions reported.

2.2.5 SAIC Quality Assurance/Quality Control Officer

The SAIC QA/QC Officer is responsible for the project QA/QC in accordance with the requirements of the project QAPP, other work plan documentation, and appropriate management guidance. This individual, in coordination with the SAIC Chemical Quality Control (CQC) Representative, will be responsible for participating in the project field activity readiness review; approving variances during field activities before work continues; approving, evaluating, and documenting the disposition of Nonconformance Reports (NCRs); overseeing and approving any required project training; and designing audit/surveillance plans followed by supervision of these activities. The SAIC QA/QC

Officer and CQC Representative report directly to the SAIC Program Manager, but will inform the SAIC Project Manager of all information and decisions reported.

2.2.6 SAIC Laboratory Coordinator

The SAIC Laboratory Coordinator is responsible for coordination of sample collection, and subsequent chemical analysis and data reporting performed by the subcontract laboratories, in accordance with the requirements defined in the QAPP. This individual will also coordinate the shipment of QA samples to the USACE South Atlantic Savannah District Laboratory, which has been designated as the government QA laboratory for the project, and receipt of analytical results from this facility. This individual will be responsible for obtaining required sample containers from the laboratory for use during field sample collection, resolving questions the laboratory may have regarding QAPP requirements and deliverables, and coordination of reduction, validation, and documentation activities related to sample data package deliverables received from the laboratory. The SAIC Laboratory Coordinator reports directly to the SAIC Project Manager.

2.2.7 Subcontractor Laboratory Quality Manager

General Engineering Laboratories, Inc. will be subcontracted by SAIC to perform laboratory services regarding chemical analyses of soil and groundwater samples collected during the project. Similarly, Singleton Labs, Inc. will be subcontracted by SAIC to perform laboratory services regarding geotechnical testing of soil samples. The Subcontractor Laboratory Quality Manager is responsible for the laboratory QA/QC in accordance with the requirements of the QAPP. In coordination with the SAIC Laboratory Coordinator, this individual will be responsible for documenting that samples received by the laboratory are analyzed in accordance with required and approved methodologies, that instrument calibration is performed properly and documented, that field and internal laboratory QC samples are analyzed and documented, and that all analytical results for both field and QC samples are reported to SAIC in the format required in the laboratory scope of work and/or QAPP. This individual is also responsible for processing laboratory NCRs in a timely manner and for implementing Corrective Action Report recommendations and/or requirements. The Subcontractor Laboratory Quality Manager reports directly to the SAIC Laboratory Coordinator.

2.2.8 SAIC Data Manager

The SAIC Data Manager, and data management personnel, will be responsible for managing the field and analytical data generated during the project. The data management team will be responsible for the accumulation, control, reduction, validation, documentation, and storage of project data in accordance with the Data Management Plan presented in Appendix B of the project QAPP. The SAIC Data Manager will also assist the SAIC QA/QC Officer in the review of laboratory procedures if required. The SAIC Data Manager reports directly to the SAIC Project Manager.

2.2.9 SAIC Field Manager

The SAIC Field Manager is responsible for implementing field activities conducted during the project in accordance with the project SAP. This individual is responsible for proper technical performance of drilling operations and field sampling activities, adherence to required sample custody and other related QA/QC field procedures, coordination of field personnel activities, management of investigation-derived wastes, field documentation, and preparation of Field Change Orders if required. The SAIC Field Manager reports directly to the SAIC Project Manager except with regard to

significant QA/QC matters that are reported directly to the SAIC QA/QC Officer, and significant health and safety matters that are reported directly to the SAIC SSHO.

2.2.10 SAIC Field Personnel

In addition to the SAIC Field Manager, other SAIC field personnel participating in the implementation of field activities for the project will include geologists and sampling technicians. These individuals, in coordination with field subcontractor personnel, will be responsible for performance of drilling operations, installation of monitoring wells, collection of soil and groundwater samples, and preparation of field logbooks and other required documentation. These individuals will perform all field activities in accordance with the project SAP and report directly to the SAIC Field Manager.

2.2.11 Subcontractor Field Personnel

Companies that will be subcontracted by SAIC to perform various field services during the project were previously identified at the beginning of this Project Management Plan. Subcontractor field personnel, under the supervision of the SAIC Field Manager, will be responsible for performing their specific scopes of work that have been incorporated into the project Work. These individuals will be required to review applicable sections of the project SAP and the SSHP prior to field mobilization. Subcontractor field personnel report directly to the SAIC Field Manager.

3.0 PROJECT SCOPE AND OBJECTIVES

3.1 SCOPE OF THE CAP-PART A UST INVESTIGATION

The scope of this project includes four main components: (1) development of a workplan describing the field investigations at the 16 separate sites at HAAF, (2) performance of the field investigations, (3) completion of No Further Action Required/site closure letters, and (4) completion of CAP-Part A Reports. All project reporting will be performed according to the requirements as defined in the USACE guidance EM-200-1-3 (September 1, 1994). The specific scope for the CAP-Part A UST Investigation includes the following:

- describe the rationale for sampling and the data quality objectives;
- list the samples that need to be taken including media to be sampled, lists of analytes, sample locations, and sampling procedures;
- formulate a QAPP and list the specific QA/QC samples;
- specify how investigation-derived wastes (IDW) will be handled and disposed of;
- present a site-specific Health and Safety Plan; and
- present a schedule for completing the field investigation.

3.2 PROJECT OBJECTIVES

The objectives of the groundwater and CAP-Part A investigations for the former UST sites at the HAAF, Georgia are the following:

- determine the horizontal and vertical extent of contamination;
- determine whether contaminants present constitute a threat to human health or the environment; and
- determine the need for future actions and/or no further action.

In order to achieve these objectives, the data to be collected are to be of sufficient quality and quantity to be legally defensible under regulatory requirements.

3.3 DATA QUALITY OBJECTIVES

The Data Quality Objectives (DQOs) process is useful in identifying data gaps and developing a sampling and analysis plan that describes the procedures for collecting sufficient data of known and defensible quality. These data will assist the decision makers in arriving at appropriate and sound decisions concerning remedial action activities. The DQO process also assists in determining appropriate detection limits, analytical methods, and sampling and handling procedures/requirements. The DQOs for the CAP-Part A investigations conducted at HAAF have

procedures/requirements. The DQOs for the CAP-Part A investigations conducted at HAAF have been developed in accordance with the Georgia Underground Storage Tank (GUST) guidance document *Underground Storage Tank Release: Corrective Action Plan (CAP) Part A* (GDNR 1995) and are presented following the seven-step process defined by the U.S. Environmental Protection Agency (EPA 1993) and are presented below.

3.3.1 Step 1 - Investigation Objectives

The technical objectives for the project are defined as follows:

1. Determine if BTEX, PAH, and/or TPH contamination exists in soil below and in the vicinity of former USTs at sites designated for CAP-Part A investigations. Also determine if BTEX and PAH constituents are present in detectable concentrations in groundwater at the site.
2. Determine the local groundwater and geologic characteristics at all investigation sites included within the project.

3.3.2 Step 2 - Identification of Decision Types

The primary decisions to be made during the course of the project include the following. All of these decisions are based on requirements defined by the Georgia Environmental Protection Division-Underground Storage Tank Management Program (GEPD-USTMP) for investigation:

1. Are BTEX, PAH, or TPH soil concentrations in excess of the chosen soil threshold limits? (Laboratory detection limits, Table A or Table B of the Georgia UST Management Regulations)
2. Are BTEX or PAH groundwater concentrations in excess of the chosen threshold limits? [Federal and state Drinking Water Maximum Concentration Levels (MCLs)]. Is free product present?
3. Determine if CAP-Part A investigations are required to be performed for any of the groundwater investigation sites.
4. Perform a site ranking to determine Environmental Sensitivity Score.
5. If YES to Decisions 1 or 2, prepare a Corrective Action Plan - Part B. If NO to Decisions 1 and 2, No Further Action Required.
6. Complete No Further Action Required/site closure letters for the eligible groundwater investigation sites.
7. Complete CAP-Part A Report.

3.3.3 Step 3 - Key Environmental Variables

Key environmental variables for the project address information needed to support the decision types are presented in the second DQO step. The following supporting data will be required for the project:

1. Information regarding the concentrations of BTEX, PAH, and TPH constituents present in soil between the ground surface and water table.
2. Information regarding the concentrations of BTEX and PAH constituents present in groundwater.
3. Information regarding the type(s) of soil material located between the ground surface and the water table, the depth of the water table below ground level, and the direction of groundwater flow within the saturated zone.

3.3.4 Step 4 - Temporal and Spatial Boundaries

According to guidance provided by the GEPD-USTMP regarding the assessment of contamination at USTs, investigations conducted in support of the assessment are conducted as "one time" events. Therefore, temporal boundaries are not applicable to the investigations to be conducted at the project sites.

The spatial boundaries for this project are defined as the maximum number of direct push and Hydropunch boreholes (both primary and reserve) defined in the scope of work developed by the USACE-Savannah District for the project.

3.3.5 Step 5 - Data Evaluation

Based on the output from the previous DQO steps, No Further Action Required/site closure letters must be prepared for the eligible groundwater investigation sites or CAP-Part A Reports must be prepared.

3.3.6 Step 6 - Data Quality Requirements

DQOs are based on the concept that different uses may require different data quality. The primary objective of the investigations to be conducted for the project is to determine if petroleum contamination is present in soil and groundwater at former UST sites. In support of this objective, both screening and definitive data will be utilized for assessment of each tank site.

3.3.7 Step 7 - Sampling Characterization Plan

The final step in the DQO process is to develop a sampling characterization plan that takes into account all elements of the process defined to this point. A detailed discussion of the field activities to be implemented during this project is presented in Section 4 of this FSP and details regarding methods and procedures to be utilized for implementation of the plan are defined in Sections 5 through 12. For data quality, the QAAP contains details of the number and types of proposed QA/QC samples.

4.0 FIELD ACTIVITIES

This section of the FSP discusses, in detail, the field activities to be accomplished at each of the 15 former UST sites being investigated at HAAF and describes, by media, the sampling rationale, the method of accomplishment, and proposed sampling locations.

4.1 GROUNDWATER

4.1.1 Rationale

At each of the 16 former UST sites, groundwater samples will be collected from direct push (Hydropunch-II or similar) sampling devices inserted directly into the saturated zone. At each site, direct push borings will be located in or immediately adjacent to each of the former tank pits and around the perimeter of the former tank site. In addition, temporary piezometers will be installed to determine the presence of free product, water table elevation, gradient, and flow. Collection of groundwater samples from direct push locations will be accomplished using nondedicated mini-bailers or peristaltic pumps. If warranted, monitoring wells may be installed as part of future investigations. If so, collection of samples from monitoring wells will be accomplished using low flow, nondedicated, bladder pumps no sooner than 14 days after completion of monitoring well development. The rationale for use of these collection methods includes the following:

Direct Push Technology

- The direct push (Hydropunch-II or similar) method will allow for the collection of in situ groundwater samples.
- The direct push method will allow for retrieval of representative samples from a discrete depth interval without drilling or construction of monitoring wells.

Piezometer

- Temporary piezometers will allow for detecting the presence of free product and determining the water table elevation, gradient, and flow direction without the cost of installing a permanent groundwater monitoring well.

Monitoring Wells

- Monitoring wells will not be installed as part of the CAP-Part A Investigations. However, they may be installed as part of future investigations to characterize groundwater quality in areas downgradient and/or upgradient of sites where no wells currently exist.
- Monitoring wells will allow for monitoring of the seasonal fluctuations in groundwater levels.

4.1.1.1 Direct Push Locations

Direct Push

There are 16 sites being investigated as part of this project and at each site, groundwater samples will be collected using direct push (Hydropunch-II or equivalent equipment) technology. A summary of the groundwater sampling activities and analytical requirements is provided on Table 4.1. The project scope requires that an initial groundwater investigation be conducted at six sites. At each of these sites, two direct push soil borings will be located in or immediately adjacent to each of the former tank pits. Soil samples will be collected continuously down to the water table. Two soil samples from each boring will be sent to an off-site laboratory and analyzed for BTEX, PAH, and TPH-GRO and DRO. Direct push samplers will then be pushed to a depth of at least 5 feet below the top of the water table, estimated to be approximately 10 feet BGS, at which point a groundwater sample will be collected and analyzed for BTEX and PAH compounds. In each of the direct push borings, a temporary piezometer will be installed and allowed to equilibrate for a minimum of 24 hours to detect the presence of free product and to determine the water table elevation, gradient, and flow direction for each site. The project scope assumes that two of these groundwater investigation sites will require further investigation under the CAP-Part A investigation, which will require two additional direct push borings/piezometers and one vertical profile boring per site.

CAP-Part A investigations will occur at 10 sites, which will require one direct push soil boring and one vertical profile boring to be located in or immediately adjacent to each of the former tank pits and three direct push borings to be located around the perimeter of the former tank site. At each of the direct push soil borings, soil samples will be collected continuously down to the water table with two samples from each boring sent to an off-site laboratory for BTEX, PAH, and TPH-GRO and DRO analysis. Direct push samplers will then be pushed to a depth of at least 5 feet below the top of the water table and a groundwater sample will be collected and analyzed for BTEX and PAH compounds. Temporary piezometers will then be installed in each boring. In addition, one vertical profile boring will be installed at each site to delineate the vertical extent of groundwater contamination. Direct push samplers will be pushed below the water table and discrete groundwater samples will be collected every 10 feet until the Hawthorn clay layer (confining unit) is encountered (anticipated to be approximately 50 feet BGS). Groundwater samples will be analyzed for the same parameters discussed previously.

The project scope allows for the option to install 10 reserve direct push soil borings and groundwater samples and install 10 reserve temporary piezometers to obtain additional data to assist in closing out a site.

For data quality, the QAAP contains details of the number and types of proposed QA/QC samples. In general, duplicate samples will be taken at a rate of 10 percent of the total number of samples, and trip blanks will be taken at a rate of one per cooler used to store portions of groundwater samples designated for volatile organic analysis. In addition, QA split samples will be collected for the USACE—Savannah District during performance of sampling activities at a rate of 10 percent.

The groundwater investigation activities to be conducted at each site along with the sampling locations are described below. The proposed sampling locations were chosen based on the field measurement data (FID/PID results) and analytical results presented in the ACE, Inc. site closure reports, guidance provided by the USACE, and the GUST. The proposed sampling locations are illustrated in figures presented in Appendix C.

Table 4.1. Summary of Groundwater Sampling Activities and Analytical Requirements for the CAP-Part A UST Site Investigations for Former UST Sites at HAAF, Georgia

Site Name	Soil Borings			Vertical Profile Borings		Groundwater Analysis	
	Soil Borings	Groundwater Samples Per Boring	Piezometers	Vertical Profile	Groundwater	VOC ¹	PAH ²
				Borings	Samples Per Boring		
Initial Groundwater Investigation Sites							
BLDG 1336, Tank 111	2	1	2	0	0	2	2
BLDG 1327, Tank 110	2	1	2	0	0	2	2
BLDG 8629, Tank 104	2	1	2	0	0	2	2
BLDG 1346, Tank 108	2	1	2	0	0	2	2
BLDG 8570-2, Tank X	2	1	2	0	0	2	2
BLDG 8571, Tank X	2	1	2	0	0	2	2
CAP-Part A Investigation Sites							
BLDG 8464, Tank 112	4	1	4	1	4	8	8
BLDG 1310, Tank 109	4	1	4	1	4	8	8
BLDG 8059, Tanks 27 & 28	5	1	5	2	4	13	13
BLDG 9002, Tank 116	4	1	4	1	4	8	8
BLDG 7002, Tank 117	4	1	4	1	4	8	8
BLDG 1327, Tanks 21 & 22	5	1	5	2	4	13	13
BLDG 725, Tank X	4	1	4	0	0	4	4
BLDG 850, Tanks A & B	4	1	4	0	0	4	4
BLDG 8582, Tank X	4	1	4	1	4	8	8
BLDG 8593-1,Tank X	4	1	4	1	4	8	8
GW Site	2	1	2	1	4	6	6
GW Site	2	1	2	1	4	6	6
Reserves							
To Be Determined	10	1	10	0	0	10	10
Total for GroundwaterInvestigation							
Subtotal (All Sites & Reserve)	68		68	12		116	116
QC Duplicates (10% of total) ³	0		0	0		12	12
QA Splits (10% of total) ⁴	0		0	0		12	12
QC Trip Blanks ⁵	0		0	0		7	0
QA Trip Blanks ⁵	0		0	0		7	0
Total Groundwater Activities	68		68	12		154	140

This Table is in conformance with EM 200-1-3.

¹VOC - Volatile Organic Compounds, SW-846, EPA 8020

²PAH - Polynuclear Aromatic Compounds, SW-846, EPA 8270

³QC - Quality Control

⁴QA - Quality Assurance

⁵Quality Control/Quality Assurance Trip Blanks - One trip blank with each cooler containing water samples for VOC analysis only

Building 1336, Tank 111 (GW investigation site)

- Install two direct push soil borings.
- Collect four soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.1).
- Collect two groundwater samples using direct push technology (Figure C.1).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct push borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

Building 1327, Tank 110 (GW investigation site)

- Install two direct push soil borings.
- Collect four soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.2).
- Collect two groundwater samples using direct push technology (Figure C.2).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct push borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

Building 8629, Tank 104 (GW investigation site)

- Install two direct push soil borings.
- Collect four soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.3).
- Collect two groundwater samples using direct push technology (Figure C.3).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.

- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct push borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

Building 1346, Tank 108 (GW investigation site)

- Install two direct push soil borings.
- Collect four soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.4).
- Collect two groundwater samples using direct push technology (Figure C.4).
- Analyze samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

Building 8464, Tank 112

- Install four direct push soil borings.
- Collect 8 soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.5).
- Collect four groundwater samples using direct push technology (Figure C.5).
- Install a vertical profile boring and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 1310, Tank 109

- Install four direct push soil borings.
- Collect 8 soil samples using direct push technology and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.6).
- Collect four groundwater samples using direct push technology (Figure C.6).
- Install one vertical profile boring and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 8059, Tanks 27 and 28

- Install 10 direct push soil borings.
- Collect 10 soil samples using direct push technology and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.7).
- Collect five groundwater samples using direct push technology (Figure C.7).
- Install two vertical profile borings and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 9002, Tank 112

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.8).
- Install a vertical profile boring and collect discrete groundwater samples every 10 feet.
- Collect four groundwater samples using direct push technology (Figure C.8).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.

- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 7002, Tank 117

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.9).
- Collect four groundwater samples using direct push technology (Figure C.9).
- Install a vertical profile boring and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 1327, Tanks 21 and 22

- Install five direct push soil borings.
- Collect 10 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.10).
- Collect four groundwater samples using direct push technology (Figure C.10).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 725, Tank X

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.11).
- Collect four groundwater samples using direct push technology (Figure C.11).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).

- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 850, Tanks A & B

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.12).
- Collect four groundwater samples using direct push technology (Figure C.12).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install a temporary piezometer in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 8582, No Assigned Tank No.

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.13).
- Collect four groundwater samples using direct push technology (Figure C.13).
- Install a vertical profile boring and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install temporary piezometers in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 8593-1, No Assigned Tank No.

- Install four direct push soil borings.
- Collect 8 direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.14).
- Collect four groundwater samples using direct push technology (Figure C.14).

- Install a vertical profile boring and collect discrete groundwater samples every 10 feet.
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install temporary piezometers in each of the direct push boreholes.
- Reserve groundwater samples may be collected, if necessary, to obtain additional data to assist in closing out the site.

Building 8570-2, No Assigned Tank No. (GW investigation site)

- Install two direct push soil borings.
- Collect four direct push soil samples and analyze for BTEX, PAH, and TPH-GRO/DRO (Figure C.15).
- Collect two groundwater samples using direct push technology (Figure C.15).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install temporary piezometers in each of the direct push boreholes.
- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct push borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

Building 8571, No Assigned Tank No. (GW investigation site)

- Install two direct push soil borings.
- Collect four soil samples using direct push technology and analyze samples for BTEX, PAH, and TPH-GRO/DRO (Figure C.16).
- Collect two groundwater samples using direct push technology (Figure C.16).
- Analyze groundwater samples for BTEX and PAH (Table 4.1).
- Install temporary piezometers in each direct push borehole.
- If the groundwater is found not to be contaminated, the site will be closed.
- If the groundwater is found to be contaminated, the site will require further investigation and two additional direct push borings and one vertical profile boring will be installed. Piezometers will also be installed in each of the direct push borings.

4.1.1.2 Sample Collection and Field/Laboratory Analysis

A summary of the number of groundwater samples and analytical parameters to be collected is presented in Table 4.1. Information regarding the analytical testing methods for these groundwater samples is presented in the QAPP.

At those locations where a direct push (Hydropunch-II or similar), sampling device is used for groundwater collection, the sampler will be pushed into the top of the saturated zone and opened, allowing for the infiltration of groundwater. A mini-bailer or peristaltic pump will then be used to collect volumes of groundwater samples required for field analysis of pH, specific conductance, oxidation reduction potential, turbidity and temperature and for placement into laboratory containers for submittal to an off-site laboratory analysis.

In the event that the full volume of a groundwater sample required for both field parameter and chemical analyses cannot be collected within approximately 1 hour because of slow recharge into the direct push device, the entire volume of the sample will be used for chemical analysis, and measurement of field parameters will not be conducted.

If future investigations are warranted, groundwater collection may be accomplished from a monitoring well, where purging and sampling will be performed with a low flow nondedicated bladder pump or equivalent samplers. Field measurements of pH, specific conductance, dissolved oxygen, oxidation reduction potential (ORP), temperature, and turbidity will be conducted during purging and sampling.

In cases where groundwater recharge to the monitoring well is rapid, groundwater samples will be collected immediately after completion of purging. However, in cases where recharge is slow, groundwater samples will be collected as soon as sufficient groundwater is present in the well. If the volume of groundwater sample collected from slow recharge wells is not sufficient to perform both field parameter and chemical analyses, the entire volume of the sample will be used for chemical analysis, and measurement of field parameters will not be conducted.

4.1.1.3 Upgradient, QA/QC, and Blank Samples and Frequency

Three different types of QC samples will be collected during performance of groundwater sampling activities. These sample types will be duplicates, rinsate blanks, and trip blanks.

QC Duplicate Samples

During the sampling of groundwater from direct push technology or monitoring wells, QC duplicates will be collected along with groundwater samples. The direct push/monitoring well locations selected for duplicate sampling will be random. The exact number of duplicate samples will depend on the total number of groundwater samples collected for the project. However, the total number will be at least 10 percent of the entire sample population. The QC duplicates will be analyzed for the same groundwater analytes listed in Table 4.1.

QC Rinsate Blank Samples

During the decontamination of sampling equipment used for groundwater purging and collection, QC rinsate blanks will be collected from the bladder pumps and/or Teflon bailers used to collect groundwater samples from groundwater monitoring wells. As specified in the scope of work

developed by the USACE-Savannah District for the project, QC rinsate blanks will not be collected on the mini-bailers used with the collection of groundwater samples from the direct push sampling device. The total number of rinsate blanks to be collected from the monitoring wells will represent approximately 5 percent of the entire sample population. These samples will be collected on a regular basis throughout implementation of investigation activities. The QC rinsate blanks will be analyzed for the same groundwater analytes listed in Table 4.1.

QA Split Samples

In addition to the field QC samples described above, QA split samples will be collected for the USACE-Savannah District during performance of groundwater sampling activities. QA split samples will be collected along with groundwater samples from both direct push and monitoring well locations. The locations selected for QA split sampling will be random. The exact number of split samples will depend on the total number of groundwater samples collected for the project. However, the total number will be at least 10 percent of the entire sample population. At a minimum, at least one QA split will be collected where groundwater samples are collected from monitoring wells. The QA splits will be analyzed for the same groundwater analytes listed in Table 4.1.

QC Trip Blank Samples

QC trip blanks consisting of sealed containers of American Society of Testing and Materials (ASTM) Type II or equivalent water will be used for the project. One trip blank will be placed into each cooler used to store portions of groundwater samples designated for volatile organic analysis at the off-site laboratory. These blanks will remain with the other sample containers until groundwater sampling is completed, and the samples are shipped to the off-site laboratory for chemical analysis.

Table 4.2. Soil Parameters Associated with Borehole Logging

Soil Parameters
Classification
Depositional environment and formation, if known
ASTM D 2488 group symbol
Secondary components and estimated percentages
Color (using Munsell Soil or GSA Rock Color Chart). Give both narrative and numerical description and note which chart was used.
Plasticity
Consistency (cohesive soil)
Density (noncohesive soil)
Moisture content in relative terms
Structure and orientation
Grain angularity

Table 4.3. Summary of Field Instruments and Calibration/Performance Requirements for Groundwater Sampling

Instrument and Use	Calibration	Performance
QED Water Quality Monitoring System ^a -used for determination of water temperature	1 point comparison to mercury thermometer on a daily basis	+0.4 °C
QED Water Quality Monitoring System ^a - used for determination of water conductivity	1 point using 10 mmho standard solution on a daily basis	±3% of reading
QED Water Quality Monitoring System ^a - used for determination of water pH	2 point using pH 4.0 and 7.0 standard solutions on a daily basis	±0.1 units
QED Water Quality Monitoring System ^a - used for determination of water ORP	2 points using Eh standard solutions on a daily basis	±2%
QED Dissolved Oxygen Meter ^a - used for determination of water dissolved oxygen	1 point using calculated value for water at atmospheric temperature and pressure	±0.1 ppm
H.F. Scientific Turbidity Meter ^a - used for determination of water turbidity	2 points using standard solutions on daily basis	±0.02 NTUs
Foxboro TVA 1000 Vapor Analyzer ^a - used for determination of organic vapor concentrations	1 point using 100 ppm isobutylene and 100 ppm methane gas standard on a daily basis	±10% of reading

^a or equivalent instrument
ppm = parts per million

QA Trip Blank Samples

The QA trip blanks will be used for all split samples submitted for chemical analysis to the designated government laboratory in the same manner as described for QC trip blanks.

A summary of the QA/QC groundwater sample types to be collected during the project is presented in Table 4.1. Information regarding the analytical testing methods to be performed on project QA/QC groundwater samples is presented in the QAPP.

4.1.2 Direct Push, Piezometer, and Monitoring Well Installation

4.1.2.1 Direct Push and Piezometer Installation Methods and Equipment

Groundwater (Hydropunch-II or similar) samples will be collected through the use of direct push sampling techniques in both soil and vertical profile borings. Temporary piezometers will be installed in the soil borings to determine the presence of free product and the water table elevation, gradient, and flow direction. The direct push techniques will provide in situ groundwater samples/measurements without the generation of soil cuttings. Direct push groundwater sampling equipment will be mounted on a drill rig or off-road, all-terrain vehicle, if necessary.

cuttings. Direct push groundwater sampling equipment will be mounted on a drill rig or off-road, all-terrain vehicle, if necessary. Decontaminated sampling tubes will be used for soil sample collection and temporary piezometer installation. The sampling tubes will be hydraulically pushed to the water table, estimated to be between 10 to 20 feet. Disposable, thin-walled plastic (acetate), open-ended tubes, 1.5-inch diameter by 45 inches will be placed in the sampling tube to collect a soil sample. Soil samples will be collected continuously on 5.0 foot centers from ground surface to the water table at each site. For the installation of the temporary piezometers, the direct push sampling tube will be advanced to approximately 5 feet below the water table. The hole created by the direct push sampling will allow the installation of a 1-inch diameter temporary piezometer.

The temporary piezometers will be constructed of 1-inch outside diameter (OD) Schedule 40 polyvinyl chloride (PVC) slotted screen and solid riser. The screen will be 10 feet in length and commercially fabricated and slotted with openings equal to 0.010 inch. The screen will be installed to approximately 5 feet below the water table. No well completion (sand, bentonite, etc.) will be required for the temporary piezometers. Groundwater samples will be taken immediately upon installation of the piezometers, however, the piezometers will remain in place for up to 5 days to allow the piezometers to be surveyed for location and elevation. This will allow for an accurate measurement of groundwater flow direction. The groundwater sample will be retrieved using a mini bailer or peristaltic pump and pre-cleaned 1/4-inch inside diameter (ID) tubing. The temporary piezometers will be removed and the hole grouted to ground level after approximately 5 days.

4.1.2.2 Monitoring Well Installation Drilling Methods and Equipment

The hollow-stem auger drilling method may be used during the project for drilling soil boreholes. This method will be implemented as a dry drilling method for the project. The augers used for drilling of boreholes for soil sample collection, groundwater monitoring well installation, will have a 4.25-inch inside diameter and will create an approximate 9.5-inch boring. During all borehole drilling, soil samples will be collected continuously on 5.0-foot centers from the ground surface to the water table. For the installation of monitoring wells, if warranted for future investigations, boreholes will be drilled to allow 7.0 feet of screen to be placed beneath the water table.

Soil drilling using the hollow-stem auger method will be accomplished using truck-mounted CME-55 auger rigs, or equivalent, of sufficient size and power that will advance augers to the anticipated maximum drilling depth. The total depth of each borehole will be dictated by the depth where the water table is encountered. For the project, the average water table depth is anticipated to be approximately 10 to 20.0 feet below ground level. At selected locations, after the hollow-stem augers have been advanced to the water table at each borehole location, 2.0-inch PVC groundwater monitoring wells will be installed.

In the event that the borehole/monitoring well location is not accessible by vehicles, a portable hollow-stem auger rig, Mobile Drill Portable Minuteman, will be used. The augers used for drilling with this rig will have a 2.5-inch inside diameter and will create an approximate 6.5-inch borehole. During all boreholes drilled with this portable rig, soil samples will be collected continuously using 2.0-foot centers from the ground surface to the water table.

4.1.2.3 Materials

4.1.2.3.1 Well Casing and Screen

Well Casing

The well casing materials used for construction of monitoring wells will be composed of new, pre-cleaned, 2.0-inch Schedule 40 PVC. Casing sections will be flush threaded, and thermal or solvent welded couplings will not be used. Gaskets, pop rivets, and screws will also not be used during monitoring well construction.

All materials used for monitoring well construction will be as chemically inert as technically practical with respect to the site environment. All PVC well casing and fittings will conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage or Annual Book of ASTM Standards: Volume 08.04; F 480 and will bear the appropriate rating logo.

Well Screen

The well screen materials used for construction of monitoring wells will be composed of new, pre-cleaned, 2.0-inch Schedule 40 PVC. Screen sections will be commercially fabricated and slotted with openings equal to 0.008 to 0.020 (nominal 0.010) inches. The well screen slot size will be determined based on either rapid turnaround laboratory sieve analysis or a field sieve analysis of the screen interval at each site. Field sieve analysis procedures are given in the following text. Screen sections will be flush threaded, and thermal or solvent welded couplings will not be used. Gaskets, pop rivets, and screws will also not be used during monitoring well construction. Each screen section will measure 10.0 feet in length and a threaded PVC cap or plug will be placed on the bottom of each screen.

All materials used for monitoring well construction will be as chemically inert as technically practical with respect to the site environment. All PVC screens and fittings will conform to NSF Standard 14 for potable water usage or Annual Book of ASTM Standards: Volume 08.04; F 480 and will bear the appropriate rating logo.

Field Sieve Analysis

Field sieve analysis will be performed on soil material collected from the saturated zone at one of the borehole locations drilled at each. This analysis will be performed to determine the appropriate filter pack/screen slot size combination for each monitoring well to be installed during the project. ASTM Method D5092 states that the filter pack is usually selected to have a 30 percent finer (d_{30}) grain size that is about 4 to 10 times greater than the 30 percent finer (d_{30}) grain size of the hydrologic unit being filtered. Recommended filter pack characteristics for common screen slot sizes are also presented in this method. A Keck SS-94, or similar, mechanical sieve field analysis kit will be used.

Based on the guidance provided in ASTM Method D5092, the following procedure will be used for field sieve analysis and determination of the appropriate filter pack/screen slot size for the hydrologic units within which monitoring wells will be installed.

1. Select the soil sample from the depth of interest and dry it out using a field stove.
2. Weigh out approximately 50 grams of soil, or enough to fit in the field kit container.
3. Assemble the field kit using several different screen sizes. No. 8, 20, 40, 100, and 200 size screens will provide a representative plot, however, different sizes may be substituted.
4. Place the sample in the field sieve kit and shake the sample until the top container is empty.
5. Record the dry weight retained on each sieve and calculate the cumulative weight retained and the percent passing each sieve.
6. Plot the results of the sieve analysis on a grain size distribution chart and determine the size of the native soil at 30 percent finer (d_{30}).
7. If the stratum is fine and uniform, then multiply the native soil d_{30} by a number between 4 and 6. However, if the stratum is nonuniform and contains silt size particles, then multiply the native soil d_{30} by a number between 6 and 10. This value will be the desired d_{30} size of the filter pack.
8. Using grain size distribution plots supplied by the filter pack manufacturer, select the filter pack size that has a d_{30} size close to the value calculated in step 7.
9. Based on the size of filter sand selected in step 8, select the appropriate screen size that would be used with corresponding sand size.

4.1.2.3.2 Filter Pack, Bentonite, Grout

Filter Pack

Granular filter pack material used for monitoring well installation will be approved by the USACE-Savannah District before commencement of field activities (Figure 4.1). A 1-pint representative sample of the granular filter pack material proposed for use will be submitted to the USACE-Savannah District Project Manager for approval, if requested. Based on the screen slot size of 0.010 inch to be used for monitoring well construction and the native sandy to clayey sand soil, the granular filter pack material used will generally be Global Supply No. 7 (size equals 0.0188 inch) sand, or equivalent.

The granular filter pack material will be visually clean (as seen through a 10-power hand lens), free of material that would pass through a No. 200 sieve, inert, siliceous, and composed of rounded grains. The filter material will be packaged in bags or buckets by the supplier and delivered intact to the site.

Bentonite Seal

Bentonite will be used for one or more of the following purposes:

- creation of an annular seal during monitoring well construction between the granular filter pack and grout seal,

GRANULAR FILTER PACK APPROVAL		
Project for intended use:		
1.	Filter Material Brand Name:	
2.	Lithology:	
3.	Grain Size Distribution:	
4.	Source:	
	Company that made product:	
	Location of pit/quarry origin:	
5.	Processing method:	
6.	Slot Size of Intended Screen:	
SUBMITTED BY:		
	Company:	
	Person:	
	Telephone Number:	
	Date	
FOA APPROVAL (A)/DISAPPROVAL (D)		(check one)
	Project Officer/Date:	A D
	Project Geologist/Date:	A D

Figure 4.1. Granular Filter Pack Material Approval Form

- additive in grout mixture used for creation of grout seal during monitoring well construction, and/or
- additive in grout mixture used for abandonment of boreholes from using direct push technology.

Bentonite material used for monitoring well installation will be approved by the USACE-Savannah District before commencement of field activities (Figure 4.2). A 1-pint representative sample of each type of bentonite material proposed for use will be submitted to the USACE-Savannah District Project Manager for approval, if requested. Compressed powdered bentonite pellets, generally measuring 0.25 inch in size, will be used for annular seal applications. Powdered bentonite will be used for grout additive applications.

Grout Mixture

Grout used for monitoring well installation or borehole abandonment (if required) will be composed of Type I portland cement, 3 pounds of dry powdered bentonite per 94-pound sack of dry cement, and a maximum of 7 gallons of approved water per sack of cement, approximate grout weight 12.0 to 15.0 pounds per gallon (ppg). All grout materials will be combined in an above ground rigid container or mixer and mechanically blended on site to produce a thick, lump-free mixture throughout the mixing vessel. The grout will be placed using a tremie pipe of rigid construction for vertical control of grout placement. The tremie pipe will be equipped with side discharge holes rather than an open end to help maintain the integrity of the underlying material onto which the grout is placed.

4.1.2.3.3 Surface Completion

Well Caps

The well caps used for construction of monitoring wells will be composed of new, precleaned PVC. The tops of all monitoring well casings will be covered with slip-joint type well caps. The caps will be fitted to the casings and will be designed to preclude binding to the casing resulting from tightness of fit, unclean surface, or frost, and to allow for equilibration between hydrostatic and atmospheric pressures (vented). The caps will also be designed to fit securely enough to preclude debris and insects from entering the monitoring well.

Well Protection Assembly

Only one type of monitoring well surface completion may be used for the 15 former UST sites being investigated. Flush mount surface completions will be installed for monitoring wells located within known vehicle traffic areas (Figure 4.3).

The protective casing used for construction of all monitoring wells will be composed of new iron/steel. Protective casings associated with flush mount surface completions will be equipped with bolt down covers. Locking well caps will be installed on flush mount well casings. A minimum of two sets of keys will be provided to HAAF Directorate of Public Works (DPW).

The diameter of all protective casings will be 6.0 inches. The length of protective casing used for flush mount surface completions will be 4.0 feet, all of which will extend below the ground surface.

BENTONITE APPROVAL

Project for intended use:

1. Bentonite Material Brand Name:

Annular seal:

Grout additive:

2. Manufacturer:

Annular seal:

Grout additive:

3. Manufacturer's Address and Telephone Number(s):

Annular seal:

Grout additive:

4. Project Description:

Annular seal:

Grout additive:

5. Intended Use of Product:

Annular seal:

Grout additive:

6. Potential Effects on Subsequent Analyses:

Annular seal:

Grout additive:

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date

FOA APPROVAL (A)/DISAPPROVAL (D)

(check one)

Project Officer/Date:

A D

Project Geologist/Date:

A D

Figure 4.2. Bentonite Material Approval Form

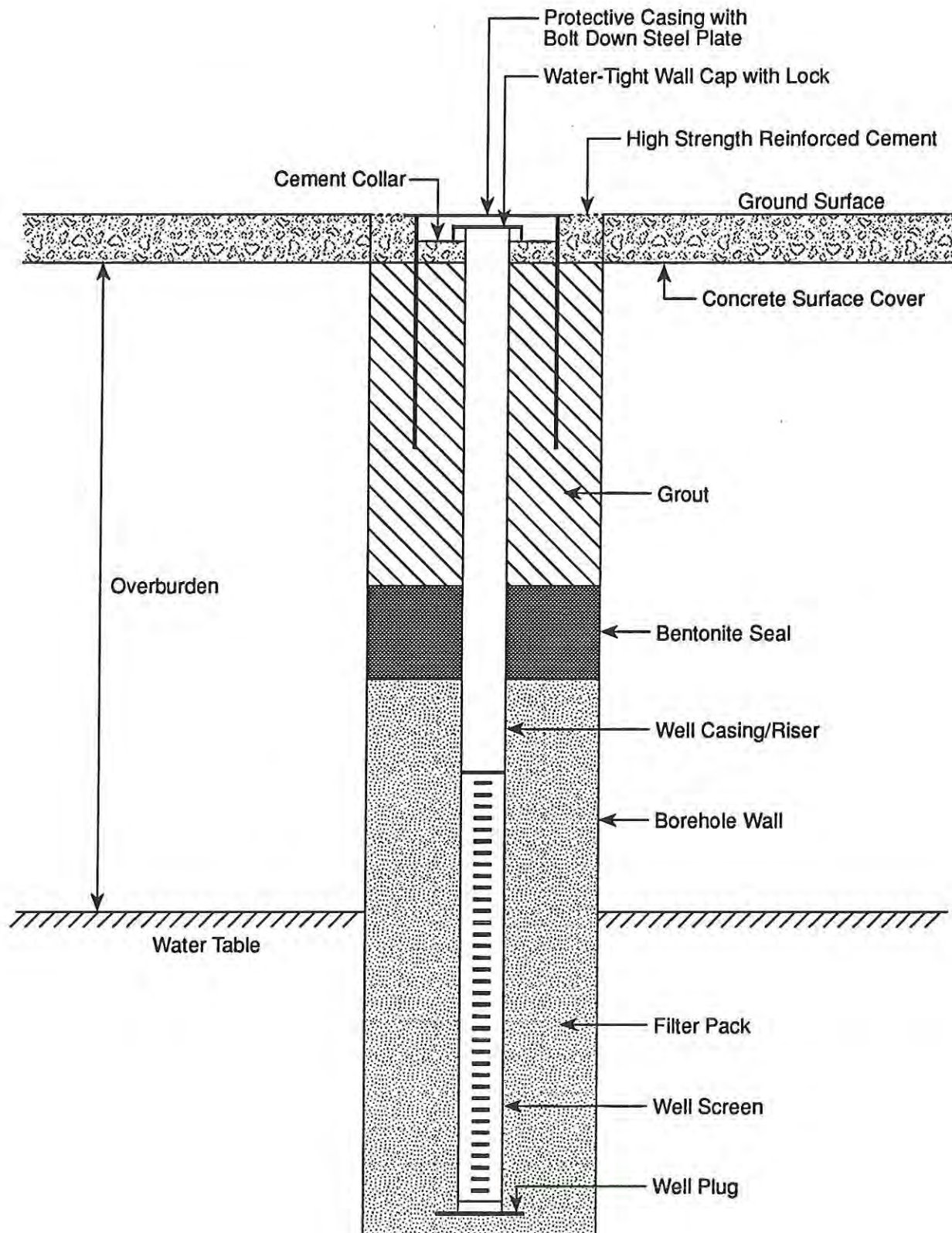


Figure 4.3. Flush Mount Surface Monitoring Well Completion

25-052296-014 B

4.1.2.3.4 Water Source

Water will be used for the following purposes:

- tremie granular filter pack or bentonite, if necessary;
- preparation of grout mixture used for monitoring well installation or borehole abandonment;
- preparation of cement mixture used for construction of monitoring well surface completions;
- hydration of bentonite seals and/or columns as necessary; and
- decontamination of drilling and sampling equipment.

The water source used for the project will be identified by the HAAF DPW and will be free of contaminants. The water source used for the project will also comply with other requirements defined in Section 3-9, Subsection b, Item #1a through #1f of USACE Procedure EM 1110-1-4000 (August 31, 1994) and will be approved by the USACE-Savannah District Project Manager before use. Field personnel will be responsible for transport and storage of the approved water required for investigation needs in a manner to avoid the chemical contamination or degradation of the approved water once obtained.

4.1.2.3.5 Delivery, Storage, and Handling of Materials

All monitoring well construction materials will be supplied and delivered by the subcontracted drilling company. Upon delivery to the site, the SAIC Field Manager will inspect all of the materials to ensure that the required types of materials have been delivered and that the materials have not been damaged or contaminated during transport to the site. During this inspection, the SAIC Field Manager will collect and file any material certification documentation attached to or accompanying the materials. All material certification documentation will be maintained on site until completion of the project, at which time the documentation will be transferred to the project file. All materials will be stored in a dry and secure location until used for monitoring well construction.

All well screens and well casings used for monitoring well construction will be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and will be washed with approved water before use. However, if the materials have been packaged by the manufacturer and have their packaging intact up to the time of installation, no prewashing will be conducted. Pipe nomenclature stamped or stenciled directly on well screens and/or solid casing to be located within and below the bentonite seal will be removed by sanding, unless removable by approved water washing. Washed screens and casing will be stored in plastic sheeting until immediately before insertion into the borehole. All well screens and casings used for construction will be free of unsecured couplings, ruptures, and other physical breakage and/or defects.

All protective casing materials will be cleaned before placement, free of extraneous openings, and devoid of any asphaltic, bituminous, encrusting, and/or coating materials (with the exception of black paint or primer applied by the manufacturer). Washed protective casing materials will be stored in plastic sheeting until immediately before placement around monitoring well casings.

4.1.2.4 Installation

As noted previously, only one type of monitoring well surface completion will be required for the project: flush mount surface completions. Figure 4.3 conceptually illustrates the proposed construction for this type of well. A discussion of the monitoring well installation process for the project is presented below.

4.1.2.4.1 Test Holes

Test holes will not be drilled as part of this project.

4.1.2.4.2 Soil Sampling and Rock Coring During Drilling

Soil sampling during drilling for the installation of monitoring wells will be performed using 5.0-foot split-barrel sampler continuously from the ground surface down to the water table. Soil sampling using direct push technologies will be performed using 2.0-foot samplers continuously from the ground surface to the water table. Soil collected from these methods will be used for field measurements and off-site chemical analysis. Soil samples for geotechnical analysis will be collected during drilling using a thin-walled sampler.

No rock coring during drilling will be performed during this project.

4.1.2.4.3 Geophysical Logging

No geophysical logging will be performed as part of this project.

4.1.2.4.4 Borehole Diameter and Depth

Soil boreholes advanced for the purpose of monitoring well installation will be drilled using 4.25-inch inside diameter hollow-stem augers for truck-mounted CME-55 or equivalent drilling rig which will create an approximate 9.5-inch boring. In the event that the location is not accessible by vehicles, a portable Minute Man rig with 2.5-inch inside diameter hollow-stem augers, which will create an approximate 6.5-inch borehole, may be used. Each shallow borehole will be advanced to a depth of approximately 7.0 feet below the water table.

4.1.2.4.5 Screen and Well Casing Placement

All screens used for monitoring well construction will be installed such that the bottom of each well screen is placed no more than 2.0 feet above the bottom of the drilled borehole. The screen bottom will be securely fitted with a threaded PVC cap or plug. The cap/plug will be within 6.0 inches of the open portion of the screen. The length of each screen section to be used for monitoring well construction will be 10.0 feet. The top of each installed monitoring well casing will be level so that the difference in elevation between the highest and lowest points on the top of the well casing is less than or equal to 0.2 inches.

4.1.2.4.6 Filter Pack Placement

Granular filter pack material used for monitoring well construction will be placed within the annular space around the monitoring well screen using a tremie pipe. If approved water is used to place the filter pack, the amount of this water will be recorded and added to the volume of water to be removed during well development. The filter pack will extend from the bottom of the borehole to 2.0 feet above the top of the well screen. In addition, 6.0 inches of sand will be placed under the bottom of the well screen to provide a firm footing. The final depth to the top of the filter pack will be measured directly with a weighted tape and recorded on the associated well construction diagram.

4.1.2.4.7 Bentonite Seal

The type of bentonite material used for construction of monitoring well seals will be composed of commercially available pellets. Pellet seals will be at least 2.0 feet thick as measured immediately after placement, without allowance for swelling. A tremie pipe will not be used for placement of the pellets unless significant bridging occurs or is suspected to be a problem. Placement of the bentonite will include periodic tamping of the bentonite pellets to prevent bridging during emplacement. After placement of the bentonite pellets, a small volume of approved water will be used, if necessary, to hydrate the pellets, and the hydration time for the pellets will be a minimum of 1 hour. The final depth to the top of the bentonite seal will be measured directly with a weighted tape and recorded on the associated well construction diagram.

4.1.2.4.8 Cement/Bentonite Grout Placement

All prescribed portions of grout material used for monitoring well construction will be combined in an aboveground rigid container and mechanically blended to produce a thick, lump-free mixture throughout the mixing vessel. The grout will be placed using a rigid tremie pipe with side discharge, initially located just over the top of the bentonite seal.

Based on the anticipated method to be implemented for well construction, the hollow-stem augers will be incrementally removed during the grouting operation. After grouting has been completed to within approximately 10.0 feet of the ground surface, the remaining augers will be removed from the boring and the remaining annulus will be grouted from the surface.

Upon initiation of grouting operations, the process will be conducted continuously until the surface casing is installed or the well is grouted to the required levels. After 24 hours, the site will be checked for grout settlement and more grout will be added at that time to fill any depression. This process will be repeated until firm grout remains at or near the required depth. Incremental quantities of grout added in this manner will be recorded on the well construction diagram.

4.1.2.4.9 Protective Cover Placement

Protective iron/steel casing will be installed around each monitoring well the same day as initial grout placement within the well annulus. The protective casing for flush mount installations will be set flush with the surrounding ground surface. All protective casings will be installed so that the distance between the top of the protective casing and the top of the well casing is no more than 2.4 inches.

4.1.2.4.10 Well Identification

For each monitoring well installed, the well designation information will be engraved on a metal tag bearing the following information: contractor's name, registration number, well identification number, top of casing elevation [mean sea level (MSL)], total depth, and date installed. The tag will be permanently attached to the protective casing or well casing. In addition, all wells will be permanently labeled as MONITOR WELL - NOT FOR WATER SUPPLY. Also, a placard labeled with the monitoring well identification number will be attached to the protective casing in such a manner as to be readable from a road or trail.

Wells installed during the investigation will be numbered consecutively following the established numbering system of presently installed wells. Boreholes drilled for monitoring well installation that are subsequently abandoned will also be numbered consecutively.

4.1.2.4.11 Well Development

The development of monitoring wells installed during the project will be initiated no sooner than 48 hours after internal mortar collar placement or the final grouting of the wells.

Pump and Bailer Usage

Development of monitoring wells will be accomplished using a Teflon bailer in combination with a Grundfos pump. During development operations, the pump will be alternately started and stopped during groundwater removal, allowing the well to equilibrate and creating a surging action. The bailer will be used (as required) to agitate and mobilize particulates around the well screen by rapidly surging the bailer up and down within the screen section of the well. In situations where a high percentage of fine material is suspended in the groundwater, a surge block may also be used in coordination with the noted devices to mobilize particulates drawn into the granular filter pack.

Development Criteria

Development of each monitoring well will proceed until the following criteria are achieved:

- The well water is clear to the unaided eye.
- The sediment thickness remaining within the well is less than 0.1 foot.
- A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30 percent annular porosity) has been achieved.
- Turbidity does not exceed 10 nephelometric turbidity units (NTU).

In the event that the development criteria noted above cannot be achieved after six consecutive hours, development will be terminated. At that time, the USACE-Savannah District Project Manager will be contacted to discuss the situation and to formulate an approach that will allow the well to meet standards for required sample quality.

Development Water Sample

For each monitoring well developed, a 1-liter sample of the last water removed during development will be placed into a clear glass jar and labeled with the well number and date. Each sample will be individually agitated and immediately photographed close up with a 35-millimeter camera loaded with color print film, using a back-lit setup to show water clarity. These photographs, minimally 5 × 7 inches in size and individually identified with project name, well number, and photograph date, will be in the well development record provided to the USACE-Savannah District at project close out. The film negatives will also be provided to the USACE-Savannah District with the photograph prints. After the development water samples have been photographed, the samples will be disposed of in the same manner as the other water removed from the monitoring wells during the development operation.

Monitoring Well Washing

As part of each monitoring well development operation, the entire well cap and the interior of the well casing between the water table and the ground surface will be washed using water from the well. The purpose of this activity will be to remove extraneous materials (grout, bentonite, sand, etc.) from the interior of the well. The monitoring well washing activity will be conducted during the overall development operation.

4.1.2.4.12 Well Survey

Coordinates and elevations shall be established for each temporary piezometer and monitoring well. The coordinates shall be to the closest 1.0 foot and referenced to the State Plane Coordinate System. If the State Plane Coordinate System is not readily available, an existing local grid system shall be established. A permanent survey mark (control point) shall be scribed on the top of each monitor well riser casing. Ground elevations to the closest 0.1 foot, and an elevation on the top of each temporary piezometer and well riser casing to the closest 0.01 foot shall be determined. Elevations shall be referenced to the National Geodetic Vertical Datum of 1983.

4.1.2.4.13 Alignment Testing

Well alignment testing will not be conducted as part of this project.

4.1.2.4.14 In situ Permeability Testing

In situ permeability testing will not be conducted as part of this project.

4.1.2.5 Documentation

4.1.2.5.1 Logs and Well Installation Diagrams

Borehole Logs

Each borehole log generated during the project will fully describe the subsurface environment and the procedures used to gain that description. All boreholes will be recorded in the field by the site geologist on Engineer Forms 5056-R and 5056A-R (Figure 4.4). A scale of 1 inch equals 1.0 foot will be used during borehole log preparation. Each original borehole log will be submitted by SAIC to the USACE-Savannah District Project Manager. Original borehole logs will be of sufficient legibility and contrast so as to provide comparable quality in reproduction and will be recorded directly in the field without transcribing from a field book or other document.

All borehole logs generated during the project will routinely contain the following information:

- Unique borehole number and location denoted on a sketch map as part of the log.
- Depths or heights recorded in feet and decimal fractions thereof (tenths of feet).
- Field estimates of soil classification in accordance with the Annual Book of ASTM Standard, Volume 04.08, D2488 prepared in the field at the time of sampling by the site geologist.
- Full description of each soil sample collected, including the parameters noted in Table 4.2.

HTRW DRILLING LOG		DISTRICT		HOLE NUMBER	
1. COMPANY NAME		2. DRILL SUBCONTRACTOR		SHEET SHEETS OF	
3. PROJECT		4. LOCATION			
5. NAME OF DRILLER		6. MANUFACTURERS DESIGNATION OF DRILL			
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT		8. HOLE LOCATION			
		9. SURFACE ELEVATION			
		10. DATE STARTED		11. DATE COMPLETED	
12. OVERBURDEN THICKNESS		15. DEPTH GROUNDWATER ENCOUNTERED			
13. DEPTH DRILLED INTO ROCK		16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED			
14. TOTAL DEPTH OF HOLE		17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)			
18. GEOTECHNICAL SAMPLES		DISTURBED		UNDISTURBED	
19. TOTAL NUMBER OF CORE BOXES					
20. SAMPLES FOR CHEMICAL ANALYSIS		VOC		METALS	
		OTHER (SPECIFY)		OTHER (SPECIFY)	
		OTHER (SPECIFY)		OTHER (SPECIFY)	
21. TOTAL CORE RECOVERY %					
22. DISPOSITION OF HOLE		BACKFILLED		MONITORING WELL	
		OTHER (SPECIFY)			
23. SIGNATURE OF INSPECTOR					
LOCATION SKETCH/COMMENTS SCALE:					
PROJECT HOLE NO.					

ENG FORM 5056-R, AUG 94

(Proponent: CECW-EG)

Figure 4.4. Engineer Forms 5056-R and 5056A-R

HTRW DRILLING LOG						HOLE NUMBER
PROJECT			INSPECTOR			SHEET
ELEV. (A)	DEPTH (B)	DESCRIPTION OF MATERIALS (C)	FIELD SCREENING RESULTS (D)	GEOTECH SAMPLE OR CORE BOX NO. (E)	ANALYTICAL SAMPLE NO. (F)	REMARKS (G)

Figure 4.4. (continued)

- Visual numeric estimates of secondary soil constituents and quantitative definitions of description terms (i.e., trace, some, several, etc.) recorded on the log.
- Description of disturbed samples (if used to supplement subsurface description) in terms of the appropriate soil parameters, to the extent practical. At a minimum, classification along with a description of drill action for the corresponding depth will be recorded. Notations will be made on the log that these descriptions are based on observations of disturbed material rather than intact samples.
- Description of drilling equipment, including such information as auger size (inner and outer diameter), bit types, compressor type, rig manufacturer, and model.
- Sequence of drilling activities.
- Any special problems encountered during drilling and their resolution.
- Dates and times for the start and completion of the borehole along with notation by depth for drill crew shifts and individual days.
- Each sequential boundary between various soil types and individual lithologies.
- The depth of first-encountered free water along with the method of determination
- Interval by depth for each sample collected, including the length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).
- Total depth of drilling and sampling.
- Results of soil sample organic vapor headspace readings. Notation will include interval sampled, corresponding vapor readings, and key to the specific instrument used to obtain readings. A general note will be made on the log indicating the manufacturer, model, serial number, and calibration information for each instrument used.
- Definition of any special abbreviations used at the first occurrence of their usage.

Well Installation Diagrams

Each monitoring well installed during the project will be depicted in an as-built well construction diagram. Each diagram will be attached to the original borehole log for that installation and will graphically denote, by depth from the ground surface, the following information:

- location of the borehole bottom and borehole diameter(s);
- location of the well screen;
- location of any joints;
- location of the granular filter pack;
- location of the bentonite seal;
- location of grout;
- location of centralizers;
- height of riser (stickup), without cap/plug, above the ground surface;
- height of the protective casing, without cap/cover, above the ground surface;

- depth of protective casing base below the ground surface;
- location and size of drainage port;
- location of the internal mortar collar;
- sloped concrete pad height and diameter;
- protective post configuration; and
- water level 24 hours after completion of installation with date and time of measurement.

Additional information to be described on each as-built well construction diagram will include the following:

- actual quantity and composition of the grout, bentonite seal, and granular filter pack used for construction of the monitoring well;
- the screen slot size in inches, slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer;
- type of material located between the bottom of the borehole and the bottom of the screen;
- the outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing;
- the joint design and composition;
- the design and composition of centralizers;
- depth and description of any permanent pump or sampling device installed within the monitoring well;
- the composition and nominal inside diameter of protective casing;
- any special problems encountered during well construction and their resolution;
- dates and times for the start and completion of monitoring well installation; and
- definition of any special abbreviations used at the first occurrence of their usage.

4.1.2.5.2 Development Records

For each monitoring well developed during the project, a record will be prepared to include the following information:

- project name and location;
- well designation and location;
- date(s) and time(s) of monitoring well installation;
- date(s) and time(s) of monitoring well development;

- static water level from top of well casing before and 24 hours after completion of well development with dates and times of measurements;
- quantity of water lost during drilling, removed before well insertion, and added during granular filter placement;
- quantity of standing water contained with the well, and contained within the saturated annulus (assuming 30 percent porosity), before well development;
- field readings of pH, specific conductance, turbidity, and temperature measured before, twice during, and after completion of well development using appropriate devices and methods (see Section 4.1.5 of this plan for the field measurement parameters and procedures to be used for field measurements);
- depth from top of well casing to bottom of well;
- length of the well screen;
- depth from top of the well casing to the top of sediment inside the well, both before and after development, as measured directly at the time of development;
- physical character of the removed water, including changes during development in clarity, color, particulates, and any noted odor;
- type and size/capacity of the bailer or pump used for development;
- description of the surge technique used during development;
- height of the well casing above ground surface as measured directly at the time of development;
- estimated recharge rate at the time of development;
- quantity of water removed from the well during the development operation and the time for removal (presented as both incremental and total values); and
- photograph of the last water removed during monitoring well development (see Sections 4.1.2.3.12 and 4.1.2.4.4).

4.1.2.5.3 Geophysical Logs

Geophysical logging will not be performed under this project.

4.1.2.5.4 Photographs

For each photograph taken during the project, the following items will be noted in the field logbook:

- date and time,
- photographer (name and signature),
- site name,

- aspect and description of the subject taken, and
- film roll number and sequential number of the photograph.

Photographs taken to document sampling points will include two or more permanent reference points within the photograph to facilitate relocating the point at a later date. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required.

4.1.2.6 Well Abandonment

Abandonment of soil boreholes for the installation of monitoring wells and monitoring wells (if required) during the project will be conducted in a manner precluding any current or subsequent fluid media from entering or migrating within the subsurface environment along the axis or from the endpoint of the borehole or well. Abandonment will be accomplished by filling the entire volume of the borehole or well with grout composed of Type I portland cement, 3 pounds of dry powdered bentonite per 94-pound sack of dry cement, and a maximum of 7 gallons of approved water per sack of cement. In the event that abandonment of a completed monitoring well is required, all above grade and subsurface well materials will be removed prior to completion of abandonment.

Each borehole or well located in grass/gravel covered areas will be sealed by grouting from the bottom of the borehole or well to the ground surface. For boreholes or wells located in concrete covered areas, grout will be poured to the interface between the overlying concrete pad and underlying gravel/soil base. All grouting will be accomplished by placing a tremie pipe to the bottom of the borehole (i.e., to the maximum depth drilled) and pumping grout through this pipe until undiluted grout is present at the ground surface or the base of the surrounding concrete cover. After a 24-hour period, the abandoned site will be checked for grout settlement. At that time, any settlement depression will be filled with grout. Additional grout will be added using a tremie pipe inserted to the top of the firm grout, unless the depth of the unfilled portion of the well or borehole is less than 10 feet and this portion is dry. This process will be repeated until firm grout remains at the ground surface.

The USACE-Savannah District Project Manager will be contacted by telephone if closure of any borehole or well not scheduled for abandonment per this project is required. At that time, the Project Manager will be informed of the borehole or well in question, current status (depth, contents of hole, stratigraphy, water level, etc.), and the proposed reason for abandonment. Based on this information, the Project Manager will either approve the abandonment or will determine some other action to be taken.

For each abandoned borehole or well, a record will be prepared to include the following information:

- project and borehole or well designation;
- location with respect to the replacement borehole or well (if any);
- open depth of the borehole or well before grouting;
- casing or items left in borehole by depth, description, composition, and size (if applicable);
- copy of the borehole log;
- copy of construction diagram for the abandoned well (if applicable);
- reason for abandonment;
- description and total quantity of grout used initially;
- description and daily quantities of grout used to compensate for settlement;

- dates of grouting; and
- water or mud level prior to grouting and date measured.

All depths reported in the borehole or abandonment record will be designated in feet from ground surface. Any replacement boreholes or wells installed during the project will be offset at least 20.0 feet from any abandoned installation in a presumed upgradient or crossgradient groundwater direction.

4.1.2.7 Water Level Measurement

Water level measurements will be taken from both direct push borings and monitoring wells. At least one complete set of measurements will be made over a single, consecutive 10- to 12-hour period for all site-related wells, including newly installed and existing wells. For monitoring wells, these measurements will be taken at least 24 hours after development or sampling. These measurements will include a notation for the presence of any streams, lakes, and/or open water bodies (natural and man-made) within 300 feet of these wells.

Static groundwater level measurements will be made using an electronic water level indicator. Initially, the indicator probe will be lowered into each monitoring well or temporary direct push boring without touching the probe to the well/direct push casing until the alarm sounds and/or the indicator light illuminates. The probe will then be withdrawn several feet and slowly lowered again until the groundwater surface is contacted as noted by the alarm and/or indicator light. All probe cords used for measurement will be incrementally marked at 0.02-foot intervals. Water level measurements will be estimated to the nearest 0.01 foot based on the difference between the nearest probe cord mark to the top of the well/piezometer casing.

The distance between the top of casing and the groundwater surface will be recorded to within 0.01 foot. At temporary direct push installations, the distance between the top of casing and the surrounding ground surface will also be recorded to within 0.01 foot. The static water level measurement procedure will be repeated two or three times to ensure that the water level measurements are consistent (plus or minus 0.01 foot). If this is the case, then the first measured level will be recorded as the depth to groundwater. If this is not the case, the procedure will be repeated until consistent readings are obtained from three consecutive measurements.

4.1.3 Determine Free Product Presence and Sampling

If a free product layer is identified, it will be measured using an interface probe. Initially, the indicator probe will be lowered into each monitoring well or temporary piezometer without touching the probe to the well/piezometer casing until the alarm sounds and/or the indicator light illuminates. The probe will then be withdrawn several feet and slowly lowered again until the liquid surface is contacted as noted by the alarm and/or indicator light. Different alarms are used for product and water contact. If the meter indicates that a product layer is not present, water level measurements are conducted as described in Section 4.3.2. If the meter indicates a free product layer, continue lowering the meter until the alarm indicates the water interface. All probe cords used for measurement will be incrementally marked at 0.02-foot intervals. Water/product level measurements will be estimated to the nearest 0.01 foot based on the difference between the nearest probe cord mark to the top of the well/piezometer casing.

The distance between the top of casing and the groundwater surface will be recorded to within 0.01 foot. At temporary piezometer installations, the distance between the top of casing and the

surrounding ground surface will also be recorded to within 0.01 foot. The free product measurement procedure will be repeated two or three times to ensure that the measurements are consistent (plus or minus 0.01 foot). If this is the case, then the first measured level will be recorded. If this is not the case, the procedure will be repeated until consistent readings are obtained from three consecutive measurements.

4.1.4 Aquifer Testing

Aquifer testing will not be performed under this project.

4.1.5 Field Measurement Procedures and Criteria

Groundwater field measurements performed during the project will include measurement of pH, oxidation reduction potential, specific conductance, temperature, turbidity, and dissolved oxygen. A description of each field instrument, associated calibration requirements, and performance checks for field measurements is presented in Table 4.3. A summary of the procedures and criteria to be used for the measurement of field parameters of groundwater samples is presented below.

pH, Oxidation Reduction Potential, Specific Conductance, and Temperature

The pH, oxidation reduction potential, specific conductance, and temperature measurements will be recorded for groundwater during well development, well purging, and groundwater sampling. These measurements will be made using a combination meter designed to measure these parameters. Initially, a groundwater sample will be retrieved from each monitoring well or direct push sampler and immediately poured into a clean glass container placed onto a stable surface at the well or direct push. With the combination meter set in the pH mode, the meter electrode will be swirled at a slow constant rate within the sample until the meter reading reaches equilibrium. The sample pH will be recorded to the nearest 0.1 pH unit. The pH measurement procedure will be repeated, using a new sample each time, until the pH measurements are consistent (less than 0.2 pH units variation).

Upon completion of the pH measurement, ORP will be recorded for groundwater during groundwater sampling. The measurement will be performed using the combination meter switched to the millivolts (mV) mode. The ORP reading will be taken similarly as described for pH. Initially groundwater will be retrieved from each monitoring well or direct push sampler and immediately poured into a clean glass container placed on a stable surface at the well or direct push borehole. With the combination meter set in the mV mode, the Eh probe will be swirled at a slow constant rate until the meter reading reaches equilibrium. The sample Eh will be recorded to the nearest 10 mV. The oxidation reduction potential measurement will be repeated, using a new sample each time, until the Eh measurements are consistent (less than 20 mV variation).

Upon completion of the pH and oxidation reduction potential measurement, conductivity and temperature measurements will be made on a groundwater sample collected in the same manner as described above. With the combination meter set in the conductivity mode, the sample will be swirled with the temperature probe at a slow constant rate until the meter reading reaches equilibrium. The sample conductivity will be recorded to the nearest 10 $\mu\text{mhos/cm}$ and the temperature to the nearest 0.1 °C. The conductivity and temperature measurement procedure will be repeated, a minimum of three times using a new sample each time, until the measurements are consistent (less than 10 percent variation for conductance and less than 0.5 °C variation for temperatures).

Dissolved Oxygen

The dissolved oxygen measurements will be recorded for groundwater during groundwater sampling. The measurements will be made using a probe lowered into the monitoring well and swirled at a constant rate until the meter reading reaches equilibrium. The sample dissolved oxygen will be recorded to the nearest 0.01 ppm. The dissolved oxygen measurement procedure will be repeated until the dissolved oxygen measurements are consistent (less than 0.02 ppm variations).

Turbidity

Turbidity will be recorded during groundwater sampling using a turbidimeter. The turbidimeter will be calibrated with the referenced standard prior to measuring turbidity of groundwater collected from each monitoring well or direct push sample. Groundwater will be retrieved from each monitoring well and direct push sampler and immediately poured into the turbidimeters sample cuvette. The groundwater sample turbidity will be measured to the nearest 0.05 NTUs.

Headspace Gas Concentration

Headspace gas concentration measurements will be made using a field organic vapor meter (OVM). Initially, each groundwater sample collected will be placed into a glass jar, leaving some air space, and the jar will be covered with plastic cling wrap or aluminum foil to create an air-tight seal. The sample will be allowed to volatilize for a minimum of 15 minutes. The sealed jar will then be punctured with the OVM probe and headspace gas drawn until the meter reading is stable. The concentration of the headspace gas will be recorded to the nearest 0.1 ppm.

4.1.6 Groundwater Sampling Methods—General

Groundwater Sampling from Direct Push Borings

Collection of groundwater samples from direct push (Hydropunch-II, or similar device) boreholes will be accomplished using direct push samplers. The direct push drive point will be driven to a depth of approximately 5.0 feet below the water table or desired depth. The sampler will then be opened for the infiltration of groundwater. Groundwater retrieval will be similar as described previously. The direct push sampler will then be driven in intervals of 10 feet and the sampling repeated. Vertical extent groundwater sampling will be performed to a maximum of 50 feet or the Hawthorn clay layer.

The VOC groundwater sample volume obtained initially will be used for laboratory chemical testing for VOC. Sample volumes obtained subsequently will be used for field parameter measurements. Groundwater samples for VOC will be transferred directly into laboratory sample container from the sampler. Immediately after collection of the sample and completion of sample container label information, the container will be placed into an ice-filled cooler to ensure preservation. The remaining groundwater sample or additional sample collected will be used for measurement of field parameters.

Groundwater Sampling from Monitoring Wells

Collection of groundwater samples from monitoring wells will be accomplished in three general steps: (1) well purging, (2) measurement of field parameters, and (3) groundwater sample collection. All of the activities will not be initiated any sooner than 14 days after completion of monitoring well

development. Purging and sampling of monitoring wells will be accomplished using a decontaminated nondedicated low flow bladder pump, or similar.

The inlet of the sampling pump will be placed at the mid-point of the screened interval. This level will be adjusted for wells where the static water level is within the well screen. Prior to installation of the sampling pump, the static water level will be recorded. Purging and sampling activities may not begin until either the static water level returns to within 10 percent of the initial static water level or 12 hours have passed since installation of the pump, whichever occurs first.

Micropurging techniques will be used in all wells to minimize the volume of purge water, disturbance of the aquifer, and samples. The field parameters, pH, conductivity, temperature, dissolved oxygen, ORP, and turbidity will be monitored during micropurging. The purge rate will be adjusted, as necessary, to avoid purging any well to dryness and to equal the recharge of the aquifer. Purging will be considered complete when the field parameters stabilize within plus or minus 10 percent after a minimum of three readings at 5-minute intervals.

Sampling of the monitoring well will begin immediately after completion of purging. The groundwater sample volume obtained initially will be used for laboratory chemical testing. All groundwater samples will be transferred directly into laboratory sample containers from the sampler. The portion of the sample designated for volatile organic analysis will be poured into laboratory sample containers first, followed by pouring of the remaining sample portion into containers designated for other types of chemical analyses. Sample containers designated for volatile organic analysis will be filled so that no headspace is present in the containers. Immediately after collection of samples and completion of sample container label information, each container will be placed into an ice-filled cooler to ensure preservation.

4.1.7 Groundwater Sampling Methods—Filtration

Filtered groundwater samples will be collected using the same procedures as for unfiltered samples. Filtering of groundwater samples will be performed in the field by attaching a 0.45 μ filter to the end of the low-flow pump sampling line.

4.1.8 Sample Containers and Preservation Techniques

This section describes the recommended sample containers and preservatives required for the collection and preservation of groundwater samples. The specific containers and preservatives are listed in the QAAP. Actual sample volumes required by the subcontract laboratory may differ from these recommended volumes. Sample containers listed are the minimum type sample containers recommended for each analysis. These containers may be upgraded to the next level container based on availability. Container types progress from high density polyethylene (HDPE) to clear glass up to amber glass.

4.1.9 Field Quality Control Sampling Procedures

Three different types of field QC samples will be collected or used during performance of groundwater sampling activities. These sample types will be duplicates, rinsate blanks, and trip blanks.

QC Duplicate Samples

QC duplicate groundwater samples will be collected using the same procedure described for groundwater samples.

QC Rinsate Samples

QC rinsate blanks will be collected from the bailers and/or pumps used to collect groundwater samples from soil boreholes and monitoring wells. Each of these blanks will be collected after decontamination of the sampling devices. The blanks will be collected by pouring ASTM Type I or equivalent water over and into the device, and collecting the water directly into appropriate sample containers. Sample containers designated for volatile organic analysis will be filled so that no headspace is present in the containers.

QC and QA Trip Blank Samples

QC and QA trip blanks used for the project will consist of sealed containers of ASTM Type II or equivalent water. One QC or QA trip blank will be placed into the cooler used to store groundwater sample containers designated for volatile organic analysis. The blank will remain in the cooler until groundwater sampling at the site is completed, and will be shipped off site within the cooler for chemical analysis by the contracted laboratory.

QA Split Samples

QA split samples of groundwater will be collected and sent to the government QA laboratory assigned by the USACE-Savannah District for the project. The QA split samples will be collected using the same procedure described for groundwater sampling.

4.1.10 Equipment Decontamination

Decontamination of equipment used for the development and purging of monitoring wells and collection of groundwater samples will be conducted between samples. The decontamination area will be designed so that all decontamination liquids are contained and can be recovered for disposal as IDW. Nondedicated equipment will be decontaminated after each use. The procedure for decontamination of this type equipment will be as follows:

- (1) Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
- (2) Rinse thoroughly with approved potable water.
- (3) Rinse thoroughly with ASTM Type I or equivalent water.
- (4) Rinse thoroughly with isopropyl alcohol.
- (5) Rinse thoroughly with ASTM Type I or equivalent water.
- (6) Place equipment on clean plastic if immediate use is anticipated, or wrap in plastic or aluminum foil to prevent contamination if longer-term storage is required.

In addition to the sampling equipment, field measurement instruments will also be decontaminated between uses. Only those portions of each instrument that come into contact with potentially contaminated environmental media will be decontaminated. Because of the delicate nature of these instruments, the decontamination procedure will only involve initial rinsing of the instrument probes with approved water, followed by a final rinse using ASTM Type I or equivalent water.

4.2 SUBSURFACE SOIL

4.2.1 Rationale

At each of the 16 former UST sites, subsurface soil samples will be collected in a discrete manner from direct push sampling devices (i.e., Geoprobe or similar). At each site, direct push borings will be located in, or immediately adjacent to, each of the former tank pits and around the perimeter of the former tank site. If installing monitoring wells, soil boreholes will be advanced down to the water table using the hollow-stem auger drilling method. All auger drilled soil boreholes drilled will be advanced using 4.25-inch inside diameter hollow-stem augers. These 4.25-inch augers will be used because they are of sufficient diameter to accommodate the split-barrel samplers needed for sample collection, construct 2-inch monitor wells, and minimize the overall quantity of IDW generated during the project.

The rationale for use of these collection methods includes the following:

Direct Push Technology

- The direct push method will allow for the collection of soil samples for screening purposes to determine extent of soil contamination.
- The direct push method will allow for the retrieval of representative samples from a discrete depth interval without generation of IDW.

Auger Drilling Method

- The hollow-stem auger method will allow for the collection of relatively undisturbed samples.
- The hollow-stem auger method will allow for retrieval of representative samples from all borehole depth intervals.
- The hollow-stem auger method will minimize potential cross-contamination because the augers will not be withdrawn until all sampling within a borehole is completed.
- The hollow-stem auger method will allow for the installation of permanent monitoring wells in an efficient and accurate manner.

4.2.1.1 Direct Push and Soil Boring Locations

There are 16 sites being investigated as part of this project, and at each site, soil samples will be collected using direct push (Hydropunch-II or equivalent equipment) technology. A summary of the soil sampling and analytical requirements is provided on Table 4.4.

**Table 4.4. Summary of Soil Sampling and Analytical Requirements for the CAP-Part A
UST Site Investigations at HAAF, Georgia**

Site Name	Soil Borings	Analytical Soil Samples Per Boring	Headspace Analysis	Soil Analysis				
				VOC ¹	PAH ²	TPH (GRO) ³	TPH (DRO) ⁴	Geotechnical ⁵
Initial Groundwater Investigation Sites								
BLDG 1336, Tank 111	2	2	Each Sample	4	4	4	4	0
BLDG 1327, Tank 110	2	2	Each Sample	4	4	4	4	0
BLDG 8629, Tank 104	2	2	Each Sample	4	4	4	4	0
BLDG 1346, Tank 108	2	2	Each Sample	4	4	4	4	0
BLDG 8570-2, Tank X	2	2	Each Sample	4	4	4	4	0
BLDG 8571, Tank X	2	2	Each Sample	4	4	4	4	0
CAP-Part A Investigation Sites								
BLDG 8464, Tank 112	4	2	Each Sample	8	8	8	8	1
BLDG 1310, Tank 109	4	2	Each Sample	8	8	8	8	1
BLDG 8059, Tanks 27 & 28	5	2	Each Sample	10	10	10	10	1
BLDG 9002, Tank 116	4	2	Each Sample	8	8	8	8	1
BLDG 7002, Tank 117	4	2	Each Sample	8	8	8	8	1
BLDG 1327, Tanks 21 & 22	5	2	Each Sample	10	10	10	10	1
BLDG 725, Tank X	4	2	Each Sample	8	8	8	8	1
BLDG 850, Tanks A & B	4	2	Each Sample	8	8	8	8	1
BLDG 8582, Tank X	4	2	Each Sample	8	8	8	8	1
BLDG 8593-1,Tank X	4	2	Each Sample	8	8	8	8	1
GW Site	2	2	Each Sample	4	4	4	4	1
GW Site	2	2	Each Sample	4	4	4	4	1
Reserves								
To Be Determined	10	2	Each Sample	20	20	20	20	0
Total for Soil Investigation								
Subtotal (All Sites & Reserve)	68			136	136	136	136	12
QC Duplicates (10% of total) ⁶	0			14	14	14	14	0
QA Splits (10% of total) ⁷	0			14	14	14	14	0
Total Soil Activities	68			164	164	164	164	12

This Table is in conformance with EM 200-1-3.

¹ VOC - Volatile Organic Compounds, SW-846, EPA 8020

² PAH - Polynuclear Aromatic Compounds, SW-846, EPA 8270

³ TPH(GRO) - Total Petroleum Hydrocarbon Gasoline Range Organics, SW-846, EPA 8015 (5030)

⁴ TPH (DRO) - Total Petroleum Hydrocarbon Diesel Range Organics, SW-846, EPA 8015 (3550)

⁵ Geotechnical Analysis includes moisture content, grain size, bulk density, total organic carbon, hydraulic conductivity, and porosity.

⁶ QC - Quality Control

⁷ QA - Quality Assurance

The project scope requires that an initial groundwater investigation be conducted at six sites. At each site, two direct push soil borings will be located in or immediately adjacent to each of the former tank pits. Soil samples will be collected continuously during the installation of the borings. Direct push samples will be pushed from the ground surface down to the water table, collecting soil samples every 2 feet. Two soil samples will be collected from each boring and sent for off-site analysis. The project scope assumes that two of the groundwater investigation sites will require further investigation under the CAP-Part A investigation, which will require two additional direct push borings to be installed per site.

CAP-Part A investigations will occur at 10 sites, which will require one direct push boring to be located in or immediately adjacent to each of the former tank pits and three direct push borings to be located around the perimeter of the former tank site. Soil samples will be collected continuously during the installation of the borings. Direct push samples will be pushed from the ground surface down to the water table, collecting soil samples every 2 feet. Two soil samples will be collected from each boring and sent for off-site analysis. In addition, at each site, one geotechnical soil will be collected and analyzed by an off-site laboratory. The project scope allows for the option to install 10 reserve direct push soil borings to obtain additional data to assist in closing out a site.

During the drilling of each soil borehole for the installation of monitoring wells, soil samples will be collected with a split-barrel sampler continuously over 5.0-foot intervals from the ground surface to the water table. Upon retrieval of each soil sample interval, except in those cases where geotechnical samples are being collected, the soil core will be removed from the split-barrel sampler and split into two sections. A portion of each section will be used for field analysis of headspace gas and determination of soil classification and characteristics. The remaining portion of each section will be placed into separate sets of laboratory containers. Two samples from each boring will be sent to an off-site laboratory and analyzed for BTEX, PAH, and TPH-GRO and DRO.

For data quality, the QAAP contains details of the number and types of proposed QA/QC samples. In general, duplicate samples will be taken at a rate of 10 percent of the total number of samples, equipment rinsate samples will be taken at a rate of 5 percent, and trip blanks will be taken at a rate of one per cooler used to store portions of groundwater samples designated for volatile organic analysis. In addition, QA split samples will be collected for the USACE—Savannah District during performance of sampling activities at a rate of 10 percent.

The soil investigation activities to be conducted at each site along with the sampling locations are described below. The proposed sampling locations were chosen based on the field measurement data (FID/PID results) and analytical results presented in the ACE, Inc. site closure reports, guidance provided by the USACE, and the GA EPD. The proposed sampling locations are illustrated in figures presented in Appendix C.

Building 1336, Tank 111 (GW investigation site)

- Install two direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.1).
- Select two soil samples from each borehole and submit to off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- If the analytical results show that the site is not contaminated, the site will be closed.

- If the analytical results determine that contamination is present, further investigation will be required and two additional direct push borings and four additional samples will be collected and sent to an off-site laboratory for analysis.

Building 1327, Tank 110 (GW investigation site)

- Install two direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.2).
- Select two soil samples from each borehole and submit to off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- If the analytical results show that the site is not contaminated, the site will be closed.
- If the analytical results determine that contamination is present, further investigation will be required and two additional direct push borings and four additional samples will be collected and sent to an off-site laboratory for analysis.

Building 8629, Tank 104 (GW investigative site)

- Install two direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.3).
- Select two soil samples from each borehole and submit to off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- If the analytical results show that the site is not contaminated, the site will be closed.
- If the analytical results determine that contamination is present, further investigation will be required and two additional direct push borings and four additional samples will be collected and sent to an off-site laboratory for analysis.

Building 1346, Tank 108 (GW investigative site)

- Install two direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.4).
- Select two soil samples from each borehole and submit to off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- If the analytical results show that the site is not contaminated, the site will be closed.
- If the analytical results determine that contamination is present, further investigation will be required and two additional direct push borings and four additional samples will be collected and sent to an off-site laboratory for analysis.

Building 8464, Tank 112

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.5).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 1310, Tank 109

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.6).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 8059, Tanks 27 and 28

- Install five direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.7).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 9002, Tank 112

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.8).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).

- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 7002, Tank 117

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.9).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 1327, Tanks 21 and 22

- Install five direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.10).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 725, Tank X

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.11).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 850, Tanks A & B

- Install four direct push soil borings.
- Collect continuous soil samples using direct push technology (Figure C.12).
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 8582, No Assigned Tank No.

- Install four direct push soil borings (Figure C.13).
- Collect continuous soil samples using direct push technology.
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 8593-1, No Assigned Tank No.

- Install four direct push soil borings (Figure C.14).
- Collect continuous soil samples using direct push technology.
- Collect one geotechnical soil sample and submit to off-site laboratory for analysis (Table 4.4).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- Collect reserve soil samples, if necessary, to obtain additional data to assist in closing out the site.

Building 8570-2, No Assigned Tank No. (GW investigation site)

- Install two direct soil borings.
- Collect continuous soil samples using direct push technology (Figure C.15).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).

- If the analytical results show that the site is not contaminated, the site will be closed.
- If the analytical results determine that contamination is present, further investigation will be required and two additional direct push borings and four additional soil samples will be collected.

Building 8571, No Assigned Tank No. (GW investigation site)

- Install two direct soil borings.
- Collect continuous soil samples using direct push technology (Figure C.16).
- Select two soil samples from each borehole and submit to an off-site laboratory to be analyzed for BTEX, PAH, TPH-GRO and DRO (Table 4.4).
- If the analytical results that the site is not contaminated, the site will be closed.
- If the analytical results show determine that contamination is present, further investigation will be required and two additional direct push borings and four additional soil samples will be collected.

4.2.1.2 Sample Collection and Field/Laboratory Analysis

Soil Sampling with Direct Push

Soil samples to be submitted to an off-site laboratory for chemical analysis will be selected based on the results of the field headspace gas analysis. Each 2-foot section of soil material collected will undergo headspace gas analysis. All of the analysis results for each location will be evaluated and soil samples will be selected for analysis based on the following criteria:

- the 2-foot interval exhibiting the highest detected organic vapor concentration or
- the 2-foot interval above the water table.

Geotechnical Sampling

Geotechnical samples will be collected to characterize the soils and for evaluating site-specific transport conditions and the potential effectiveness of corrective action alternatives. One soil sample from each site will be analyzed for grain size distribution, moisture content, hydraulic conductivity, bulk density, porosity, and total organic carbon (Table 4.4). Geotechnical soil samples will be collected from one of the direct push borehole intervals representative of the soil material located between the ground surface and the water table. The sample will be collected from a two-foot interval using a Shelby tube sampler.

Soil Sampling with Auger Rig

Soil samples to be submitted to an off-site laboratory for chemical analysis will be selected based on the results of the field headspace gas analyses. Each 2.5-foot section of soil material collected from each borehole will undergo headspace gas analysis immediately after collection and the results recorded. After drilling of the borehole is completed, all of the analysis results will be evaluated and soil samples will be selected for chemical analysis based on the following criteria:

- 0 to 2 ft below ground surface,
- the 2.5-foot interval exhibiting the highest detected organic vapor concentration, or
- one foot above the saturated zone.

A summary of the subsurface soil samples and analytical parameters to be collected is presented in Tables 4.1. Information regarding the analytical testing methods to be performed on the groundwater samples is presented in the QAPP.

4.2.1.3 Background, QA/QC, and Blank Samples and Frequency

One type of QC samples will be collected during performance of subsurface sampling activities. This sample type will be duplicate samples. QC and QA trip blanks will not accompany subsurface soil samples designated for VOC analysis at the off-site laboratory.

QC Duplicate Samples

Duplicate samples will be collected along with subsurface soil samples. The borehole/monitoring well locations selected for duplicate sampling will be random. The total number will be at least 10 percent of the entire sample population. The QC duplicates will be analyzed for the same subsurface soil analytes listed in Table 4.4.

QA Split Samples

In addition to the QC samples described above, QA split samples will be collected for the USACE-Savannah District during performance of subsurface soil sampling activities for the installation of monitoring wells. QA split samples will be collected along with subsurface soil samples. The locations selected for QA split sampling will be random. The total number will be at least 10 percent of the entire sample population. The QA splits will be analyzed for the same subsurface soil analytes listed in Table 4.4.

A summary of the QA/QC subsurface soil sample types to be collected during the project is presented in Table 4.4. Information regarding the analytical testing methods to be performed on project QA/QC subsurface soil samples is presented in the QAPP.

4.2.2 Procedures

4.2.2.1 Direct Push Methods and Equipment

Soil samples will be collected through the use of direct push sampling techniques. These techniques will provide soil samples without the generation of soil cuttings. Direct push soil sampling equipment (e.g., Geoprobe or similar equipment) will be mounted on a drill rig or off-road, all terrain vehicle, if necessary. Decontaminated sampling tubes measuring 2-inches OD × 48 inches will be used for the installation of direct push holes for soil sample collection and temporary piezometer installation. The sampling tubes will be hydraulically pushed to the water table estimated to be approximately 10 to 20 feet. Disposable, thin-walled plastic (acetate), open-ended tube measuring 1.5-inches OD × 45 inches will be placed in the sampling tube to collect a soil sample. Soil samples will be collected continuously on 2.0 foot centers from ground surface to the water table for direct push locations within the investigation sites.

4.2.2.2 Drilling Methods

If warranted for future investigations, the hollow-stem auger drilling method will be used for drilling of soil boreholes for the installation of monitoring wells. This method will be implemented as a dry drilling method for the project. The augers used for drilling of boreholes for soil sample collection and groundwater monitoring will have a 4.25-inch inside diameter and will create an approximate 9.5-inch boring. During all borehole drilling, soil samples will be collected continuously on 5.0-foot centers from the ground surface to the water table.

Soil drilling using the hollow-stem auger method will be accomplished using truck-mounted CME-55 auger rigs, or equivalent, of sufficient size and power that will advance augers to the anticipated maximum drilling depth. The total depth of each borehole will be dictated by the depth where the water table is encountered. At selected locations, after the hollow-stem augers have been advanced to the water table at each borehole location, 2.0-inch PVC groundwater monitoring wells will be installed.

In the event that the borehole/monitoring well location is not accessible by vehicles, a portable hollow-stem auger rig, Mobile Drill Portable Minute Man, will be used. The augers used for drilling with this rig will have a 2.5-inch inside diameter and will create an approximate 6.5-inch borehole. During all boreholes being drilled with this portable rig, soil samples will be collected continuously using 2.0-foot centers from the ground surface to the water table.

4.2.2.3 Boring Logs

Each borehole log generated for the installation of a monitoring well during the project will fully describe the subsurface environment and the procedures used to gain that description. All boreholes will be recorded in the field by the site geologist on Engineer Forms 5056-R and 5056A-R (Figure 4.5). A scale of 1 inch equals 1.0 foot will be used during borehole log preparation. Each original borehole log will be submitted by SAIC to the USACE-Savannah District Project Manager. Original borehole logs will be of sufficient legibility and contrast so as to provide comparable quality in reproduction and will be recorded directly in the field without transcribing from a field book or other document.

All borehole logs generated during the project will routinely contain the following information:

- Unique borehole number and location denoted on a sketch map as part of the log.
- Depths or heights recorded in feet and decimal fractions thereof (tenths of feet).
- Field estimates of soil classification in accordance with the Annual Book of ASTM Standard, Volume 04.08, D2488 prepared in the field at the time of sampling by the site geologist.
- Full description of each soil sample collected, including the parameters noted in Table 4.4.
- Visual numeric estimates of secondary soil constituents and quantitative definitions of description terms (i.e., trace, some, several, etc.) recorded on the log.
- Description of disturbed samples (if used to supplement subsurface description) in terms of the appropriate soil parameters, to the extent practical. At a minimum, classification along with a description of drill action for the corresponding depth will be recorded. Notations will be made

on the log that these descriptions are based on observations of disturbed material rather than intact samples.

- Description of drilling equipment, including such information as auger size (ID and OD), bit types, compressor type, rig manufacturer, and model.
- Sequence of drilling activities.
- Any special problems encountered during drilling and their resolution.
- Dates and times for the start and completion of the borehole along with notation by depth for drill crew shifts and individual days.
- Each sequential boundary between various soil types and individual lithologies.
- The depth of first-encountered free water along with the method of determination.
- Interval by depth for each sample collected, including the length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).
- Total depth of drilling and sampling.
- Results of soil sample organic vapor headspace readings. Notation will include interval sampled, corresponding vapor readings, and key to the specific instrument used to obtain readings. A general note will be made on the log indicating the manufacturer, model, serial number, and calibration information for each instrument used.
- Definition of any special abbreviations used at the first occurrence of their usage.

4.2.2.4 Field Measurement Procedures and Criteria

Soil field measurements performed during the project will include the measurement of headspace gas for organic vapors. Organic vapors will be measured using a photoionization detector (PID) based OVM, calibrated daily with 100 ppm isobutylene. A summary of the procedures and criteria for soil sample field measurements is presented below.

Headspace gas concentration measurements will be made using a field OVM. Initially, each soil sample collected from a borehole will be placed into a glass jar, leaving some air space, and the jar will be covered with plastic cling wrap or aluminum foil to create an air-tight seal. The sample will be allowed to volatilize for a minimum of 15 minutes. The sealed jar will then be punctured with the OVM probe and headspace gas drawn until the meter reading is stable. The concentration of the headspace gas will be recorded to the nearest 0.1 ppm. All soil samples used for field measurements will be allowed to volatilize for an equal period of time before screening.

4.2.2.5 Sampling for Physical/Geotechnical Analyses

Soil samples for geotechnical analyses will be collected from boreholes using a thin-walled (Shelby) tube sampler device. Samples will be collected using this device as part of hollow-stem auger drilling or direct push installation of the boreholes. The Shelby tube sampler will be hydraulically pushed until approximately 2.0 feet of soil material is collected. Upon retrieval of the sampler, the

percentage of recovery will be recorded and the ends of the sampler will be sealed with wax or rubber packers to preserve moisture content. The preparation of Shelby tube samplers for shipment to an off-site laboratory for analysis will be conducted in accordance with ASTM Method D1587-83.

4.2.2.6 Sampling for Chemical Analyses

Soil samples for chemical analyses will be collected from boreholes using 5.0-foot split-barrel samplers (CME-55 drill rig or equivalent) or 2.0-foot split-barrel samplers. Samples will be collected using these samplers as part of hollow-stem auger drilling of the borehole installation. Upon retrieval of the sampling device, the contained soil core will be split into two lengthwise sections using a stainless steel knife. A portion of each section will be used for field measurements.

Samples designated for possible laboratory analysis will be collected from each section using a stainless steel spoon. The spoon will be run lengthwise down the core to collect a sample representative of the entire core section. The portion of the sample designated for volatile organic analyses will be placed into laboratory sample containers first, followed by placement of the remaining portion of the sample into the containers designated for other types of analyses. Sample containers designated for volatile organic analyses will be filled so that minimal headspace is present in the containers. No portion of the soil core that is in contact with the sampling device wall will be included in the sample collected for laboratory analysis.

Immediately after collection of each sample and completion of bottle label information, each sample container will be placed into an ice-filled cooler to ensure preservation. A clean split-barrel sampling device will be used to collect soil core from each interval of the project boreholes. Soil samples, which are not selected for laboratory analysis, will be disposed of as IDW.

4.2.2.7 Sample Containers and Preservation Techniques

This section describes the recommended sample containers and preservatives required for the collection and preservation of soil samples. These containers and preservatives are listed in Table 1.1 of the QAAP. Actual sample volumes required by the subcontract laboratory may differ from these recommended volumes. Sample containers listed are the minimum type sample containers recommended for each analysis. These containers may be upgraded to the next level container based on availability. Container types progress from HDPE to clear glass up to amber glass.

4.2.2.8 Field Quality Control Sampling Procedures

Two types of QA/QC samples will be collected or used during performance of soil sampling activities. These sample types will be duplicates and split samples.

QC Duplicate Samples

QC duplicate soil samples will be collected using the same procedure described for field sample collection.

QA Split Samples

QA split samples of soil will be collected and sent to the government QA laboratory assigned by the USACE-Savannah District for the project, and will serve as independent duplicates to check

analytical results generated by contracted laboratory. The QA split samples will be collected using the same procedure described for field sample collection.

4.2.2.9 Decontamination Procedures

Decontamination of equipment used for the collection of soil samples will be conducted between samples. The decontamination area will be designed so that all decontamination liquids are contained and can be recovered for disposal as IDW. Nondedicated equipment will be decontaminated after each use. The procedure for decontamination of this type equipment will be as follows:

- (1) Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.
- (2) Rinse thoroughly with approved potable water.
- (3) Rinse thoroughly with ASTM Type I or equivalent water.
- (4) Rinse thoroughly with isopropyl alcohol.
- (5) Rinse thoroughly with ASTM Type I or equivalent water.
- (6) Place equipment on clean plastic if immediate use is anticipated, or wrap in plastic or aluminum foil to prevent contamination if longer-term storage is required.

In addition to the sampling equipment, field measurement instruments will also be decontaminated between uses. Only those portions of each instrument that come into contact with potentially contaminated environmental media will be decontaminated. Because of the delicate nature of these instruments, the decontamination procedure will only involve initial rinsing of the instrument probes with approved water, followed by a final rinse using ASTM Type I or equivalent water.

4.3 CONCRETE CORING

4.3.1 Rationale

Concrete coring will be performed to provide drill rig access for soil sampling through the high strength concrete during the site investigations. All concrete coring will be performed using either a water-cooled pneumatic concrete corer or a water-cooled electric concrete corer. For locations where monitoring wells will not be installed, a 6-inch diameter core will be drilled through the concrete and an 8-inch diameter core will be drilled to a depth of 4.0 inches below the surface. This will provide a hole large enough to accommodate a Hydropunch II or similar technology system and will provide an adequate surface for the concrete patch to fasten to. For locations where monitoring wells will be installed, a larger diameter core may be required to accommodate the requirements of the surface completion.

The rationale for use of the concrete coring method includes the following:

- The concrete coring method will provide a clean cut through the concrete and a smooth surface to patch.

- The concrete coring method will allow the center core to remain in place until the soil sampling is performed.

4.3.1.1 Concrete Coring Locations

Concrete coring will be performed at soil boring and monitoring well locations that are located in concrete-covered areas. Actual locations will depend upon the surface cover of the final boring/monitoring well locations and may be altered due to the presence of underground utilities.

4.3.1.2 Discrete/Composite Sampling Requirements

No samples will be collected during the concrete coring.

4.3.1.3 Sample Collection and Field and Laboratory Analysis

No samples will be collected during the concrete coring.

4.3.1.4 Background/Upgradient, QA/QC, and Blank Samples and Frequency

No samples will be collected during the concrete coring.

4.3.2 Procedures

4.3.2.1 Coring Methods

The concrete coring will be performed using either a water-cooled pneumatic or electric drill. A tap will be inserted into the center of the core to allow for the removal of the concrete core. The cutting bit will be centered over the borehole/monitoring well location. The base of the drill will be anchored to the concrete to prevent movement during use. Following connection of the water line to the drill, a hole will be cut through the entire thickness of the concrete, approximately 10.0 inches in diameter. The diameter of this hole will be dependent upon whether a monitoring well will be installed in the locations or not. A second hole using a bit with a diameter at least 2.0 inches larger than the first hole will be drilled to a depth of 4.0 inches below the surface. This will provide a smooth support surface for the concrete patch.

4.3.2.2 Field Measurement Procedures and Criteria

Field measurements will not be required during concrete coring.

4.3.2.3 Sample Containers and Preservation Techniques

No samples will be collected during the concrete coring.

4.3.2.4 Field Quality Control Sampling Procedures

No samples will be collected during the concrete coring.

4.3.2.5 Decontamination Procedures

No decontamination of the concrete coring equipment will be required, as the equipment will not come in contact with the potentially contaminated material below the concrete.

5.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

5.1 FIELD LOGBOOKS

All information pertinent to drilling and sampling activities, including field instrument calibration data, will be recorded in field logbooks. The logbooks will be bound and the pages will be consecutively numbered. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all activities, individuals involved in drilling and sampling activities, date and time of drilling and sampling, weather conditions, any problems encountered, and all field measurements. Lot numbers, manufacturer name, and expiration dates of standard solutions used for field instrument calibration will be recorded in the field logbooks. A summary of each day's activities will also be recorded in the logbooks.

Sufficient information will be recorded in the logbooks to permit reconstruction of all drilling and sampling activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be kept in the possession of field personnel responsible for completing the logbooks, or in a secure place when not being utilized during field work. Upon completion of the field activities, all logbooks will become part of the final project evidence file. The title page of each logbook will be labeled with the following information:

- logbook title,
- project name,
- USACE-Savannah District contract number and project delivery order number,
- start date for field activities recorded in the logbook, and
- end date for field activities recorded in the logbook.

Entries recorded in logbooks will include, but not be limited to, the following information:

- name and title of author, date, and times of arrival at and departure from the work site;
- purpose of the drilling and/or sampling activity;
- name and address of the field contact(s);
- names and responsibilities of field crew members;
- names and titles of any site visitors;
- type, matrix, and containerization method for IDW generated;
- sample collection method;
- number and volume of sample(s) collected;
- location, description, and log of sampling point photographs;
- references for all maps and photographs of the sampling site(s);

- information regarding sampling changes, scheduling modifications, and change orders;
- information regarding drilling decisions, not recorded on the boring log;
- information regarding access agreements, if applicable;
- details of the sampling location, including a sketch map illustrating the sampling location;
- date and time of sample collection, and name of collector;
- field observations;
- types of field instruments used and purpose of use, including calibration methods and results;
- any field measurements made (e.g., pH, specific conductance, temperature, and static groundwater level);
- sample identification number(s);
- information from containers, labels of reagents used, deionized and organic-free water used, etc;
- sampling type and methodology, including distinction between grab and composite samples;
- sample preservation methods;
- sample distribution and transportation (e.g., name and address of the laboratory and courier);
- name and address of the government QA laboratory for the project and the associated project Laboratory Information Management System (LIMS) number;
- sample documentation information including:
 - chain-of-custody (COC) record numbers;
 - description of the number of shipping containers packaged (including contained COC records) and the shipping method employed (noting applicable tracking numbers);
- decontamination procedures;
- IDW documentation information including:
 - types of containers/drums;
 - contents, type, and approximate volume of waste;
 - type of contamination and predicted level of contamination based on available information;
- summary of daily task (including costs where appropriate) and documentation on any cost or scope or work changes required by field conditions; and
- signature and date entered by personnel responsible for observations recorded.

5.2 PHOTOGRAPHS

For each photograph taken during the project, the following items will be noted in the field logbook:

- date and time,
- photographer (name and signature),
- site name,
- aspect and description of the subject taken, and
- film roll number and sequential number of the photograph.

Photographs taken to document sampling points will include two or more permanent reference points within the photograph to facilitate relocating the point at a later date. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required.

5.3 SAMPLE NUMBERING SYSTEM

A unique sample numbering scheme will be used to identify each sample designated for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets and/or logbooks, COC records, and all other applicable documentation used during the project.

The sample numbering scheme used for field samples will also be used for duplicate samples so that these type samples will not be discernible by the laboratory. However, other types of field QC samples will be numbered so that they can be readily identified from other sample types. A summary of the sample numbering scheme to be used for the project is presented in Table 5.1

5.4 SAMPLE DOCUMENTATION

5.4.1 Sample Labels

Labels will be affixed to all sample containers during sampling activities. Information will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels will be as follows:

- contractor name,
- sample identification number,
- sample type (discrete or composite),
- site name and sampling station number,
- analysis to be performed,
- type of chemical preservative present in container,
- date and time of sample collection, and
- sampler's name and initials.

An example of the sample label to be used for this project is illustrated in Figure 5.1.

**Table 5.1. Sample Numbering Scheme for the CAP-Part A Investigations,
HAAF, Georgia**

Sample Identification: XXMLT#	
XX = Area Designator	Area designators used for the project will be the Tank #
	<u>Examples</u>
	111 = Tank 111
M = Sample Media	<u>Examples</u>
	1 = soil 2 = groundwater
L = Borehole/Sample Location	<u>Examples</u>
	1 = first sample location (i.e., subsurface soil, groundwater, etc.)
	2 = second sample location (i.e., subsurface soil, etc.)
T = Sample Type	<u>Examples</u>
	1 = Environmental Sample
	2 = Duplicate
	3 = QA Split
	4 = Rinsate Blank
	5 = Screening
# = Sample Number	<u>Sample number will be a sequential number</u>
	1 = first sample from borehole
	2 = second sample from borehole
All trip blank samples used during the project will be consecutively identified as follows: TB0001, TB0002, TB0003, etc.	
All IDW samples taken during the project will be consecutively identified as follows: WW0002, etc.	

SAIC	
SAMPLE NO.:	PROJECT NO.:
CONTENTS	
STATION:	
SAMPLE MEDIA:	
SAMPLE TYPE:	
ANALYSIS:	
PRESERVATIVE:	
RAD SCREEN:	VOLUME:
SAMPLE DATE/TIME:	UNITS:
COMMENTS:	
COLLECTOR'S INITIALS:	

Figure 5.1. Example of a Sample Label

5.4.2 Sample Field Sheets and/or Logbook

Each field team will have a field logbook that will contain, at a minimum, a table of contents, task team activity log sheets, and sample log sheets or other applicable sheets depending on the logbook activity. Each field logbook will consist of bound forms that have been devised based on this Sampling and Analysis Plan. The logbooks will be completed by the field personnel during sampling or other field activities. The sample log/field sheets will contain the following information:

- project name or identification,
- names and affiliations of sample collector,
- instrument measurements,
- sample identification numbers,
- date and time of sample collection,
- method of sample collection and deviations from the sample procedure, and
- analyses required.

The sample field/log sheet will also act as the field COC form for each sample collected until the samples are transferred to the laboratory COC form for shipment.

5.4.3 Chain-of-Custody Records

COC procedures implemented for the project will provide documentation of the handling of each sample from the time of collection until completion of laboratory analysis. The COC form serves as a legal record of possession of the sample. A sample is considered to be under custody if one or more of the following criteria are met:

- (1) The sample is in the sampler's possession.
- (2) The sample is in the sampler's view after being in possession.
- (3) The sample was in the sampler's possession and then was placed into a locked area to prevent tampering.
- (4) The sample is in a designated secure area.

Custody will be documented throughout the project field sampling activities by the COC form initiated for each day during which samples are collected. This record will accompany the samples from the site to the laboratory and will be returned to the SAIC Laboratory Coordinator with the final analytical report. All personnel with sample custody responsibilities will be required to sign, date, and note the time on the COC form when relinquishing samples from their immediate custody (except in the case where samples are placed into designated secure areas for temporary storage prior to shipment). Bills of lading or airbills will be used as custody documentation during times when the samples are being shipped from the site to the laboratory, and they will be retained as part of the permanent sample custody documentation.

COC forms will be used to document the integrity of all samples collected. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, COC forms will be filled out for sample sets as determined appropriate during the course of field work. An example of the COC form to be used for the project is illustrated in Figure 5.2. The following information will be recorded on all COC forms:

- sample number (for each sample in shipment);
- collection date and time (for each sample in shipment);
- number of containers for each sample;
- sample description (i.e., environmental medium);
- analyses required for each sample;
- sample preservation technique(s);
- COC or shipment number;
- USACE LIMS number (only on COC records for government QA sample shipments);
- shipping address of the laboratory;
- date, time, method of shipment, courier, and airbill number; and
- spaces to be signed as custody is transferred between individuals.

The individual responsible for shipping of the samples from the field to the laboratory will be responsible for completing the COC form and noting the date and time of shipment. This individual will also inspect the form for completeness and accuracy. In addition, this individual is responsible for determining the shipping classification for samples under U.S. Department of Transportation (DOT) HM126F. After the form has been inspected and determined to be completed satisfactorily, the responsible individual will sign, date, and note the time of transfer on the form. For commercial couriers, the COC form will be placed in a sealable plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. For laboratory couriers, the COC form will be placed in a sealable plastic bag on the top of the cooler for the courier to accept custody. The field copy of the form will be appropriately filed and kept at the site for the duration of the site activities.

In addition to the COC form, COC seals will also be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers in such a manner that if the cooler is opened, the seals will be broken. The COC seals will be used to ensure that no sample tampering occurs between the time the samples are placed into the coolers and the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the COC form contained within the cooler.

5.4.4 Cooler Receipt Checklist

The condition of shipping coolers and enclosed sample containers will be documented upon receipt at the analytical laboratory. This documentation will be accomplished using the cooler receipt checklist presented in Figure 5.3. One of these checklists will be placed either into each shipping cooler along with the completed COC form or provided to the laboratory at the start of the project. A copy of the checklist will be faxed to the SAIC Project Manager immediately after it has been completed at the laboratory. The original completed checklist will be transmitted with the final analytical results from the laboratory.

5.5 DOCUMENTATION PROCEDURES

The tracking procedure to be utilized for documentation of all samples collected during the project will involve the following series of steps:

- (1) Collection and placement of samples into laboratory sample containers as defined in Section 4.0.

- (2) Completion of sample container label information as defined in Section 5.4.1.
- (3) Placement of sample containers into an ice-filled cooler.
- (4) Completion of sample documentation information in the field logbook as defined in Section 5.1.
- (5) Completion of project and sampling information sections of the COC form(s) as defined in Section 5.4.3 for all samples to be transported in a single cooler.
- (6) Completion of the airbill for the cooler to be shipped.
- (7) Performance of a completeness and accuracy check of the COC form(s).
- (8) Completion of the sample relinquishment section of the COC form(s) as defined in Section 5.4.3 and placement of the form(s) into or on the cooler.
- (9) Placement of COC seals on the exterior of the cooler as defined in Section 5.4.3.
- (10) Packaging and shipment of the cooler to the laboratory as defined in Section 6.0.
- (11) Receipt of cooler at the laboratory, inspection of contents, and transmittal via fax of contained COC form(s) and cooler receipt form(s) as defined in Section 5.4.4.
- (12) Transmittal of original COC form(s) with final analytical results from laboratory.

5.6 CORRECTIONS TO DOCUMENTATION

All original information and data in field logbooks, on sample labels, on COC forms, and on any other project-related documentation will be recorded in black waterproof ink and in a completely legible manner. Errors made on any accountable document will be corrected by crossing out the error and entering the correct information or data. Any error discovered on a document will be corrected by the individual responsible for the entry. Erroneous information or data will be corrected in a manner that will not obliterate the original entry, and all corrections will be initialed and dated by the individual responsible for the entry.

6.0 SAMPLE PACKAGING AND SHIPPING

6.1 SAMPLE PACKAGING

Sample containers will be packaged in thermally insulated, styrofoam coolers that will be sealed and placed into heavy cardboard shipping boxes, or in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with applicable DOT specifications. Packaging and shipping procedures to be utilized for environmental and IDW samples collected during the project will include the following:

- Sample containers will be adequately identified with sample labels placed onto each container.
- All bottles, except those containing samples designated for volatile organic analyses, will be taped shut with electrical tape.
- Each sample bottle will be placed into a separate plastic bag that will then be sealed. For groundwater samples, each volatile organic analyte vial will be wrapped in paper towel and the vials placed into one plastic bag. Trip blank containers will be wrapped and placed in the bag with the volatile organic analyte vials. As much air as possible will be squeezed from the sample container bags before sealing.
- All of the sample containers will be placed upright in the shipping coolers along with wet ice or chemical ice in double plastic bags that will be placed around, among, and on top of the sample containers. For laboratory provided couriers the ice may be contained in single plastic bags. Before initial placement of samples into a rigid-body cooler, the cooler drain plug will be taped shut from both the inside and outside, and the cooler will be lined with a large plastic bag.
- Inert packing material will be placed into the cooler, if required, to prevent shifting of the sample containers during transport.
- All required laboratory paperwork, including the COC form(s), will be placed inside a plastic bag and taped to the inside of the cooler lid. If a laboratory provided courier is used, the paperwork may be attached to the outside of the cooler to facilitate exchange of sample custody.
- Upon completion of the packing process, the cooler lid will be closed and two signed/dated custody seals will be placed on the cooler, one across the front and one across the side.
- The styrofoam coolers will be placed into heavy cardboard shipping boxes that will be sealed with strapping tape. Rigid-body coolers will be sealed by applying strapping tape directly to the cooler body.
- The airbill for the shipment will be completed and attached to the top of the shipping box/cooler, which will then be transferred to the courier for delivery to the laboratory.

The checklist presented in Figure 6.1 will be used by the individual responsible for packaging environmental samples to verify completeness of sample shipment preparations. In addition, the laboratory will document the condition of the environmental samples upon receipt. This documentation will be accomplished using the cooler receipt checklist discussed in Section 5.1.4.

SAMPLE PACKAGING CHECKLIST

ATTN: Failure to properly handle or document the project sample could jeopardize the useability of the sample results and ultimately the project objectives. Prior to sending this cooler to the analytical laboratory at the address indicated on the COC form, please check the following items:

- Is the project clearly identified on the COC form (including the USACE delivery order number)?
- Are all enclosed sample containers clearly labeled with waterproof (permanent) ink?
- Are the required analyses indicated on the bottle labels and COC form, and are the metals to be analyzed individually noted on the COC form?
- Does the information on the COC form match the information on the sample container labels?
- Has the COC form been placed into a plastic bag and attached to the inside of the cooler lid?
- Have the samples been properly preserved (acid or base and cooling to 4°C)?
- Is the client information, including point of contact and telephone number, complete on the COC form?
- Is there sufficient ice (double bagged in sealable plastic bags) in the cooler to ensure preservation of the samples during shipment?

Figure 6.1. Sample Packaging Checklist

6.2 SAMPLE SHIPPING

All environmental samples collected during the project will be shipped no later than 48 to 72 hours after the time of collection. The latter time of 72 hours may be necessary if the samples are collected on a Friday and have to be shipped on a Monday via commercial courier. During the time period between collection and shipment, all samples will be stored in ice-filled coolers or refrigerated and maintained in a secure area. All coolers containing environmental samples will be shipped overnight to the laboratory by Federal Express, similar courier, or laboratory courier. Due to holding time limitations, SAIC will discourage the shipping of samples on Fridays unless it is absolutely necessary and the laboratory has assured SAIC that personnel will be present on Saturdays to receive and effect any necessary processing within the holding time.

6.3 ANALYTICAL LABORATORIES

The analytical laboratory contracted by SAIC for the project will be General Engineering Laboratories (GEL), 2040 Savage Road, Charleston, South Carolina, 29414, (803) 556-8171. This laboratory is currently approved by the USACE-Missouri River Division to perform the analytical methods required for the project. Environmental samples, associated QC samples, and IDW samples collected during the project investigations will be submitted to GEL for chemical testing. A summary of the specific chemical analyses and associated testing methods for each sample type to be collected is presented in Table 3.3 of the QAPP.

The government QA laboratory designated by the USACE-Savannah District for the project will be the South Atlantic Savannah (SAS) Laboratory, 611 South Cobb Drive, Marietta, Georgia 30060. The point of contact at the SAS Laboratory for the project will be Blais Willis (770) 919-5295. Environmental QA split samples collected during the project will be submitted to the SAS Laboratory for analysis of the same chemical constituents as those for the primary field samples. The SAS Laboratory will be responsible for proper implementation of chemical analysis methods and procedures for QA split samples. Therefore, these methods and procedures are not addressed in the QAPP.

7.0 INVESTIGATION-DERIVED WASTE

During the performance of field investigation activities at HAAF, IDW will be managed in accordance with Resource Conservation and Recovery Act (RCRA) requirements and the U.S. Environmental Protection Agency (EPA) IDW policy. IDW includes all materials generated during performance of an investigation that cannot be effectively reused, recycled, or decontaminated in the field. IDW consists of materials that could potentially pose a risk to human health and the environment (e.g., sampling and decontamination wastes) and materials that pose no risk to human health and the environment (e.g., sanitary solid wastes). The types of IDW anticipated to be generated during the field activities are (1) soil cuttings, (2) residual soil samples, (3) monitoring well development and purge waters, (4) decontamination fluids, and (5) noncontaminated compactible and miscellaneous trash.

All soil cuttings generated from the use of Hydropunch II or similar technology, hollow-stem augering of soil borings and monitoring wells, monitoring well development and purge water, and decontamination fluids will be collected and drummed/contained. Analytical results from the field soil and groundwater samples submitted for laboratory analysis will be used for waste characterization of soil cuttings and monitoring well development/purge water. Characterization of decontamination fluids generated during the project will be accomplished through sampling and analysis of the decontamination fluids.

Soil and groundwater sample results will be reviewed by SAIC and a recommendation sent to the USACE-Savannah District as to whether any drummed soil cuttings or monitoring well development/purge waters are considered potentially hazardous. The USACE-Savannah District will then determine what waste is hazardous and notify SAIC of this decision. SAIC will, as soon as possible after the USACE-Savannah District determination, label any hazardous waste drums.

7.1 IDW COLLECTION AND CONTAINERIZATION

7.1.1 Types of Waste

Indigenous IDW generated during the project will include soil cuttings from boreholes, sediment from dredge sampling, and groundwater from development/purging of monitoring wells. Nonindigenous IDW generated will include solid compactible trash [expendable sampling materials, disposable personal protective equipment (PPE), etc.], decontamination solutions (water/isopropyl alcohol and water/soap) from the decontamination of equipment, and possibly sludge (water/soil) from the cleaning of equipment in the equipment decontamination area.

7.1.2 Waste Collection and Containment

7.1.2.1 Soil Wastes and Drill Cuttings

All soil wastes and drill cuttings will be segregated by borehole and drummed at the point of generation. The drummed wastes will then be transported to a staging area established for the project and temporarily stored in accordance with requirements defined in Section 7.3 until the waste is transferred for final disposal.

7.1.2.2 Personal Protective Equipment and Sanitary Waste

Used PPE and sanitary waste that are noncontaminated will be placed in trash bags at point of generation. These bags of sanitary PPE and waste will be collected in lined, sanitary trash cans (30 gallons) with lids. PPE and sanitary waste visibly contaminated will be placed in a new 55-gallon DOT Specification 17C open-top drum at the point of generation. The drummed wastes will then be transported to the staging area and temporarily stored in accordance with requirements defined in Section 7.3 until the waste is transferred for final disposal. Prior to the placement of any PPE into trash bags or drums, the PPE will be torn/cut in such a manner as to render it unusable.

7.1.2.3 Groundwater and Decontamination Water Waste

Water derived from decontamination activities and monitoring well development/sampling activities will be segregated from each other and placed in polyethylene tanks or other temporary containment vessels. Monitoring well development and purge water will be placed into temporary containment vessels at the point of generation. These vessels will then be transported to the staging area and placed into the polyethylene tanks used to contain well development and purge waters. In the event that free petroleum product is encountered during the development and/or purging of a monitoring well, this waste will be segregated and stored separately from other purge/development water at the staging area.

7.1.2.4 Excess Sample/Sludge Waste

Excess quantities of soil samples used for measurement of field parameters will be placed into the 55-gallon DOT Specification 17C drums used to contain the soil cuttings generated from the corresponding soil borehole. Excess quantities of groundwater samples used for measurement of field parameters during monitoring well development and sampling will be placed into temporary containment vessels at the point of generation. These vessels will then be transported to the staging area and placed into the polyethylene tanks used to contain well development and purge waters. Excess soil/sludge generated from decontamination of hollow-stem augers will be placed in a 55-gallon DOT Specification 17C open-top drum at the staging area. The drummed wastes will then be temporarily stored in accordance with requirements defined in Section 7.3 until the waste is transferred for final disposal.

7.1.3 Waste Minimization

To minimize the amount of wastes generated during the investigation, the indigenous, uncontaminated soil cuttings wastes will be returned to the area of origin after characterization has occurred. During project activities, waste generation will be minimized at all times to the greatest extent practicable. Waste will be minimized by limiting access to restricted areas, reuse and decontamination of equipment, and use of nonhazardous materials.

7.2 IDW CONTAINER LABELING

Drums containing the same type of waste will be grouped and placed on pallets (four drums to a pallet) within the staging area with labels clearly visible for identification and inspection. Only one size of drum will be placed on each pallet. Labels will be applied adjacent to, but not covering, the container's seam to allow for visual inspection of the seam. Labels will not be placed on the top of the container lid. If a container is not actively being used for waste accumulation, an "Empty" label will be affixed to the container and the container will be stored inverted. Poly tanks will be labeled

on opposite sides and easily visible for identification and inspection. Each poly tank will be labeled according to the type of waste that it contains (i.e., decontamination water or monitoring well water).

Drums will be staged in single rows of pallets with a minimum 3.0 feet of aisle space between each row for accessibility and with all labels clearly visible for inspection. All drums or other containers will be properly sealed when not in use and labeled in indelible, waterproof ink.

7.2.1 General Waste Labeling Requirements

Upon initial placement of IDW into a bag, drum, or poly tank, a "Waste Container Label" (Figure 7.1) will be affixed to the container with all required information recorded on the label.

7.2.2 Nonhazardous and Hazardous Waste Labeling Requirements

All IDW, with the exception of monitoring well development/purge waste containing free petroleum product, will be managed and labeled as nonhazardous waste until characterization and classification of the waste for disposal are completed in accordance with the requirements defined in Section 7.4. Prior to classification, the IDW Waste Container Label will state that analysis for the purposes of classification of the waste is in progress. Containers of IDW determined to be nonhazardous will be labeled in accordance with the general waste labeling requirements defined in Section 7.2.1.

Containers of IDW determined to be contaminated nonhazardous will be marked with a "Nonhazardous Waste" label (Figure 7.2) in addition to the general waste labeling requirements. Containers of IDW determined to be hazardous will be marked with a "Hazardous Waste" label (Figure 7.3) in addition to the general waste labeling requirements. Placement of "Nonhazardous Waste" and "Hazardous Waste" labels onto containers will be completed no later than 30 days after receipt of final analytical results used to characterize and classify the waste.

7.3 IDW FIELD STAGING

7.3.1 Staging Area Locations

The staging areas for project wastes will be established within an area or areas designated by the USACE-Savannah District and HAAF DPW prior to initiation of field activities. If possible, this location will have restricted access. SAIC will secure, to the greatest extent possible, the waste containers storage area to prevent unauthorized access.

7.3.2 Staging Area Descriptions

Special requirements for the staging areas will include sufficient space to stage all drums and tanks needed during the project. Labeling for these containers will follow requirements outlined in Section 7.2. The staging areas will be flagged or roped off, and applicable warning signs will be posted as needed. If required, materials identified as hazardous wastes will be transported to an approved storage area designated by the USACE-Savannah District and/or HAAF DPW, as applicable. All waste containers will be inspected to ensure container integrity and handled in a manner that is protective of human health and the environment.

All waste types generated at the various areas addressed during the project will be containerized as described in Section 7.1, and moved to a staging area within approximately 48 hours of

WASTE CONTAINER LABEL	
DRUM NUMBER	_____
CONTENTS	_____

SOURCE OF WASTE	_____
SOURCE LOCATION	_____
COMMENTS	_____

WASTE TYPE:	() LIQUID () SOLID
RESPONSIBLE ORGANIZATIONS:	
SAIC Project Manager	_____
Telephone Number	_____
USACE Project Manager	_____
Telephone Number	_____
GENERATION DATE(S)	_____

Figure 7.1. Example of a Waste Container Label

**NON-
HAZARDOUS
WASTE**

OPTIONAL INFORMATION:

SHIPPER _____

ADDRESS _____

CITY, STATE, ZIP _____

CONTENTS _____

NON-HAZARDOUS WASTE

CARLTON INDUSTRIES INC. LA GRANGE, IL 60138

Figure 7.2. Example of a Nonhazardous Waste Label

HAZARDOUS WASTE

**FEDERAL LAW PROHIBITS IMPROPER DISPOSAL
IF FOUND. CONTACT THE NEAREST POLICE, OR PUBLIC SAFETY
AUTHORITY, OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY**

GENERATOR INFORMATION:

NAME _____

ADDRESS _____ PHONE _____

CITY _____ STATE _____ ZIP _____

EPA / MANIFEST
ID NO. / DOCUMENT NO. _____ / _____

ACCUMULATION (See Below) EPA
START DATE _____ WASTE NO. (See Below) _____

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

EPA 128

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Accumulation Start Date - In a Satellite Accumulation Area, the date the container is filled and sealed for removal to a 90-Day Accumulation Area. In a 90-Day Accumulation Area, the date waste is first placed into the container.

EPA Waste No. - All applicable EPA waste code numbers.

Figure 7.3. Example of a Hazardous Waste Label

containerization. The wastes will remain within the staging area until characterization and classification are completed and/or approval for disposal is granted by the USACE-Savannah District and Fort Stewart DPW.

7.4 IDW CHARACTERIZATION AND CLASSIFICATION FOR DISPOSAL

7.4.1 Soil Wastes

Analytical data gathered from environmental soil samples will be used to characterize indigenous soil IDW generated during the project. The characterization resulting from these data will be submitted to USACE-Savannah District and/or HAAF for review and approval. If the investigation sample analytical data are insufficient for characterization of the containerized wastes, the wastes will be sampled and analyzed by SAIC for RCRA toxicity characteristic contaminants using the Toxicity Characteristic Leaching Procedure (TCLP).

Analytical data will be extrapolated to reflect TCLP values (i.e., $20 \times$ divisor rule for soils). Generator knowledge may be used to evaluate the media's potential for corrosivity, ignitability, and reactivity. Except for listed hazardous wastes, if analytical results indicate contaminant levels below 75 percent of TCLP, no additional analytical testing will be performed and the media will be considered nonhazardous. However, nonhazardous media may be considered contaminated. Analytical results will be used on a site-by-site basis to determine if media from a site should be classified as contaminated.

When analytical results indicate that elevated contaminant levels (i.e., greater than 75 percent of TCLP) are present, additional analyses will be performed. In these cases, composite samples will be taken for each specific generation location (i.e., soil borehole). Samples will be taken directly from the containers. The analytical suite to be run will be based on suspected contaminants and any prior available analytical data. Generator knowledge may be used to minimize the number of analytical tests required to adequately characterize the media. Soil waste will be considered hazardous if either of the following conditions are encountered: (1) contaminant concentrations exceed TCLP values and (2) soil is found to contain solvent-constituents associated with listed hazardous wastes known to have been generated at the facility. Soil wastes that are characterized as hazardous will be stored in accordance with 40 *CFR* 262.34 and 40 *CFR* 265 as referenced by the Georgia Hazardous Waste Management Act and Rules.

7.4.2 Excess Sludge Waste

As noted in Section 7.1.2.4, excess soil/sludge generated from decontamination of hollow-stem augers will be stored in 55-gallon open-top drums. Characterization of this material will be accomplished by extrapolating the analytical data from the individual locations and extrapolating to reflect TCLP values as described above. Based on these results, the contents of each drum will be classified according to the criteria presented in Section 7.4.1.

7.4.3 Liquid Waste

Analytical data gathered from grab samples collected directly from filled poly tanks will be used to characterize decontamination waters generated during the project. One sample will be collected from each filled poly tank and submitted to an off-site laboratory for analysis of VOCs, oil and grease, and

phenols. For characterization of purge/development water, analysis of the environmental data will be supplemental with composite samples analyzed for oil and grease and phenols.

The analytical data will be submitted to the HAAF DPW water engineer for evaluation. Based on this evaluation, the water engineer will determine if the waste can be released into the facility industrial wastewater treatment system. If this type of disposal is approved, the HAAF DPW will approve release of each poly tank contents on a case-by-case basis. SAIC will also notify and coordinate with the USACE-Savannah District and HAAF DPW of each proposed release prior to the release.

In the event that the HAAF DPW water engineer rejects the release of waste to the industrial wastewater treatment system, SAIC will transfer the contents of the subject poly tank into 55-gallon 17E closed-top drums and label the waste as contaminated nonhazardous.

Characterization of containers containing monitoring well development/purge water contaminated with free petroleum product will be conducted through sampling and analysis of this type of waste. One waste characterization sample will be collected from each drum and submitted for analysis of TCLP and hazardous characteristics (pH, corrosivity, ignitability, and reactivity). Based on these results, the water will be classified as either contaminated nonhazardous material or hazardous material. Liquid wastes that are characterized as hazardous will be stored in accordance with 40 *CFR* 262.34 and 40 *CFR* 265 as referenced by the Georgia Hazardous Waste Management Act and Rules.

7.4.4 Sanitary/PPE Waste

Sanitary and PPE waste generated during the project will be handled as noncontaminated (i.e., used) or contaminated nonhazardous (i.e., visibly contaminated) waste, as applicable. This type of waste will be considered non-contaminated if it did not come into contact with contaminated media (i.e., media exhibiting detectable headspace gas readings as measured during field screening) and no visible contamination is present, or if visible contamination is present but it can be removed by decontamination. In the event that contaminated media cannot be removed from the waste by decontamination, the waste will be considered to be contaminated nonhazardous. With the exception of the criteria noted above, no other characterization of sanitary and PPE waste will be conducted.

7.5 IDW SAMPLING

IDW will be characterized to determine the appropriate disposal requirements. For containerized soil and sludges, if contaminant levels exceed 75 percent of TCLP (as discussed in Section 7.9.1), composite samples will be taken from all drums related to that location. These samples will be analyzed for TCLP metals and hazardous characteristics.

For containerized decontamination fluids, grab samples will be collected from the poly tank. These samples will be analyzed for VOCs, oil and grease, and phenols.

For containerized well development/purging water, composite samples will be collected from each container storing these waters. This sample will be analyzed for oil and grease and phenols.

7.6 IDW DISPOSAL

7.6.1 Soil Waste

Soil cuttings will be managed as nonhazardous waste pending the results of analytical data. If analytical data establish that the soil is noncontaminated, the material will be transported from the staging area to the area of origin and spread on the ground. If analytical data indicate that the soil is contaminated nonhazardous or hazardous, the material will be disposed of off site in accordance with all applicable EPA, DOT, and state of Georgia regulations at a permitted landfill capable of accepting the waste. Containerized hazardous waste will be transported off site for disposal within 90 days of receipt of sample data indicating that the waste is hazardous.

7.6.2 Liquid Waste

All decontamination and monitoring well development/purge waters stored in poly tanks will be released on a regular basis during the course of field activities into the industrial waste water treatment system as approved by the HAAF DPW. The poly tanks will be transported to a disposal location designated by the USACE-Savannah District and HAAF DPW for liquid waste disposal. Release of liquid waste stored in poly tanks will not be conducted without benefit of prior analytical characterization.

With regard to decontamination and monitoring well development/purge waters transfer from poly tanks into 55-gallon closed-top drums (i.e., waste not approved for release into industrial waste water treatment system), and monitoring well development/purge water contaminated with free petroleum product and stored in drums, all of this material will be disposed of off site in accordance with all applicable EPA, DOT, and State of Georgia regulations at a permitted treatment facility capable of accepting the waste. Containerized hazardous waste will be transported off site for disposal within 90 days of receipt of sample data indicating that the waste is hazardous.

7.6.3 Sanitary/PPE Waste

Sanitary waste and PPE that are noncontaminated will be bagged and placed in a sanitary waste dumpster(s) specified for this use by USACE-Savannah District and HAAF DPW. However, prior to disposal of waste into dumpsters, SAIC will obtain written permission from the HAAF DPW for this activity. No free liquids or hazardous substances will be placed in the dumpster(s). In the event that use of Fort Stewart dumpsters is not approved for disposal of noncontaminated waste, SAIC will arrange for transportation of the waste off site for disposal. Contaminated nonhazardous waste of this type will be disposed of off site in accordance with all applicable EPA, DOT, and state of Georgia regulations at a permitted landfill capable of accepting the waste.

8.0 CONTRACTOR CHEMICAL QUALITY CONTROL PROGRAM

The Contractor Chemical Quality Control (CCQC) program to be utilized by SAIC for the project will consist of three phases. The three CCQC phases will be the preparatory phase, the initial phase, and the follow-up phase, all of which will be performed by SAIC whether or not a USACE-Savannah District representative is present. Several definable features of work will comprise the CCQC program and are identified below:

- soil sampling,
- sediment/surface water sampling,
- monitor well construction, and
- groundwater sampling.

8.1 PREPARATORY PHASE

The preparatory phase of the CCQC program will be conducted by the SAIC CQC Representative, in conjunction with SAIC and subcontractor field personnel, prior to beginning each definable feature of work. A summary of all activities performed during each preparatory phase meeting will be documented by the CQC Representative in a meeting minutes record.

Each preparatory phase meeting will address the following:

- Review of all pertinent sections of the project Work Plan in order to ensure that all field personnel are cognizant of the overall project data quality objectives, specific project activities to be accomplished, and specific sampling and analysis requirements.
- Review of calibration procedures for all instruments to be used for measurement of field parameters.
- Physical examination of all materials and equipment required to accomplish the specific project activities.
- Review of equipment decontamination procedures in accordance with project Work Plan requirements.
- Review of how each sample type is to be collected, containerized, documented, and packaged.
- Review of proper IDW management and documentation.
- Review of the procedure for completing all required information to be recorded on sample custody forms, and discussion of the project sample numbering system. Completed examples of a COC form, sample container label, and IDW drum label will be provided to the field personnel for reference.
- Review/discussion of any other activities to be performed as deemed necessary by the CQC Representative.

- Examination of the work area(s) to ascertain if all preliminary work is complete.
- Review of preparatory phase field equipment and support materials checklists. An example of the QA table that will be used to match up primary and QC samples is presented in Figure 8.1.

8.2 INITIAL PHASE

The initial phase of the CCQC program will be conducted by the CQC Representative and will include the following:

- Oversight of drilling, monitoring well installation, and/or sampling activities and review of this work to ensure compliance with delivery order requirements.
- Inspection of individual sample labels and COC forms for accuracy, completeness, and consistency.
- Inspection of sample packaging and shipping activities.
- Observation, verification, and documentation of initial and ongoing field instrument calibration.
- Inspection of field logbooks and other field records/sketches to assure that all pertinent data are recorded in accordance with delivery order requirements.
- Inspection of the QA sample match-up table to ensure that all samples collected during each day are documented properly.

8.3 FOLLOW-UP PHASE

The follow-up phase of the CCQC program will be conducted by the CQC Representative and will involve performance of the various activities noted for the initial phase on a daily basis until completion of the particular definable feature of work.

9.0 DAILY CHEMICAL QUALITY CONTROL REPORTS

During the field investigation activities performed for the project, SAIC will prepare Daily Quality Control Reports (DQCRs), which will be signed and dated by the SAIC CQC Representative. The contents of the Daily Chemical Quality Control Reports (DCQCRs) will be incorporated into the DQCR. An example of the DQCR format to be used by SAIC is illustrated in Figure 9.1. These reports will be submitted to the USACE-Savannah District Project Manager at the end of each work shift. The contents of each DQCR will include a summary of activities performed at the project site, weather information at the time of sampling, results of measurements made with field instruments, results of CQC activities performed including field instrument calibrations, departures from the approved Work Plan and its attachments, problems encountered during field activities, and any instructions received from government personnel. Any deviations that may affect the project data quality objectives will be immediately conveyed to the USACE-Savannah District Project Manager. The following will be attached to each DQCR as appropriate:

- the QA sample table that matches up primary and QA/QC samples collected,
- a summary of field-generated analytical results, and
- any other project-related forms utilized.

DAILY QUALITY CONTROL REPORT

COE PROJECT MANAGER _____
PROJECT _____
JOB NO. _____
CONTRACT NO. _____

DATE _____
DAY

S	M	T	W	TH	F	S
---	---	---	---	----	---	---

WEATHER	Bright Sun	Clear	Overcast	Rain	Snow
TEMP	To 32'	32-30'	30-70'	70-85'	85' up
WIND	Still	Moder.	High	Report No.	
HUMIDITY	Dry	Moder.	Humid		

SUB-CONTRACTORS ON SITE:

EQUIPMENT ON SITE:

WORK PERFORMED (INCLUDING SAMPLING):

Figure 9.1. Example of a Daily Quality Control Report

10.0 CORRECTIVE ACTIONS

10.1 SAMPLE COLLECTION AND FIELD MEASUREMENTS

Corrective actions will be implemented in the event that a discrepancy is discovered by field personnel, laboratory personnel, and/or during a field or desk audit. The initial responsibility for monitoring the quality of field activities and measurements lies with the field personnel. These personnel are responsible for following QA/QC procedures, while the SAIC CQC Representative is responsible for verifying that the procedures are being followed. This verification requires that the SAIC CQC Representative assess the correctness of the field methods and the ability of the field team to meet the QA objectives and to make a subjective assessment of the impact that a procedure has on the field objective and resulting data quality.

If a field problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or affect data quality, the first action taken will be an assessment of the severity of the problem by the SAIC CQC Representative. If the problem is determined to be minor, the SAIC CQC Representative will initiate an appropriate corrective action, which will be recorded in the field logbook and in a field change order (FCO). An example of the FCO form is illustrated in Figure 10.1. However, if the problem is determined to be significant or subject to reoccurrence, the SAIC CQC Representative will initiate an NCR that will be submitted to the SAIC QA/QC Officer. An example of the NCR form to be used for the project is illustrated in Figure 10.2. The SAIC QA/QC Officer will then propose and implement an appropriate corrective action as documented on the NCR.

The SAIC QA/QC Officer will be responsible for ensuring that corrective action for nonconformances are initiated by

- evaluating all reported nonconformances,
- controlling additional work on nonconforming items,
- determining disposition or action to be taken,
- maintaining a log of nonconformance,
- reviewing NCRs and corrective actions taken, and
- ensuring that NCRs are included in the project evidence file.

If appropriate, the SAIC CQC Representative or the QA/QC Officer will ensure that no additional work that depends on the nonconforming activity or instrument is performed until corrective actions are implemented.

10.2 LABORATORY ANALYSES

In the event that a laboratory problem occurs that might jeopardize the integrity of the project analytical results, cause a QA objective not to be met, or affect data quality, the first action taken will be an assessment of the severity of the problem by the SAIC Laboratory Coordinator. If the problem is determined to be minor, the SAIC Laboratory Coordinator will initiate an appropriate corrective action, which will be recorded in a memorandum submitted to the SAIC Project Manager. The SAIC Project Manager will then relate the corrective action to be implemented to the SAIC CQC Representative and/or SAIC QA/QC Officer if the problem is associated with activities being performed in the field. However, if the problem is determined to be significant or subject to reoccurrence, the SAIC Laboratory Coordinator will initiate an NCR that will be submitted to the

Field Change Request (FCR)			
FCR NO. _____		DATE INITIATED _____	
PROJECT _____			
CONTRACT NO. _____			
REQUESTOR IDENTIFICATION			
NAME _____		ORGANIZATION _____	
TITLE _____		PHONE _____	
SIGNATURE _____			
BASELINE IDENTIFICATION			
BASELINE(S) AFFECTED ☐ Cost ☐ Scope ☐ Milestone ☐ Method of Accomplishment			
AFFECTED DOCUMENT (TITLE, NUMBER AND SECTION) _____			
DESCRIPTION OF CHANGE: 			
JUSTIFICATION: 			
IMPACT OF NOT IMPLEMENTING REQUEST: 			
PARTICIPANTS AFFECTED BY IMPLEMENTING REQUEST: 			
COST ESTIMATE (\$) _____		ESTIMATOR SIGNATURE _____	
		PHONE _____ DATE _____	
PREVIOUS FCR AFFECTED ☐ YES ☐ NO; IF YES, FCR NO. _____			
CLIENT PROJECT MANAGER _____		DATE _____	
CLIENT QA SPECIALIST _____		DATE _____	
SAIC H&S MANAGER SIGNATURE (IF APPLICABLE) _____		DATE _____	

Figure 10.1. Example of a Field Change Order Form

NONCONFORMANCE REPORT	DATE OF NCR		NCR NUMBER	
	LOCATION OF NONCONFORMING ITEM			PAGE ____ OF ____
INITIATOR (Name/Organization/Phone)		FOUND BY		DATE FOUND
RESPONSIBLE ORGANIZATION/INDIVIDUAL				
DESCRIPTION OF NONCONFORMANCE				
A	INITIATOR	Date	QA/QC OFFICER	Date
				YES NO CAR REQ'D ☐ ☐
DISPOSITION, PROBABLE CAUSE AND ACTIONS TAKEN TO PREVENT RECURRENCE				
PROPOSED BY: _____				
B	NAME		Date	
VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL				
REINSPECT/RETEST REQUIRED ☐ YES ☐ NO IF YES: _____ Date Result ☐ ACCEPTABLE ☐ NOT ACCEPTABLE				
QUALITY ASSURANCE: _____				
C	NAME		Date	

Figure 10.2. Example of a Nonconformance Report

SAIC QA/QC Officer and addressed in the same manner as described in Section 10.1. All NCRs will be copied to the USACE-Savannah District Project Manager.

Laboratory personnel will be alerted that corrective actions may be necessary if one or more of the following conditions are encountered:

- QC data are outside the warning or acceptable windows for precision and accuracy.
- Blanks contain target analytes above acceptable levels.
- Undesirable trends are detected in spike recoveries or relative percent differences between duplicates.
- Unusual changes in detection limits are encountered.
- Deficiencies are detected during internal or external audits or from the results of performance evaluation samples.
- Inquiries concerning data quality are received.

10.3 FIELD VARIANCE SYSTEM

Procedures cannot fully encompass all conditions encountered during a field investigation. Variances from the operating procedures, field sampling plan, and/or safety and health plan may occur. All variances that occur during the project investigations will be documented on an FCO form or an NCR and will be noted in the appropriate field logbooks. If a variance is anticipated (e.g., because of a change in the field instrumentation), the applicable procedure will be modified and the change noted in the field logbooks. Field changes fall into three categories: (1) minor, (2) major, and (3) other, all of which are described below.

10.3.1 Minor Field Change

A minor field change is one that does not affect the objectives of the field sampling plan and may be approved by the SAIC Field Manager by noting the change in the appropriate field logbook. An example of a minor field change would be movement of a sampling point several feet from the originally defined location due to the presence of a subsurface obstruction.

Routine (minor) FCOs will be completed in the field and then routed to the SAIC Project Manager and SAIC QA/QC Officer for signature approval. A verbal approval from the USACE-Savannah District Project Manager or designee will be noted in the field logbook.

10.3.2 Major Field Change

A major field change is one that affects the field sampling objectives and/or schedule and may require GEPD approval. At a minimum, major field changes must be approved by the SAIC and USACE-Savannah District Project Managers prior to implementation. These changes may require alteration of the field sampling plan. An example of a major field change would be a decision to eliminate sampling points from the field investigation.

10.3.3 Other Field Change

The other field change falls between the minor and major field change definitions in that it significantly affects the field sampling plan without requiring a change to the plan. It is approved by the SAIC Project Manager and may require HAAF and/or GEPA approval. An example of the other field change would be a decision to change the number of samples collected at a given borehole location due to sampling difficulties.

As appropriate, regulatory agencies will be notified by the Fort Stewart Program Manager of any variances that significantly affect the scope and/or objectives of the project, and approval from the agencies will be obtained as necessary. Any variance from the safety and health plan will be approved by the SAIC Health and Safety Officer and the USACE-Savannah District Project Manager or designee. FCO forms will be maintained by the SAIC Field Manager until the field work is complete, at which time they will be forwarded to the SAIC Project Manager for inclusion in the project evidence file. Copies of the FCO forms will be sent to the USACE-Savannah District Project Manager as requested.

